PS3.3

DICOM PS3.3 ~~2020c~~2020d - Information Object Definitions

PS3.3: DICOM PS3.3 ~~2020c~~2020d - Information Object Definitions

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Foreword

This DICOM Standard was developed according to the procedures of the DICOM Standards Committee.

The DICOM Standard is structured as a multi-part document using the guidelines established in [ISO/IEC Directives, Part 2].

PS3.1 should be used as the base reference for the current parts of this Standard.

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1 Scope and Field of Application

This Part of the DICOM Standard specifies the set of Information Object Definitions (IODs) that provide an abstract definition of real-world objects applicable to communication of digital medical information. For each IOD, this Part specifies:

- any necessary information for the semantic description of the IOD
- relationships to associated real-world objects relevant to the IOD
- Attributes that describe the characteristics of the IOD

For each IOD, this Part does not specify:

- the nature of any Service Class Definition intended to reference the IOD
- the nature of any interactions that result in the usage of the IOD

This Part is related to other parts of the DICOM Standard in that:

- PS3.4 Service Class Specifications, specifies application level services by grouping DIMSE services with IODs as defined in this Part;
- PS3.5 Data Structure and Semantics, defines the data encoding used in the DIMSE Protocol when applied to IODs defined in this Part;
- PS3.6 Data Dictionary, contains an index by Tag of all IOD Attributes defined in this Part. This index includes the Value Representation and Value Multiplicity for each Attribute;
- PS3.7 Message Exchange Protocol, defines the DIMSE Services and Protocol that may be applied to IODs defined in this Part.

2 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibilities of applying the most recent editions of the standards indicated below.

2.1 International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC)

[ISO/IEC Directives, Part 2] ISO/IEC. 2016/05. 7.0. *Rules for the structure and drafting of International Standards*. http://www.iec.ch/members_experts/refdocs/iec/isoiecdir-2%7Bed7.0%7Den.pdf .

[ISO/IEC 2022] ISO/IEC. 1994. *Information technology - Character code structure and extension techniques*.

[ISO 3950] ISO. 2010. *Dentistry - Designation system for teeth and areas of the oral cavity*.

[ISO 7498-1] ISO. 1994. *Information Processing Systems - Open Systems Interconnection - Basic Reference Model*.

[ISO 7498-2] ISO. 1989. *Information processing systems - Open Systems Interconnection - Basic reference Model - Part 2: Security Architecture*.

[ISO/TR 8509] ISO. *Information Processing Systems - Open Systems Interconnection - Service Conventions. ISO/TR 8509 has been withdrawn. See ISO/IEC 2382-26:1993 Information technology - Vocabulary - Part 26: Open systems interconnection* .

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3 Definitions

For the purposes of this Standard the following definitions apply.

3.1 Reference Model Definitions

This Part of the Standard is based on the concepts developed in [ISO 7498-1] and [ISO 7498-2] and makes use of the following terms defined in them:

Application Entity (AE)	See [ISO 7498-1].
Service	See [ISO 7498-1].

3.2 Service Conventions Definitions

This Part of the Standard makes use of the following terms defined in [ISO/TR 8509]:

Primitive	See [ISO/TR 8509].

3.3 DICOM Introduction and Overview Definitions

This Part of the Standard makes use of the following terms defined in PS3.1:

Attribute	Attribute.
Command	Command.
Data Dictionary	Data Dictionary.
Message	Message.
Service-Object Pair Class (SOP Class)	Service-Object Pair Class (SOP Class).

3.4 DICOM Service Class Specifications

This Part of the Standard makes use of the following terms defined in PS3.4:

Real-World Activity	Real-World Activity.
Real-World Object	Real-World Object.
Service Class	Service Class.
Service Class User (SCU)	Service Class User (SCU).
Service Class Provider (SCP)	Service Class Provider (SCP).
Service-Object Pair Instance (SOP Instance)	Service-Object Pair Instance (SOP Instance).
Preformatted Grayscale Image	Preformatted Grayscale Image.
Preformatted Color Image	Preformatted Color Image.
Related General SOP Class	Related General SOP Class.

3.5 DICOM Data Structures and Encoding

This Part of the Standard makes use of the following terms defined in PS3.5:

Basic Offset Table (BOT)	Basic Offset Table (BOT).
Data Element	Data Element.
Data Element Tag	Data Element Tag.
Data Element Type	Data Element Type.
Data Set	Data Set.
Defined Term	Defined Term.
Enumerated Value	Enumerated Value.
Extended Offset Table (EOT)	Extended Offset Table (EOT).
Sequence of Items	Sequence of Items.
Unique Identifier (UID)	Unique Identifier (UID).

3.6 DICOM Message Exchange

This Part of the Standard makes use of the following terms defined in PS3.7:

DICOM Message Service Element (DIMSE)	DICOM Message Service Element (DIMSE).
DIMSE-N Services	DIMSE-N Services.
DIMSE-C Services	DIMSE-C Services.

3.7 DICOM Upper Layer Service

This Part of the Standard makes use of the following terms defined in PS3.8:

DICOM Upper Layer Service	DICOM Upper Layer Service.

3.8 DICOM Information Object

Acquisition Context	A description of the conditions present during data acquisition.
Acquisition Protocol Element	A sequential component of an acquisition protocol, that contains the SCANNING PARAMETERS necessary to perform a single SCAN. In the case of CT this would correspond to tube voltage, tube current, rotation time, spatial location, etc. and an Acquisition Protocol Element also corresponds to an XR-25 PROTOCOL ELEMENT.
Assertion	An affirmative statement or declaration by a specified entity about a specified or implied subject for a specified or implied purpose.
Attribute Tag	A unique identifier for an Attribute of an Information Object composed of an ordered pair of numbers (a Group Number followed by an Element number).
Basic Directory IOD	The Basic Directory Information Object Definition is an abstraction of the information to identify a File-set and facilitate access to the information stored in the files of a File-set based on key medical information.

Basic Directory Information Model	A model that defines the relationship between the various types of Directory Records that may be used in constructing DICOM Directories.
Cine Run	A set of temporally related frames acquired at constant or variable frame rates. This term incorporates the general class of serialography. Note A Cine Run is typically encoded as a multi-frame image.
Code Sequence Attribute	Attribute that (usually) includes the string "Code Sequence" in the Attribute Name and has a VR of SQ (Sequence of Items). Its purpose is to encode concepts using code values and optional text meanings from coding schemes. Section 8.1 through Section 8.8 specify the Attributes of which the Sequence Items (Attribute Sets) of Code Sequence Attributes are constructed.
Composite IOD	An Information Object Definition that represents parts of several entities in the DICOM Application Model. Such an IOD includes Attributes that are not inherent in the Real-World Object that the IOD represents but rather are inherent in related Real-World Objects.
Derived Image	An image in which the pixel data was constructed from pixel data of one or more other images (source images).
DICOM Application Model	An Entity-Relationship diagram used to model the relationships between Real-World Objects that are within the area of interest of the DICOM Standard.
DICOM Information Model	An Entity-Relationship diagram that is used to model the relationships between the Information Object Definitions representing classes of Real-World Objects defined by the DICOM Application Model.
Functional Group	A set of logically related Attributes that are likely to vary together. May be used in Multi-frame IODs to describe parameters that change on a per frame basis.
Information Entity	That portion of information defined by a Composite IOD that is related to one specific class of Real-World Object. There is a one-to-one correspondence between Information Entities and entities in the DICOM Application Model.
Information Object Definition (IOD)	A data abstraction of a class of similar Real-World Objects that defines the nature and Attributes relevant to the class of Real-World Objects represented.
Module	A set of Attributes within an Information Entity or Normalized IOD that are logically related to each other.
Multi-frame Image	Image that contains multiple two-dimensional pixel planes.
Normalized IOD	An Information Object Definition that represents a single entity in the DICOM Application Model. Such an IOD includes Attributes that are only inherent in the Real-World Object that the IOD represents.
Protocol Element	A sequential component of a protocol, consisting of all the parameters necessary to perform that component of the protocol.
~~Reconstruction Protocol Element~~ Reconstruction Protocol Element	A sequential component of a reconstruction protocol, such as generating CT thin images or multiplanar reformats.
Specialization	Specialization is the replacement of the Type, value range and/or description of an Attribute in a general Module of an IOD, by its Type, value range and/or description defined in a modality-specific Module of an IOD. Note The same Attribute may be present in multiple Modules in the same IOD but not specified to be "Specialized".

~~StorageProtocolElement~~Storage Protocol Element	A sequential component of a storage protocol, such as sending a Series of images to a PACS or an archive or a processing workstation.

3.9 Character Handling Definitions

This Part of the standard makes use of the following terms defined in [ISO/IEC 2022]:

Coded Character Set	See [ISO/IEC 2022].
Code Extension	See [ISO/IEC 2022].
Escape Sequence	See [ISO/IEC 2022].

3.10 Radiotherapy

This Part of the Standard is based on the concepts developed in [IEC 61217] and makes use of the following terms defined in it:

FIXED REFERENCE System	See [IEC 61217].
GANTRY System	See [IEC 61217].
BEAM LIMITING DEVICE System	See [IEC 61217].
WEDGE FILTER system	See [IEC 61217].
X-RAY IMAGE RECEPTOR System	See [IEC 61217].
PATIENT SUPPORT System	See [IEC 61217].
TABLE TOP ECCENTRIC System	See [IEC 61217].
TABLE TOP System	See [IEC 61217].

3.11 Macros

Attribute Macro	A set of Attributes that are described in a single table that is referenced by multiple Module or other tables.

3.12 Device Independent Pixel Values

This Part of the Standard makes use of the following terms defined in PS3.14:

P-Value	P-Value.
Profile Connection Space Value (PCS-Value)	A device independent color value that is created by the application of the transformation specified in an ICC profile.

3.13 Codes and Controlled Terminology Definitions

This Part of the Standard makes use of the following terms defined in PS3.16:

Baseline Context Group Identifier (BCID)	Baseline Context Group Identifier (BCID).
Defined Context Group Identifier (DCID)	Defined Context Group Identifier (DCID).
Context Group	Context Group.

Context Group Version	Context Group Version.
Context ID (CID)	Context ID (CID).
Mapping Resource	Mapping Resource.
Relationship Type	Relationship Type.
DICOM Content Mapping Resource (DCMR)	DICOM Content Mapping Resource (DCMR).
Template	Template.
Template ID (TID)	Template ID (TID).
Value Set	Value Set.
Baseline Template Identifier (BTID)	Baseline Template Identifier (BTID).
Defined Template Identifier (DTID)	Defined Template Identifier (DTID).
Coding Scheme	Coding Scheme.

3.14 Reference Model Security Architecture Definitions

This Part of the Standard makes use of the following terms defined in [ISO 7498-2]:

Digital Signature	The definition is "Data appended to, or a cryptographic transformation of, a data unit that allows a recipient of the data unit to prove the source and integrity of that unit and protect against forgery e.g., by the recipient."
Data Confidentiality	The definition is "the property that information is not made available or disclosed to unauthorized individuals, entities or processes."
Data Origin Authentication	The definition is "the corroboration that the source of data received is as claimed."
Data Integrity	The definition is "the property that data has not been altered or destroyed in an unauthorized manner."
Key Management	The definition is "the generation, storage, distribution, deletion, archiving and application of keys in accordance with a security policy."

3.15 Security Definitions

This Part of the Standard makes use of the following terms defined in [ECMA 235]:

Security Context	The definition is "security information that represents, or will represent a Security Association to an initiator or acceptor that has formed, or is attempting to form such an association."

3.16 DICOM Security Profiles

This Part of the Standard makes use of the following terms defined in PS3.15:

Message Authentication Code (MAC)	Message Authentication Code.
Certificate	Certificate.

3.17 Multi-dimensional Definitions

Reference Coordinate System (RCS)	The RCS is the spatial coordinate system in a DICOM Frame of Reference. It is the chosen origin, orientation and spatial scale of an Image IE in a Cartesian space. The RCS is a right-handed Cartesian coordinate system i.e., the vector cross product of a unit vector along the positive x-axis and a unit vector along the positive y-axis is equal to a unit vector along the positive z-axis. The unit length is one millimeter. Typically, the Image IE contains a spatial mapping that specifies the relationship of the image samples to the Cartesian spatial domains of the RCS.
Ophthalmic Coordinate System (OCS)	The Ophthalmic Coordinate System is used as the Frame of Reference that establishes the spatial relationship relative to the corneal vertex. The corneal vertex is the point located at the intersection of the patient's line of sight (visual axis) and the corneal surface. See Section C.8.30.3.1.4 for further explanation.
Fiducial	A fiducial is some unique feature or landmark suitable as a spatial reference or correlation between similar objects. The fiducial may contribute to the definition of the origin and orientation of a chosen coordinate system. Identifying fiducials in different collections of data is a common means to establish the spatial relationship between similar objects.
Fiducial Point	A Fiducial Point defines a specific location of a Fiducial. A Fiducial Point is relative to an image or to an RCS.
Multi-Planar Reconstruction (MPR)	Also called Multi-Planar Reformatting. A data visualization created by sampling volume data, typically represented by a stack of image planes, that lies in the neighborhood of the intersection of the volume with a plane, curved plane, slab or curved slab.
Planar Multi-Planar Reconstruction (Planar MPR)	An MPR where the samples are centered on a single plane intersected with the volume.
Volumetric Presentation State (VPS)	A Presentation State that defines a transformation from 3D spatial input data (volume) to 2D spatial output data, with or without affecting other dimensions such as temporal.
Volumetric Presentation State Reference Coordinate System (VPS-RCS)	The Reference Coordinate System to which inputs to a Volumetric Presentation State are registered and to which Attribute Values of a Volumetric Presentation State are referenced (unless stated otherwise).
Volumetric Presentation View	A presentation, with two spatial dimensions, of volume data.

3.18 Display Equipment Definitions

This Part of the Standard makes use of the following terms, some of which are defined in PS3.14 or [IEC 62563-1]:

Display System	Display System.
Display Subsystem	A part of a Display System. A Display Subsystem consists of one Display Device and zero or more other devices (such as controllers). A Display System has one or more Display Subsystems.
Display Device	See [IEC 62563-1].

Note

The definition is "specific hardware/medium used to display images presented through an analogue or digital interface".

3.19 Digital Input Values To Display Systems

This Part of the Standard makes use of the following terms defined in PS3.14:

Digital Driving Level (DDL)	Digital Driving Level (DDL).

3.20 Device Identification Definitions

Unique Device Identifier (UDI)	An alphanumeric identifier issued by the unique device identification system established by the FDA to label and identify devices through distribution and use. See http://www.fda.gov/udi.

3.21 Structured Report Definitions

Content Item	A node in the Content Tree of a DICOM SR document, consisting of either a container with a coded Concept Name, or a name-value pair with a coded Concept Name and a Concept Value.
Content Tree	The tree of Content Items of a DICOM SR document.

3.22 Miscellaneous Definitions ~~Definitions~~

Externally-Sourced Data Set	A collection of data that has been obtained from or is defined by an entity separate from the system creating an object.

4 Symbols and Abbreviations

The following symbols and abbreviations are used in this Part of the Standard.

ACR	American College of Radiology
ASCII	American Standard Code for Information Interchange
AE	Application Entity
ANSI	American National Standards Institute
BEV	Beam's-eye view
Brachy	Brachytherapy
BRHC	Bottom Right Hand Corner
CC	Counter-clockwise
CDA	Clinical Document Architecture (HL7)
CEN TC251	Comité Européen de Normalisation - Technical Committee 251 - Medical Informatics
CCIR	Consultative Committee, International Radio
Chest CAD	Computer-Aided Detection and/or Computer-Aided Diagnosis for chest radiography
CTV	Clinical target volume
CW	Clockwise
DICOM	Digital Imaging and Communications in Medicine
DIMSE	DICOM Message Service Element
DIMSE-C	DICOM Message Service Element-Composite
DIMSE-N	DICOM Message Service Element-Normalized
DRR	Digitally-reconstructed radiograph
DVH	Dose-volume histogram
EPI	Electronic Portal Image
EPID	Electronic Portal Imaging Device
FDA	(United States) Food and Drug Administration
GTV	Gross tumor volume
Gy	Gray
HISPP	Healthcare Information Standards Planning Panel
HL7	Health Level 7
HMD	Hierarchical Message Description (HL7)
ICRU	International Commission on Radiation Units
IE	Information Entity

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IHE	Integrating the Healthcare Enterprise
II	Instance Identifier (HL7)
IOD	Information Object Definition
ISO	International Standards Organization
ITU-T	International Telecommunications Union - Telecommunications Standardization Sector
IVOCT	Intravascular Optical Coherence Tomography
JIRA	Japan Medical Imaging and Radiological Systems Industries Association
JPIP	JPEG 2000 Interactive Protocol
LUT	Lookup Table
MAC	Message Authentication Code
Mammography CAD	Computer-Aided Detection and/or Computer-Aided Diagnosis for Mammography
MeV	Mega electron Volt
MLC	Multileaf (multi-element) collimator
MSDS	Healthcare Message Standard Developers Sub-Committee
MU	Monitor unit
MV	Megavolt
NaN	Not a Number (see IEEE 754)
NEMA	National Electrical Manufacturers Association
OID	Object Identifier (ISO 8824)
OPT	Ophthalmic Tomography
OSI	Open Systems Interconnection
PDF	Portable Document Format
PTV	Planning target volume
R&V	Record and verify
RCS	Reference Coordinate System
ROI	Region of interest
RT	Radiotherapy
SAD	Source-axis distance
SCP	Service Class Provider
SCTP	Structured Clinical Trial Protocol (HL7)

SCU	Service Class User
SD	Structured Documents (HL7)
SID	Source Image Receptor Distance
SOD	Source Object Distance
SOP	Service-Object Pair
SPL	Structured Product Labeling (HL7)
SR	Structured Reporting
SSD	Source-skin distance
STL	StereoLithography data format
TLHC	Top Left Hand Corner
UDI	Unique Device Identifier
UID	Unique Identifier
UUID	Universal Unique Identifier (ISO/IEC 11578)
XDS	Cross-Enterprise Document Sharing Profile (IHE)
XML	Extensible Markup Language

5 Conventions

5.1 Entity-Relationship Model

5.1.1 Entity

An entity is used in an Entity-Relationship (E-R) model to represent a Real-World Object, class of Real-World Objects, or DICOM data representation (such as an IOD or Module). An entity is depicted as shown in Figure 5.1-1.

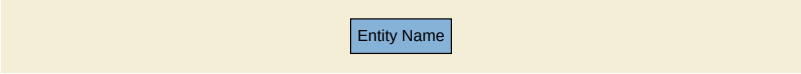


Figure 5.1-1. Entity Convention

5.1.2 Relationship

A relationship, which defines how entities are related, is depicted as a diamond within this Part of the DICOM Standard as shown in Figure 5.1-2.

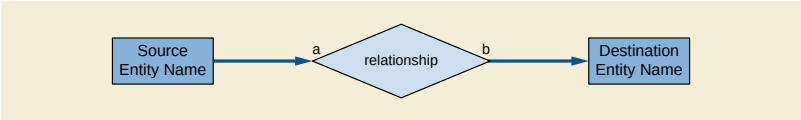


Figure 5.1-2. Relationship Convention

The relationship is read from source to destination entity as indicated by the arrows. The a and b show the source and destination cardinality of the relationship respectively. The following cardinalities are permitted:

a. (a = 1, b = 1) - one source entity is related to one destination entity

b. (a = 1, b = 0-n) - one source entity is related to zero or more destination entities

c. (a = 1, b = 1-n) - one source entity is related to one or more destination entities

d. (a = 1-n, b = 1) - one or more source entities are related to one destination entity

e. (a = 1-n, b = 0-n) - one or more source entities are related to zero or more destination entities

f. (a = 1-n, b = 1-n) - one or more source entities are related to one or more destination entities

In a relationship where (a = 1-n, b = 1-n) the values of the source and destination cardinalities may be different. The value "n" simply denotes one or more.

Note

DICOM has added the use of arrows to the E-R diagramming conventions often used in other literature. This has been done to avoid the possibility of inferring an incorrect relationship that can result from reading a relationship in the reverse order of that intended. For example, a relationship "Cat Catches Mouse" could be read "Mouse Catches Cat" if the arrows were not present.

A relationship may be bi-directional (i.e., the relationship is true in both directions). In such a case, the convention used is arrows pointing toward both the source and the destination entities.

5.2 Sequences

Certain Tables in this Standard describe Sequences of Items by using the symbol: '>'. The symbol '>' precedes the Attribute (or Module) Name of the members of an Item. All marked Attributes (or Modules) belong to the generic description of an Item that may be repeated to form a Sequence of Items. This Sequence of Items is nested in the Attribute (or Module) that precedes in the table the first member marked with a '>'.

Note

The following table describes the "Referenced Series Sequences" Attribute as a Sequence of one or more Items where each Item contains the three Attributes marked by a '>'. The Sequence of Items is nested inside the value of the Referenced Series Sequence Attribute. The following Attribute (not marked) is not part of the Items of the Sequence.

...	...
Referenced Series Sequence	…
>Series Date	…
>Series Time	…
>Series Instance UID	…
Modality	…

This notation may be used to create nested hierarchical structures by using '>>' at the second level of nesting and so on.

The Type of the Sequence Attribute defines whether the Sequence Attribute itself must be present, and the Attribute Description of the Sequence Attribute may define whether and how many Items shall be present in the Sequence. The Types of the Attributes of the Data Set included in the Sequence, including any conditionality, are specified within the scope of each Data Set, i.e., for each Item present in the Sequence. See PS3.5.

For describing the number of Items in the Attribute description the following sentences are preferred:

Sequence Attribute Type	Number of Items	Sentence
1 or 1C	1	Only a single Item shall be included in this Sequence.
1 or 1C	1-n	One or more Items shall be included in this Sequence.
2 or 2C	0-1	Zero or one Item shall be included in this Sequence.
2 or 2C	0-n	Zero or more Items shall be included in this Sequence.
3	1	Only a single Item is permitted in this Sequence.
3	1-n	One or more Items are permitted in this Sequence.

Note

The encoding of empty Sequence Attributes is described in PS3.5.

In a number of cases for Normalized IODs, the Data Element Type and Conditions are defined in the appropriate Service definition in PS3.4, in other cases in the Attribute description in PS3.3. It is not necessary to specify for any Attribute within a Sequence the condition that it is "required if a Sequence Item is present", since this is always implicit, whether or not there are additional requirements.

5.3 Triplet Encoding of Structured Data (Retired)

This section has been retired. See Section 8.

5.4 Attribute Macros

Some tables contain references to Attribute Macros. This convention is used in cases where the same Attributes are used in multiple tables or multiple places in one Module. The reference means that the Attributes of the Attribute Macro shall be included in the Module in place of the row that contains the reference to the Attribute Macro.

In some cases, the Attribute Macro is used in a Sequence (the VR of the Data Element in which the Attribute is encoded is SQ, see PS3.5). When this is done, the reference is preceded by one or more ">" characters. The number of ">" characters indicates the level in the Sequence that all of the Attributes in the Attribute Macro occupy.

There may be specialization of the description of the Attributes in the Attribute Macro. In these cases, this specialization is described in the Description column of the Module.

Following is an example of this convention.

Table 5.4-1 is an example of a Module table using the Attribute Macro convention.

Table 5.4-1. Example Module Table

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute
>Include Table 5.4-2 "Example Macro Attributes"		In this Module, Attribute D (dddd,dddd) is Type 1	

Table 5.4-2 is an example of the Attribute Macro referenced in Table 5.4-1.

Table 5.4-2. Example Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Attribute C	(cccc,cccc)	1	This is an example.
Attribute D	(dddd,dddd)	3	This Attribute is generally a Type 3.

The contents of the Example Module Table, if it had not been described with the Example Macro would have been as shown in Table 5.4-3.

Table 5.4-3. Example Module Table Without The Use of An Attribute Macro

Attribute Name	Tag	Type	Attribute Description
Attribute A	(aaaa,aaaa)	1	This is an example.
Attribute B Sequence	(bbbb,bbbb)	1	This is an example of a Sequence Attribute.
>Attribute C	(cccc,cccc)	1	This is an example.
>Attribute D	(dddd,dddd)	1	In this Module, this Attribute has been specialized to Type 1 as indicated in Table 5.4-1.

5.5 Types and Conditions in Normalized IODs

When a Normalized Information Object Definition in PS3.3 invokes Modules (e.g., the SOP Common Module) or Attribute Macros that are specified with Data Element Types, those specified Data Element Types and Conditions do not apply. Rather, the Data Element Types and Conditions have to be specified for each Attribute for both SCU and SCP in the appropriate Service definition in PS3.4.

5.6 Invocation of Context Groups

The conventions used for Code Sequences are:

- no Baseline Defined
- using the Context Group as Baseline Context Group
- using the Context Group as Defined Context Group

See also "Codes and Controlled Terminology Definitions:" in PS3.16.

In combination with the definition of the Context Group as Extensible or Non-extensible in PS3.16, the conventions in Table 5.6-1 apply.

Table 5.6-1. Conventions for Specification of Context Groups

	Extensible Context Group	Non-Extensible Context Group
No Baseline or Defined CID specified	Any Code may be used if its meaning is applicable to the context of invocation.	
Baseline Context Group Identifier (BCID)	Codes in the Context Group may be used. Alternative Codes for the same Concept (i.e., with the same meaning) may be used instead of the Codes in the Context Group, since this can be construed as not using the Baseline Context Group. Codes not in the Context Group may be used as an extension when their meaning is within the scope of that Context Group. I.e., any Code may be used if its meaning is applicable to the context of invocation. See also Section 7.2.3 “Extension of Context Groups” in PS3.16.	Non-extensible Context Groups are not used as Baseline Context Groups.
Defined Context Group Identifier (DCID)	Codes in the Context Group shall be used. Codes not in the Context Group may be used as an extension to the specified Context Group when their meaning is within the scope of that Context Group. See also Section 7.2.3 “Extension of Context Groups” in PS3.16.	Codes in the Context Group shall be used. Codes not in the Context Group shall not be used.

6 DICOM Information Model

The DICOM Information Model defines the structure and organization of the information related to the communication of medical images. Figure 6-1 shows the relationships between the major structures of the DICOM Information Model.

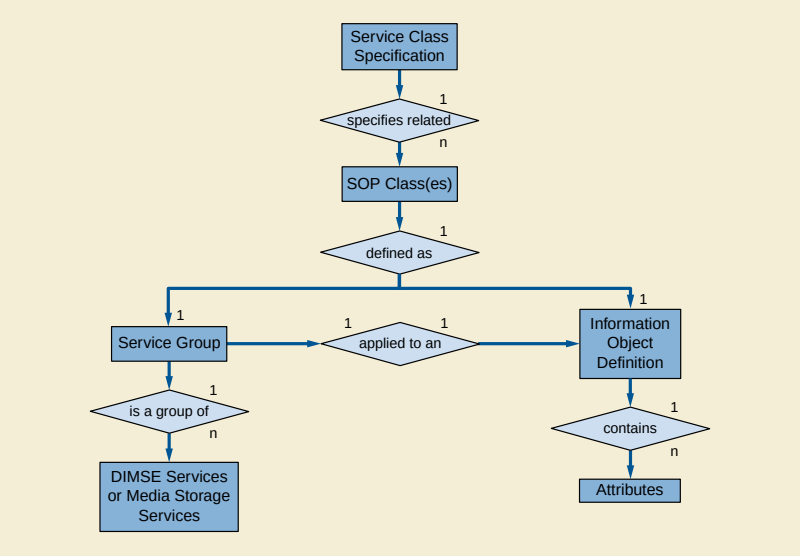


Figure 6-1. Major Structures of DICOM Information Model

6.1 Information Object Definition

An Information Object Definition (IOD) is an object-oriented abstract data model used to specify information about Real-World Objects. An IOD provides communicating Application Entities with a common view of the information to be exchanged.

An IOD does not represent a specific Instance of a Real-World Object, but rather a class of Real-World Objects that share the same properties. An IOD used to generally represent a single class of Real-World Objects is called a Normalized Information Object. An IOD that includes information about related Real-World Objects is called a Composite Information Object.

6.1.1 Composite IOD

A Composite IOD is an Information Object Definition that represents parts of several entities included in the DICOM Model of the Real World. This Model is introduced in Section 7. Such an IOD includes Attributes that are not inherent in the Real-World Object that the IOD represents but rather are inherent in related Real-World Objects.

These related Real-World Objects provide a complete context for the exchanged information. When an Instance of a Composite IOD is communicated, this entire context is exchanged between Application Entities. Relationships between Composite IOD Instances shall be conveyed in this contextual information.

The Composite IODs are specified in Annex A.

6.1.2 Normalized IOD

A Normalized IOD is an Information Object Definition that generally represents a single entity in the DICOM Model of the Real World.

When an Instance of a Normalized IOD is communicated, the context for that Instance is not actually exchanged. Instead, the context is provided through the use of pointers to related Normalized IOD Instances.

The Normalized IODs are specified in Annex B.

6.2 Attributes

The Attributes of an IOD describe the properties of a Real-World Object Instance. Related Attributes are grouped into Modules that represent a higher level of semantics documented in the Module Specifications found in Annex C.

Attributes are encoded as Data Elements using the rules, the Value Representation and the Value Multiplicity concepts specified in PS3.5. For specific Data Elements, the Value Representation and Value Multiplicity are specified in the Data Dictionary in PS3.6.

When multiple Modules containing the same Attributes(s) are included in an IOD, the Attribute shall be encoded only once into a Data Element.

6.3 On-line Communication and Media Storage Services

For on-line communication the DIMSE Services allow a DICOM Application Entity to invoke an operation or notification across a network or a point-to-point interface. DIMSE Services are defined in PS3.7.

For media storage interchange, Media Storage Services allow a DICOM Application Entity to invoke media storage related operations.

Note

These Media Storage Services are discussed in PS3.10.

6.3.1 DIMSE-C Services

DIMSE-C Services are services applicable only to a Composite IOD, except for C-FIND that may apply to both normalized and Composite Instances. DIMSE-C Services provide only operation services.

6.3.2 DIMSE-N Services

DIMSE-N Services are services applicable only to a Normalized IOD. DIMSE-N Services provide both operation and notification services.

6.4 DIMSE Service Group

A DIMSE Service Group specifies one or more operations/notifications defined in PS3.7 that are applicable to an IOD.

DIMSE Service Groups are defined in PS3.4 in the specification of a Service-Object Pair Class.

6.5 Service-Object Pair Class (SOP Class)

The SOP Class definitions in PS3.4 contain the rules and semantics that may restrict the use of the services in the DIMSE Service Group and/or the Attributes of the IOD. PS3.10 and PS3.18 contain the rules and semantics that may restrict the attributes of the IOD or the use of the services in the Media Storage Services and the Web Services respectively.

The selection of SOP Classes is used by Application Entities to establish an agreed set of capabilities to support their interaction for SOP Classes based on DIMSE Services. This negotiation is performed at association establishment time as described in PS3.7. An extended negotiation allows Application Entities to further agree on specific options within a SOP Class.

Note

The SOP Class as defined in the DICOM Information Model is equivalent in ISO/OSI terminology to the Managed Object Class. Readers familiar with object-oriented terminology will recognize the SOP Class operations (and notifications) as comprising the methods of an object class.

6.5.1 Normalized and Composite SOP Classes

DICOM defines two types of SOP Classes, Normalized and Composite. For DIMSE Services, Normalized SOP Classes are defined as the union of a Normalized IOD and a set of DIMSE-N Services, while Composite SOP Classes are defined as the union of a Composite IOD and a set of DIMSE-C Services. Media Storage Services only support Composite IODs and Web Services supports both Normalized and Composite SOP Classes.

Note

SOP Class Specifications play a central role for defining DICOM conformance requirements. It allows DICOM Application Entities to select a well-defined application level subset of the DICOM V3.0 Standard to which they may claim conformance. See PS3.2.

6.6 Association Negotiation

Association establishment is the first phase of communication between peer DICOM compliant Application Entities. The Application Entities shall use association establishment to negotiate which SOP Classes can be exchanged and how this data will be encoded.

Association Negotiation is defined in PS3.7.

6.7 Service Class Specification

A Service Class Specification defines a group of one or more SOP Classes related to a specific function that is to be accomplished by communicating Application Entities. A Service Class Specification also defines rules that allow implementations to state some pre-defined level of conformance to one or more SOP Classes. Applications may conform to SOP Classes as either or both a Service Class User (SCU) or Service Class Provider (SCP).

Service Class Specifications are defined in PS3.4.

Note

Such interaction between peer Application Entities work on a 'client/server model'. The SCU acts as the 'client', while the SCP acts as the 'server'. The SCU/SCP roles are determined during association establishment.

7 DICOM Model of the Real World

Figure 7-1a, Figure 7-1b and Figure 7-3 depict the DICOM view of the Real-World that identifies the relevant Real-World Objects and their relationships within the scope of the DICOM Standard. It provides a common framework to ensure consistency between the various Information Objects defined by the DICOM Standard.

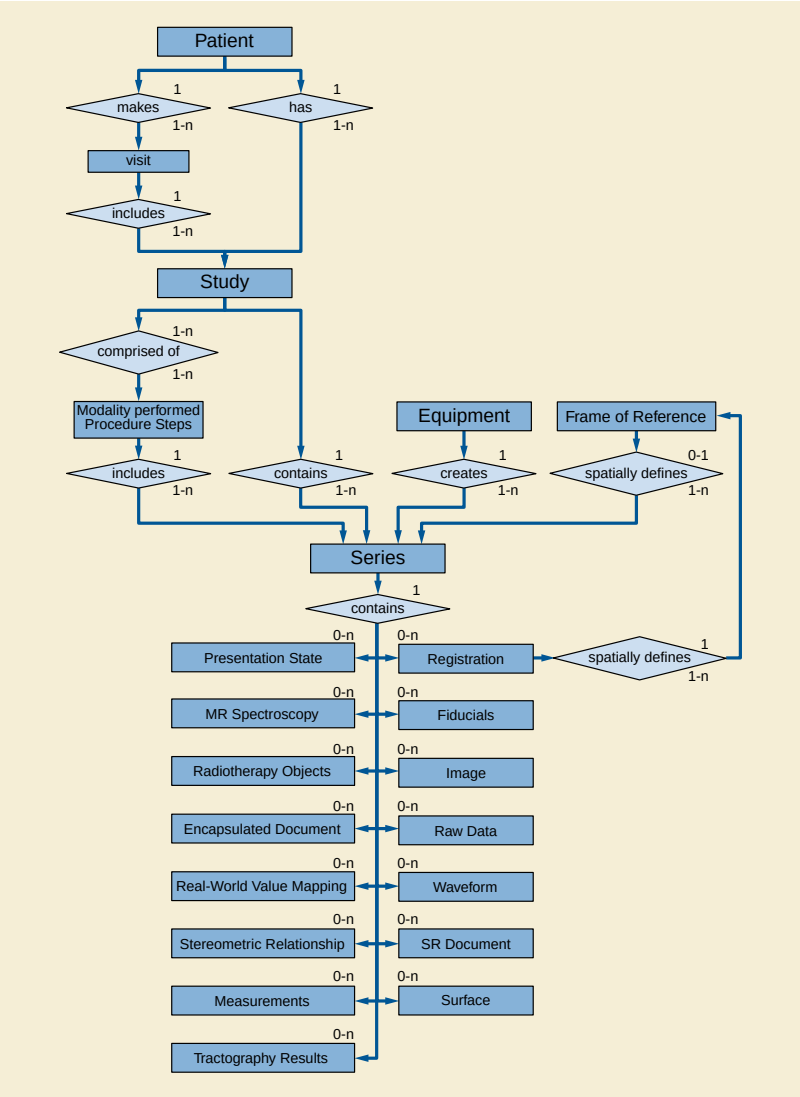


Figure 7-1a. DICOM Model of the Real World

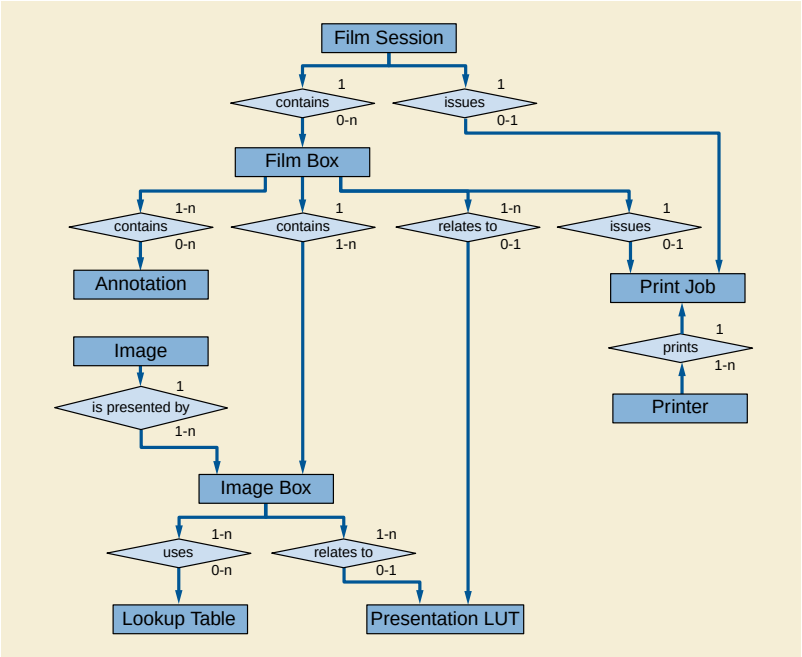


Figure 7-1b. DICOM Model of the Real World - PRINT

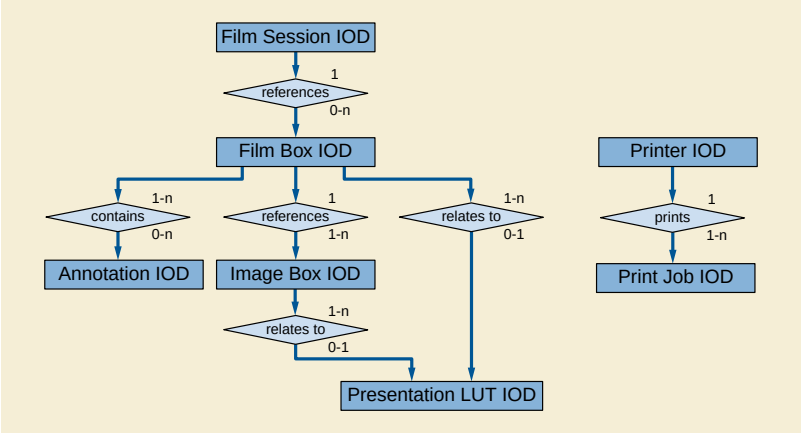


Figure 7-2b. DICOM Information Model - PRINT

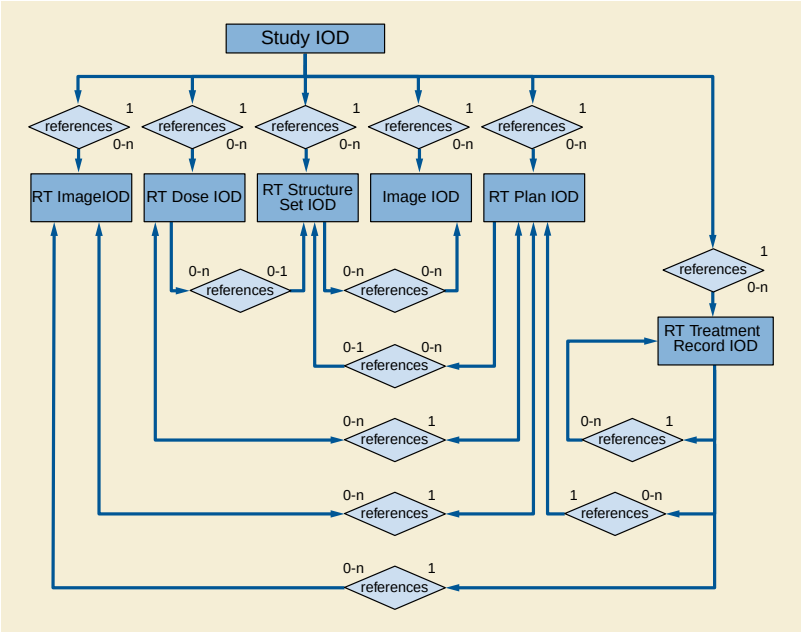


Figure 7-2c. DICOM Information Model - RADIOTHERAPY

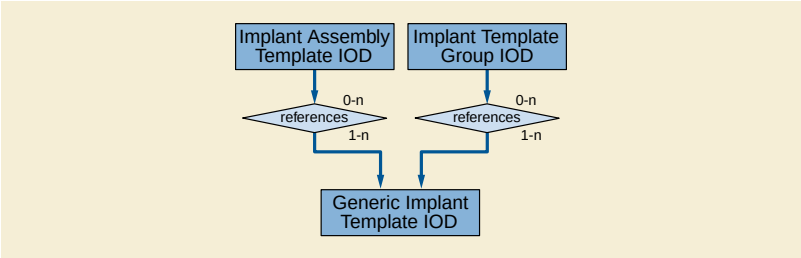


Figure 7-2d. DICOM Information Model - IMPLANT TEMPLATES

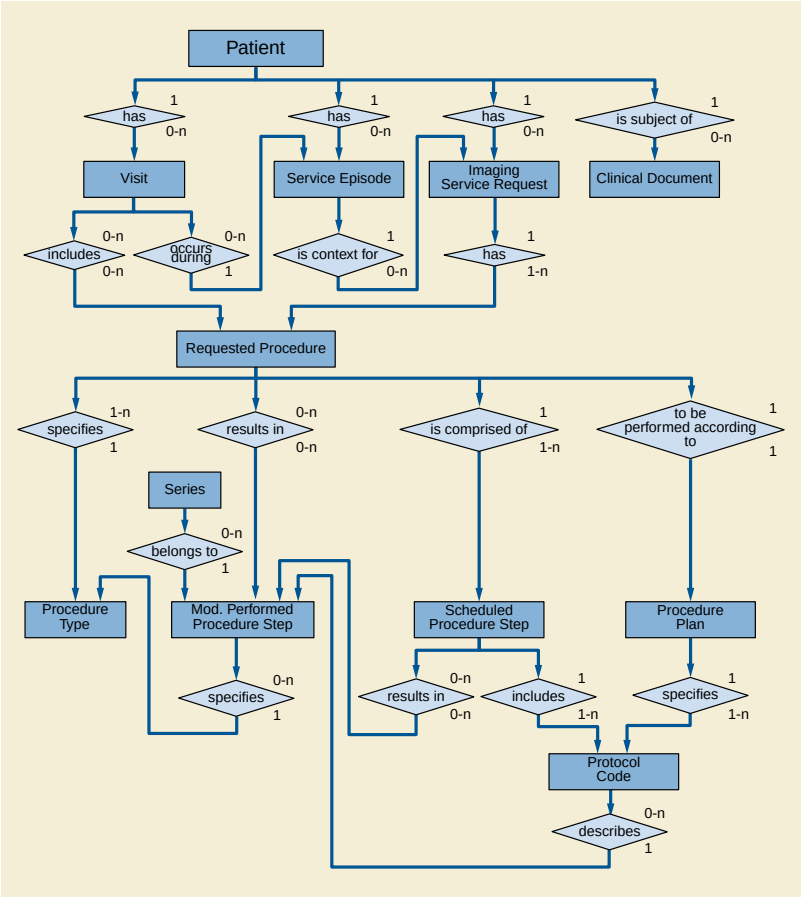


Figure 7-3. Model of the Real World for the Purpose of Modality-IS Interface

7.1 DICOM Information Model

The DICOM Information Model is derived from the DICOM Model of the Real World. The DICOM Information Model presented by Figure 7-2b, Figure 7-2c and Figure 7-2d identify the various IODs specified by this Standard and their relationships. There is not always a one-to-one correspondence between DICOM Information Object Definitions and Real-World Objects. For example a Composite IOD contains Attributes of multiple real-world objects such as Series, Equipment, Frame of Reference, Study and Patient.

The entities in Figure 7-2b, Figure 7-2c and Figure 7-2d correspond to IODs defined in Annex A, Annex B and Annex C.

7.2 Organization of Annexes A, B and C

Annex A defines Composite IODs (e.g., Images) acquired on a number of Modalities (e.g., CT, MR, NM, US, CR, Secondary Capture). These Composite IODs reference Modules found in Annex C.

Annex B defines Normalized IODs (e.g., Film Session, Print Job) for a number of Service Classes specified in PS3.4. These Normalized IODs reference Module definitions found in Annex C.

7.3 Extension of the DICOM Model of the Real World

For the purpose of the Basic Worklist Management Service Class and the Modality Performed Procedure Step SOP Classes an enhancement of the original DICOM Model of the Real World is made, as depicted in Figure 7-3.

Annex B “Integration of Modality Worklist and Modality Performed Procedure Step in The Original DICOM Standard (Informative)” in PS3.17 discusses the relationship of this extension to the original DICOM model of the real world.

Figure 7-3 is an abstract description of the real world objects invoked in the Modality-IS Interface. It is not to be seen as a database scheme for an implementation.

7.3.1 Definition of the Extensions of the DICOM Real World Model

7.3.1.1 Patient

A Patient is a human or animal receiving, or registered to receive, healthcare services, or the subject of one or more Studies for some other purpose, such as research.

Note

In some circumstances, multiple humans or animals may be studied simultaneously, and for the purpose of the model are identified as a single Patient. E.g., a mother and one or more fetuses during antepartum obstetric ultrasound, multiple specimens in a single tissue microarray, or a group of multiple research small animals imaged simultaneously.

7.3.1.2 Service Episode and Visit

A Service Episode is a collection of events, aggregated during an interval bounded by start and stop times. A Service Episode is the context in which the treatment or management of an arbitrary subset of a Patient's medical conditions occurs. The definition of the start time, stop time, and included events of a Service Episode is entirely arbitrary; it may include a single outpatient visit or a hospitalization, or extend over significant period of time, e.g., the duration of a pregnancy, or an oncology treatment regimen, or a cardiac episode from infarction through rehabilitation. A Service Episode may involve one or more Healthcare Organizations (administrative entities that authorize Healthcare Providers to provide services within their legal administrative domain, e.g., hospitals, private physician's offices, multispecialty clinics, nursing homes).

A subset of Service Episode, the Visit, is the collection of events that fall under the accountability of a particular Healthcare Organization in a single facility. A Visit may be associated with one or more physical locations (e.g., different rooms, departments, or buildings) within the Healthcare Organization's definition of a facility, with admission and discharge diagnoses and with time boundaries of the visit.

Note

1. The Visit is a part of the Service Episode. The Service Episode describes several administrative aspects of healthcare, while the Visit is limited to the description of one visit of a Patient to a facility.
2. In the context of the Modality Worklist SOP Class, the Attributes of the Service Episode are defined in the Visit Modules.
3. The Attributes for Visit often use the term "admission" for historical reasons, although a visit in an ambulatory clinic does not involve an admission as an in-patient.

7.3.1.3 Imaging Service Request

An Imaging Service Request is a set of one or more Requested Procedures selected from a list of Procedure Types. An Imaging Service Request is submitted by one authorized imaging service requester to one authorized imaging service provider in the context of one Service Episode. An Imaging Service Request includes pertinent specific and general information. Each instance of an Imaging Service Request carries the information common to one or more Requested Procedures requested at the same moment. An Imaging Service Request may be associated with one or more Visits that occur within the same Service Episode. The existence of an Imaging Service Request will typically result in the creation of one or more Imaging Service Reports and the distribution of Imaging Service Reports to one or more destinations.

In the context of the Modality Worklist the information provided by the Imaging Service Request aims at performing one or more imaging procedures, i.e., at acquiring new images.

7.3.1.4 Procedure Type

A Procedure Type identifies a class of procedures. In the context of imaging services, a Procedure Type is an item in a catalog of imaging procedures that can be requested and reported upon in an imaging service facility. An instance of a Procedure Type typically has a name and one or more other identifiers. A Procedure Type is associated with one or more Procedure Plans.

Note

The information content of this entity relates to the general identification of a Procedure Type rather than to its decomposition into the protocol(s) required to perform a specific instance of a Requested Procedure for a particular Patient.

7.3.1.5 Requested Procedure

A Requested Procedure is an instance of a Procedure of a given Procedure Type. An instance of a Requested Procedure includes all of the items of information that are specified by an instance of a Procedure Plan that is selected for the Requested Procedure by the imaging service provider. This Procedure Plan is defined by the imaging service provider on the basis of the Procedure Plan templates associated with the considered Procedure Type. An Imaging Service Request may include requests for several different Requested Procedures. The purpose of this entity is to establish the association between Imaging Service Requests and Procedure Types, to convey the information that belongs to this association and to establish the relationships between Requested Procedures and the other entities that are needed to describe them. A single Requested Procedure of one Procedure Type is the smallest unit of service that can be requested, reported, coded and billed. Performance of one instance of a Requested Procedure is specified by exactly one Procedure Plan. A Requested Procedure leads to one or more Scheduled Procedure Steps involving Protocols as specified by a Procedure Plan. A Requested Procedure may be associated with one or more Visits. A Requested Procedure may involve one or more pieces of equipment.

7.3.1.6 Scheduled Procedure Step

A Modality Scheduled Procedure Step is an arbitrarily defined scheduled unit of service, that is specified by the Procedure Plan for a Requested Procedure. A Modality Scheduled Procedure Step prescribes a Protocol, which may be identified by one or more protocol codes. A Modality Scheduled Procedure Step involves equipment (e.g., imaging Modality equipment, anesthesia equipment, surgical equipment, transportation equipment), human resources, consumable supplies, location, and time (e.g., start time, stop time, duration). While in the context of imaging services the scheduling of a Modality Scheduled Procedure Step might include only a general designation of imaging Modality that could be satisfied by multiple pieces of the same equipment type, the performance of one instance of a Modality Scheduled Procedure Step involves one and only one piece of imaging Modality equipment.

The performance of a Modality Scheduled Procedure Step may result in the creation of zero or more Modality Performed Procedure Step Instances.

Note

1. The Procedure Step entity is provided to support management of the logistical aspects of procedures (e.g., materials management, human resources, scheduling). The full definition of the contents of Procedure Steps and protocols according to which they are performed is implementation dependent and is beyond the scope of this Standard.

2. A Modality Scheduled Procedure Step may contribute to more than one Requested Procedure (e.g., a Modality Scheduled Procedure Step requiring an intravenous iodine contrast injection might be shared by an intravenous pyelogram and a CT examination). However, for billing purposes an Instance of a Modality Scheduled Procedure Step is typically considered to be a part of only one Requested Procedure.

7.3.1.7 Procedure Plan

A Procedure Plan is a specification that defines the set of Protocols that must be done in order to perform the Scheduled Procedure Steps of a Requested Procedure. Each Scheduled Procedure Step is performed according to a single Protocol, which may be identified by one or more Protocol Codes and may be described in a Defined Procedure Protocol. The Protocols actually performed during a Procedure Step may be recorded in a Performed Procedure Protocol and may differ from those prescribed in the related Procedure Plan. Audit of actually performed Protocols versus the prescribed Procedure Plan is an important element of quality control.

7.3.1.8 Protocol

A Protocol is a specification of actions prescribed by a Procedure Plan to perform a specific Procedure Step. A Scheduled Procedure Step contains only one Protocol, which may be conveyed by one or more Protocol Codes.

A Protocol may be specified by a Defined Procedure Protocol to be used on any appropriate Patient.

A Protocol can be documented, once a Procedure Step has been performed, in a Performed Procedure Protocol.

7.3.1.8.1 Defined Procedure Protocol

A Defined Procedure Protocol describes a set of parameters and associated details for the prescribed action. The Defined Procedure Protocol may provide specific values for relevant parameters, or may provide constraints on those parameters (such as an acceptable range) to guide the choice of specific values.

Defined Procedure Protocol is not associated with any particular Patient or Scheduled Procedure Step. A Defined Procedure Protocol may contain parameters specific to a particular model or version of device, or it may be generic in that it only describes parameters common to multiple device models.

A Defined Procedure Protocol may include information such as the clinical purpose, indications, and appropriate device models, intended for selection and management.

7.3.1.8.2 Performed Procedure Protocol

A Performed Procedure Protocol encodes the parameter values used. A Performed Procedure Protocol is always associated with a specific Patient and Performed Procedure Step. The Performed Procedure Protocol may reference the Defined Procedure Protocol on which it was based, but does not otherwise record the ~~orginal~~original constraints and whether or not they were satisfied by the final values as recorded in the Performed Procedure Protocol.

7.3.1.9 Modality Performed Procedure Step

A Performed Procedure Step is an arbitrarily defined unit of service that has actually been performed (not just scheduled). Logically it corresponds to a Scheduled Procedure Step, but real-world conditions may dictate that what is actually performed does not correspond exactly with what was requested or scheduled.

Note

For example, two or more Scheduled Procedure Steps, Requested Procedures or Imaging Service Requests may have been generated by different Referring Physicians but may be satisfied be a single Performed Procedure Step at the discretion of a Performing Physician or Operator. Alternatively, a single Scheduled Procedure Step may need to be satisfied by multiple Performed Procedure Steps on different types or instances of equipment, due to clinical need or failure conditions, or over extended periods of time.

It contains information describing the type of procedure actually performed. This information is represented by the Performed Protocol that may be defined by one or more Protocol Codes.

A Requested Procedure results in the creation of zero or more Performed Procedure Steps.

A Scheduled Procedure Step results in the creation of zero or more Performed Procedure Steps.

The Performed Procedure Step contains information about its state (e.g., in progress, discontinued or completed).

A Modality Performed Procedure Step is a Performed Procedure Step that results from activity (such as the acquisition of images from a Patient or other Imaging Subject) on a Modality.

It contains information describing the performance of a step of an imaging procedure, including data about the performance of the procedure itself, and data for billing and material management.

The Modality Performed Procedure Step contains references to zero or more Series of Images and other Composite SOP Instances that may be created as part of the procedure step. A particular Series is part of only one Modality Performed Procedure Step.

The purpose of the Modality Performed Procedure Step is to report what was performed; it does not imply any storage semantics. While the MPPS represents a unit of service within a workflow, the specification of the workflow itself is beyond the scope of the Standard, and the MPPS does not identify or control any subsequent activities to be performed.

Note

1. For example, a modality may create both "for processing" images for automated analysis and "for presentation" images for human review from the same acquisition. The Standard does not specify whether the production of these is a single unit of service, or two. A single Modality Performed Procedure Step Instance could list both the "for processing" images and the "for presentation" images, regardless of whether or not both sets of images were stored to the same or different

AEs, or indeed were stored at all, since the MPPS is independent of the storage semantics. Alternatively, the modality may treat these two sets of images as two separate units of service, and send two separate MPPS Instances.

A Radiation Dose SR from the irradiation events of an acquisition could be referenced in the same MPPS Instance as that of the acquired images, again irrespective of where such a Radiation Dose Structured Report might be transmitted, if at all. Alternatively, the modality may treat the production of the Radiation Dose SR as a separate unit of service, and report it in a distinct MPPS.

Another example is the case of thin and thick slice CT images acquired from the same acquisition (raw) data. When the reconstruction of both sets of images is prospectively defined and automatically initiated by the protocol selection, then both sets might be referenced from a single MPPS Instance. However, if the reconstruction of one or the other set is performed retrospectively by manual intervention some time after the acquisition MPPS had been completed, the subsequent Instances will necessarily be referenced in a new MPPS Instance, since the acquisition MPPS cannot be modified once completed.

2. The completion of an MPPS may be a significant event that triggers or enables downstream activity, but it is not the intent to require the modality to be configured to "manage" such activity. The "units of service" that the modality describes in an MPPS, and how the modality relates those Performed Procedure Steps to Scheduled Procedure Steps, are implementation decisions beyond the scope of the Standard. The IHE Radiology Scheduled Workflow Profile provides additional guidance for implementation.

3. An MPPS may describe Instances that were acquired but that have not been, nor may ever be, stored. For example, a modality may be capable of storing a CT acquisition as multiple single-frame CT Image Storage SOP Instances, as a single multi-frame Enhanced CT Image Storage SOP Instance, or as several Enhanced CT Image Storage SOP Instances that together comprise a Concatenation. An MPPS may describe all three possibilities, even though only one choice may ultimately be stored, perhaps depending on the negotiated capabilities of the storage recipient. Alternatively, separate MPPS Instances could be used for different storage SOP Classes.

4. The MPPS contains only the Instances that the modality created, not Instances converted and created subsequently in response to a query (e.g., during legacy conversion).

5. The MPPS is not a substitute for, nor is equivalent to, a Storage Commitment request, nor an Instance Availability Notification.

7.3.1.10 General Purpose Scheduled Procedure Step (Retired)

Retired. See PS3.3-2011.

7.3.1.11 General Purpose Performed Procedure Step (Retired)

Retired. See PS3.3-2011.

7.3.1.12 Workitem (Retired)

Retired. See PS3.3-2011.

7.3.1.13 Clinical Document

A Clinical Document is a part of the medical record of a Patient. A Clinical Document is a documentation of clinical observations and services and has the following characteristics:

- Persistence - A clinical document continues to exist in an unaltered state, for a time period defined by local and regulatory requirements.
- Stewardship - A clinical document is maintained by an organization entrusted with its care.
- Potential for authentication - A clinical document is an assemblage of information that is intended to be legally authenticated.
- Context - A clinical document establishes the default context for its contents.

- Wholeness - Authentication of a clinical document applies to the whole and does not apply to portions of the document without the full context of the document.
- Human readability - A clinical document is human readable.

Note

This definition is from ANSI/HL7 CDA R1.0-2000, and HL7 v3 CDA R2-2005.

Clinical Documents may provide significant context for the performance of imaging and related procedures, e.g., patient clinical history, pre-imaging-procedure lab test results, or patient advance medical directives.

Clinical Documents may be associated with Service Episodes, Service Requests, Requested Procedures, or other entities subsidiary to the Patient in the Real-World Model. Such associations are not explicitly modeled for the purposes of the Modality-IS context.

Clinical Documents are one sub-class of the class of healthcare Structured Documents; Structured Documents, in general, are not necessarily related to a Patient. Structured Documents may be used for imaging procedure operational instructions, e.g., in product labeling, Procedure Plans, or patient care plans.

Note

1. The format and semantics of Structured Documents, including Clinical Documents, are defined outside the scope of the DICOM Standard (e.g., by HL7). DICOM provides the means to reference Structured Documents within the Modality-IS context.
2. The general class of Structured Documents is not modeled in the Real-World Model; only specific sub-classes, e.g., Clinical Documents, are modeled.

7.4 Extension of the DICOM Model of the Real World for the General Purpose Worklist (Retired)

Retired. See PS3.3-2011.

7.5 Organizing Large Sets of Information

For the purpose of accommodating large sets of frames in Multi-frame Image SOP Instances the Real-World Entity Relationship Diagram has been extended to describe the relationships of these instances: Concatenation (see Section 7.5.1) and Dimension Organization (see Section 7.5.2). Figure 7.5-1 depicts the additions to Figure 7-1a.

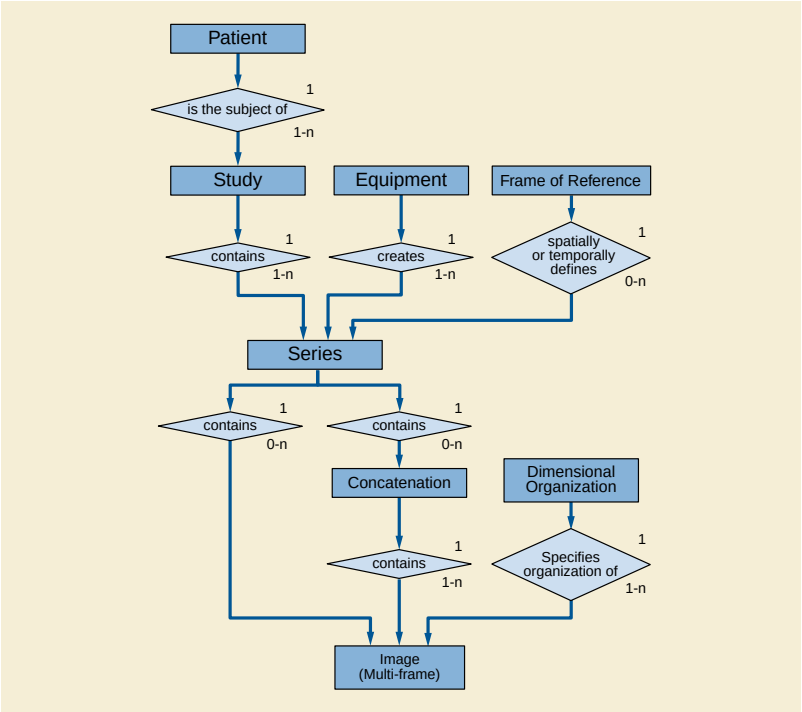


Figure 7.5-1. Extension of the Real World Model with Concatenations and Dimensions

7.5.1 Concatenation

For implementation specific reasons (such as practical limits on the maximum size of an individual SOP Instance) the content of a multi-frame image may need to be split into more than one SOP Instance. These SOP Instances together form a Concatenation, which is a group of SOP Instances within a Series that is uniquely identified by Concatenation UID (0020,9161).

7.5.2 Dimension Organization

The Dimension Organization contains a set of dimensions. A dimension is a set of Attributes that change on a per-frame basis in a manner that is known before the image is acquired, are defined by the generating application and are especially intended for presentation. Other Attributes may also change on a per-frame basis but if they are not present in the Dimension Organization, they are not considered significant as a dimension for organizational purposes.

Receiving applications shall use the order of dimensions for guidance when presenting images if the Multi-frame Dimension Module is present. The first Item of the Dimension Index Sequence shall be the slowest varying index.

Note

See Section C.7.6.17 for an example.

7.6 Extension of the DICOM Model of the Real World for Clinical Trials and Research

The DICOM Model of the Real World is extended for Clinical Trials and research with the addition of several objects whose relationships to each other and existing DICOM Real World objects are shown in Figure 7.6-1.

Attributes of the Clinical Trial Sponsor, Clinical Trial Protocol, Clinical Trial Subject, and Clinical Trial Site objects are represented in the Clinical Trial Subject Module within the Patient IOD. Attributes of the Clinical Trial Time Point object are represented in the Clinical Trial Study Module within the Study IOD. The Clinical Trial Coordinating Center Attribute is represented in the Clinical Trial Series Module within Image IODs.

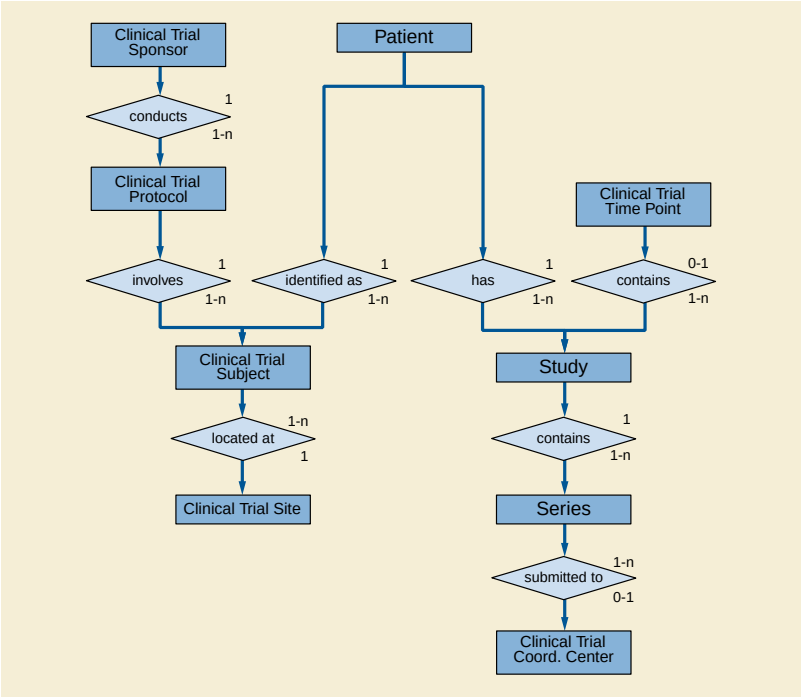


Figure 7.6-1. DICOM Model of the Real World - Clinical Trials and Research

7.6.1 Clinical Trial and Research Information Entities

For the purpose of Clinical Trial and Research Information, an extension of the DICOM Model of the Real World is made, as depicted in Figure 7.6-1.

7.6.1.1 Clinical Trial Sponsor

A Clinical Trial Sponsor identifies the agency, group, or institution responsible for conducting and/or funding the clinical trial or research, and for assigning a Protocol Identifier.

7.6.1.2 Clinical Trial Protocol

A Clinical Trial Protocol identifies the investigational Protocol in which the Subject has been enrolled. The Protocol has a Protocol Identifier and Protocol Name, as well as information related to Ethics Committee, Institutional Review Board (IRB) or Institutional Animal Care and Use Committees (IACUC) approval.

7.6.1.3 Clinical Trial Subject

A Clinical Trial Subject identifies the Patient who is enrolled as a Subject in the investigational Protocol.

7.6.1.4 Clinical Trial Site

A Clinical Trial Site identifies the location or institution at which the Subject is treated or evaluated and that is responsible for submitting clinical trial or research data. Images and/or clinical trial data may be collected for a given Subject at alternate institutions, e.g., follow-up scans at a satellite imaging center, but the Clinical Trial Site represents the primary location for Patient management and data submission in the context of a clinical trial or research. In pre-clinical research with small animals, it is typically the single laboratory or shared resource facility.

7.6.1.5 Clinical Trial Time Point

The Clinical Trial Time Point identifies an imaging Study within the context of a series of longitudinal data acquisitions in an investigational protocol. A Time Point defines a set of Studies that are grouped together as a clinical time point or submission in a clinical trial or for other research.

7.6.1.6 Clinical Trial Coordinating Center

The Clinical Trial Coordinating Center identifies the institution responsible for coordinating the collection, management, processing, and/or analysis of images and associated data for Subjects enrolled in a clinical trial or research. Within a given Clinical Trial Protocol, there may be multiple Clinical Trial Coordinating Centers, each handling different aspects of the clinical data submitted by the Clinical Trial Sites. In pre-clinical research with small animals, it may be a facility where post processing is performed, separate from the laboratory where the data is acquired.

7.7 Extension of the DICOM Model of the Real World for Hanging Protocols

See Section 7.13.

Note

The specifications of this section have been consolidated into the Real World Model for Non-Patient-Related Information.

7.8 Extension of the DICOM Model of the Real World for Color Palettes

See Section 7.13.

Note

The specifications of this section have been consolidated into the Real World Model for Non-Patient-Related Information.

7.9 Extension of the DICOM Model of the Real World for Specimens

The DICOM Model of the Real World is extended for Specimens with the addition of several objects whose relationships to each other and existing DICOM Real World objects are shown in Figure 7.9-1.

Attributes of the Specimen, Container, Component and Preparation Step objects are represented in the Specimen Module within the Image IODs.

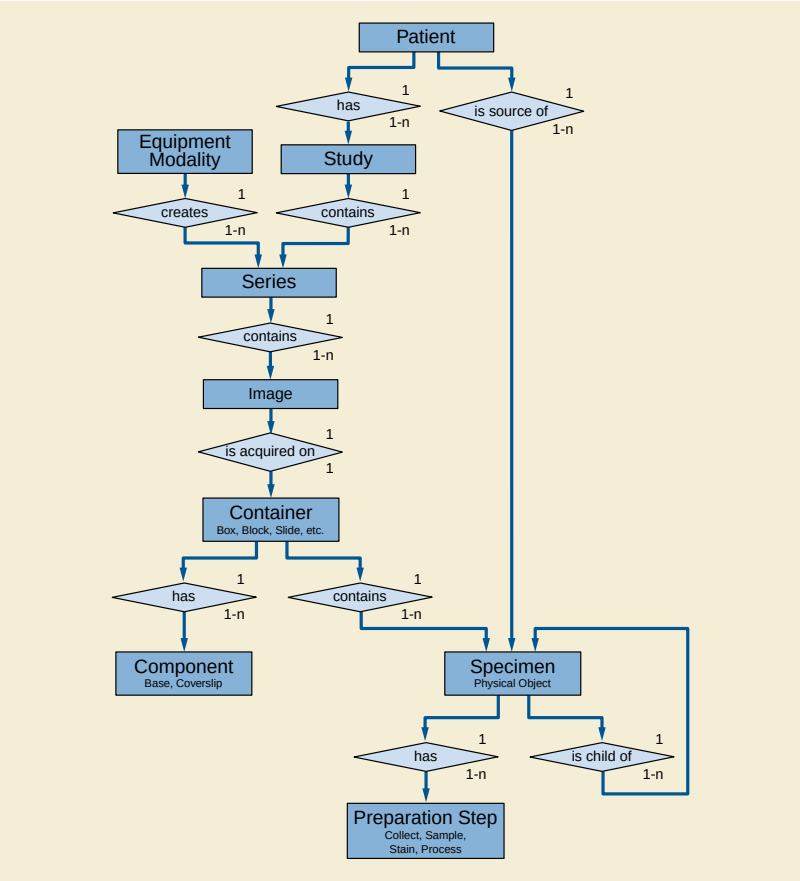


Figure 7.9-1. DICOM Model of the Real World - Specimens

7.9.1 Specimen

A physical object (or a collection of objects) is a specimen when the laboratory considers it a single discrete, uniquely identified unit that is the subject of one or more steps in the laboratory (diagnostic) workflow.

7.9.2 Container

Specimen containers (or just "containers") play an important role in laboratory (diagnostic) processes. In most, but not all, process steps, specimens are held in containers, and a container often carries its specimen's ID. Sometimes the container becomes intimately involved with the specimen (e.g., a paraffin block), and in some situations (such as examining tissue under the microscope) the container (the slide and coverslip) become part of the optical path.

7.9.3 Container Component

Containers are often made up of components. For example, a "slide" is container that is made up of the glass slide, the coverslip and the "glue" the binds them together.

7.9.4 Preparation Step

Before a slide is imaged, the preparation of the specimen (including sampling, processing and staining) will take place. Specimen preparation is described as a sequence of time-stamped process steps. Multiple steps are possible, and may include sampling from ancestor specimens.

7.10 Extension of DICOM Model of the Real World for Implant Templates

See Section 7.13.

Note

The specifications of this section have been consolidated into the Real World Model for Non-Patient-Related Information.

7.11 Extension of the DICOM Model of the Real World for the Unified Procedure Step (UPS)

The DICOM Model of the Real World is extended with the addition of a Unified Procedure Step object whose relationship to existing DICOM Real World objects is shown in Figure 7.11-1.

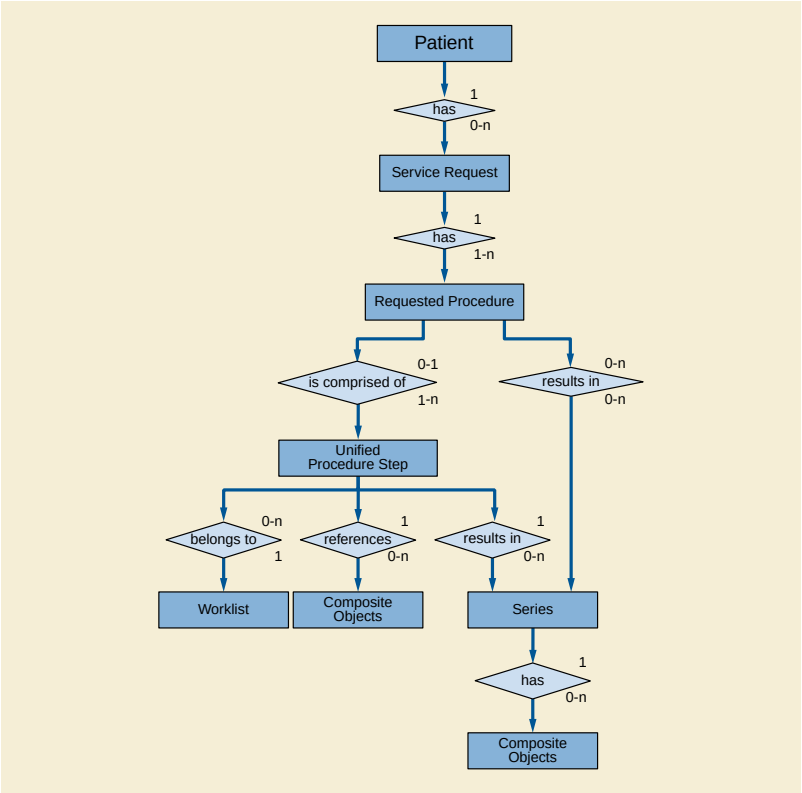


Figure 7.11-1. DICOM Model of the Real World - Unified Procedure Step

7.11.1 Unified Procedure Step

A Unified Procedure Step (UPS) represents an arbitrary unit of service. Unified Procedure Steps are generally scheduled in response to a Requested Procedure, although a UPS may be triggered by other events, such as a scheduled calibration, completion of prior work in a pipeline, etc.

The Unified Procedure Step (UPS) unifies the details of the procedure step that has been requested, the progress details during performance, and the details of the procedure step actually performed. The details can describe the specific service activity, the subject and/or data acted on, the originator and context of the request, the human/equipment/application resources involved, the priority, date, time and location of the activity, and references to resulting output data.

Normally the details about the activity as performed correspond to the details of the activity as requested, however real-world conditions may dictate that what is actually performed does not correspond exactly with what was requested or scheduled.

7.11.2 Worklist

A Worklist is an arbitrary collection of Unified Procedure Steps that share a common worklist label.

7.12 Extension of The DICOM Model of The Real World For Display System

The DICOM Model of the Real World is extended for Display System with the addition of an entity that is separate from the rest of the DICOM Real World objects, as shown in Figure 7.12-1. A Display System is not associated with any specific objects in the existing DICOM Information model, because it is not associated with a specific Patient. One Display System object is included in a Display System IOD.

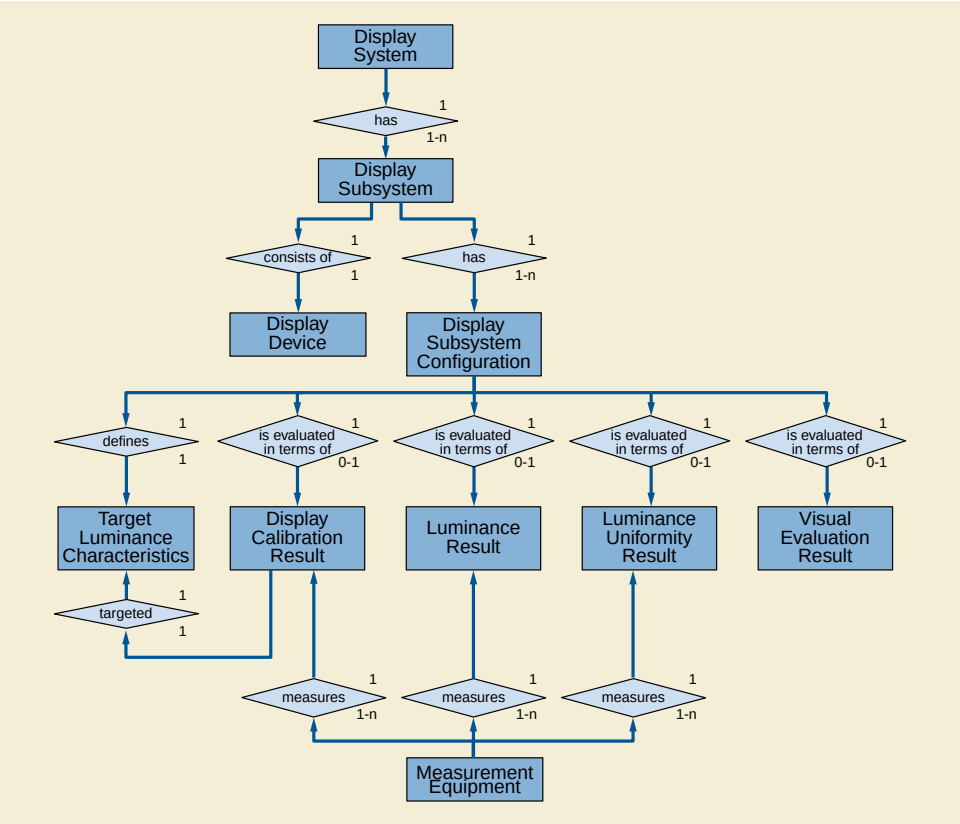


Figure 7.12-1. DICOM Model of the Real World - Display System

A Display Subsystem represents the target of a Display QA task such as calibration. For example, a PACS reading station with one color controller driving one display, and 4 grayscale displays each driven by two controllers is modeled as 5 Display Subsystems, each of which can be the target of a Display QA task. A tablet represents one Display System with a Display Device but no externally exposed controller. Although Display Subsystem may include components beyond the Display Device, this Model focuses on the Display Device only.

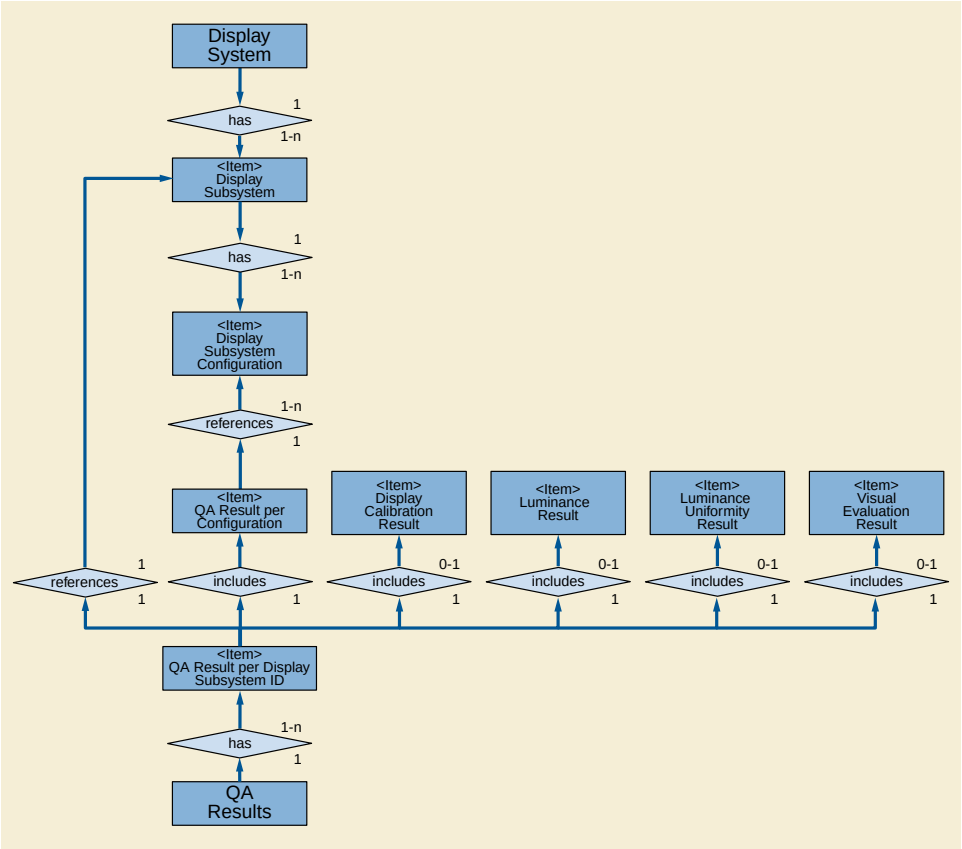


Figure 7.12-2. Display Subsystem Composition in the Display System IOD

Figure 7.12-2 illustrates how the composition of Display Subsystems is represented in the Display System IOD.

7.13 DICOM Model of the Real World for Non-Patient-Related Information

The DICOM Model of the Real World is extended for a variety of non-patient-related information with the specification of entities that are generally separate from the rest of the DICOM Real World Information Model. These information entities are not associated with a specific Patient. While there may be entity relationships, there is no hierarchy applied to these entities.

7.13.1 Hanging Protocol Information Entity

A Hanging Protocol Information Entity specifies the viewing preferences of a specific user or group, for a specific type of Study (Modality, Anatomy, Laterality combination, and optionally Procedure, and/or Reason). A Hanging Protocol definition includes descriptors that identify the Hanging Protocol, the creator, the type of Study it addresses, the type of image sets to display, the intended display environment, and the intended layout for the screen(s).

The Hanging Protocol IE does not have any relationships with other Information Entities. See Figure 7.13-1.

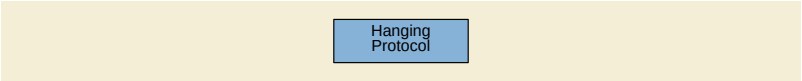


Figure 7.13-1. DICOM Model of the Real World - Hanging Protocol

7.13.2 Color Palette Information Entity

A Color Palette Information Entity specifies a color palette suitable for application to an image with a single channel of information (grayscale) to render it in color, i.e., pseudo-coloring.

The Color Palette IE may be referenced by Image or Presentation State Information Entities. See Figure 7.13-2.

The Color Palette IOD instantiates the Color Palette IE only.

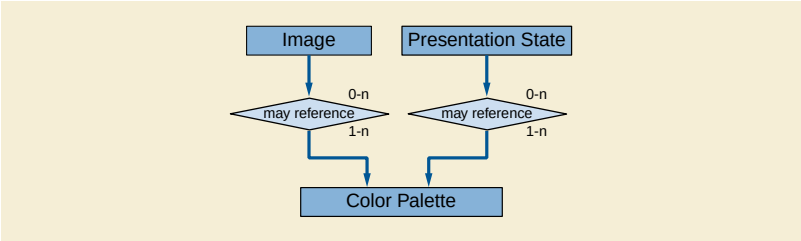


Figure 7.13-2. DICOM Model of the Real World - Color Palette

7.13.3 Implant Related Information Entities

7.13.3.1 Implant Template Information Entity

An Implant Template Information Entity specifies a 2D- and/or 3D-template representing a physical implant. The IE specifies mechanisms for implant assembly, i.e., the rigid connection of two or more implants.

The Implant Template IE may be related to a Surface IE (see Section A.1.2.18) or to an Encapsulated Document IE (see Section A.1.2.16) for the specification of the 2D- or 3D-template.

The Implant Template IE may be related to a Frame of Reference IE (see Section A.1.2.5) to support registration of the template with Patient anatomical landmarks in a separate Frame of Reference.

The Implant Template IE may be related to an Implant Assembly Template IE for the specification of multi-part assemblies. The Implant Template IE may be related to an Implant Template Group IE for shared management of a set of templates.

See Figure 7.13-3.

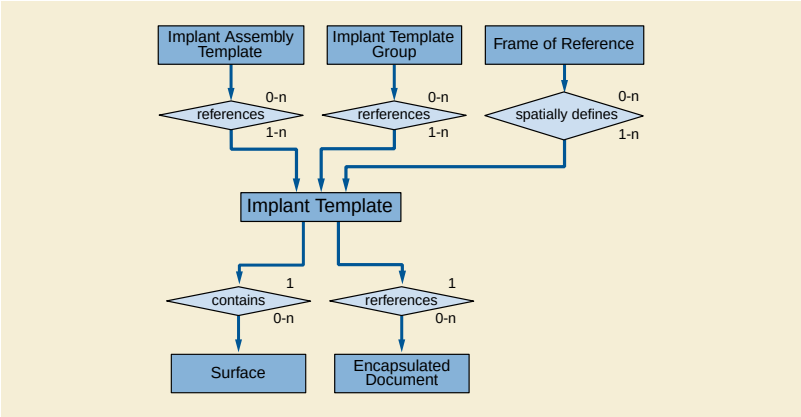


Figure 7.13-3. DICOM Model of the Real World - Implant Templates

7.13.3.2 Implant Assembly Template Information Entity

An Implant Assembly Template Information Entity specifies how to combine several implants to fulfill a certain purpose.

The Implant Assembly Template IE is related to Implant Template IEs.

7.13.3.3 Implant Template Group Information Entity

An Implant Template Group Information Entity specifies a set of Implant Templates for shared specification and management. It facilitates browsing through a set of similar implants by providing similar matching coordinates, and by ordering the referenced templates by dimensional size or similar attributes.

The Implant Template Group IE is related to Implant Template IEs.

7.13.4 Extension of The DICOM Model of The Real World For Protocol Storage

The DICOM Model of the Real World is extended with the addition of Defined Procedure Protocol and Performed Procedure Protocol objects whose ~~whose~~ relationship to existing DICOM Real World objects is shown in Figure 7.13.4-1.

Note that the information in the Equipment IE describes the equipment that created the Instance. The information in the Protocol Parameters may describe the equipment on which the protocol is intended to be executed which may or may not be the same as the equipment that created the Instance.

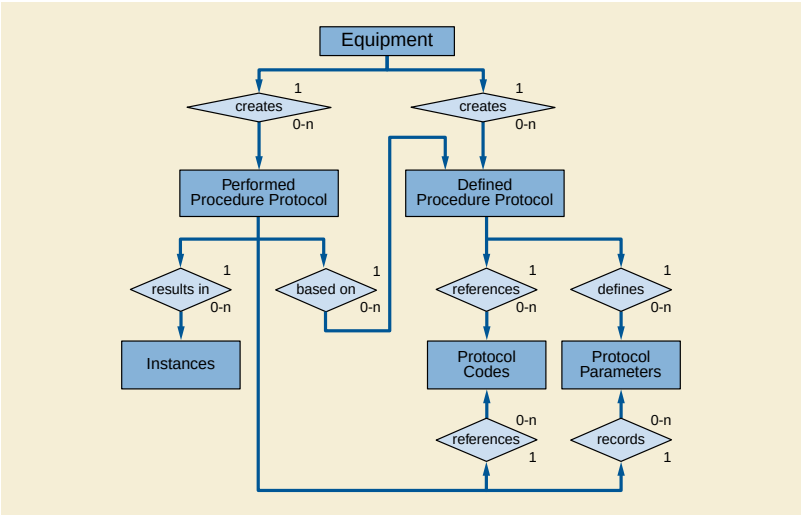


Figure 7.13.4-1. DICOM Model of the Real World - Protocol Storage

7.13.5 Approval Information Entity

An Approval Information Entity describes an approval of an Instance.

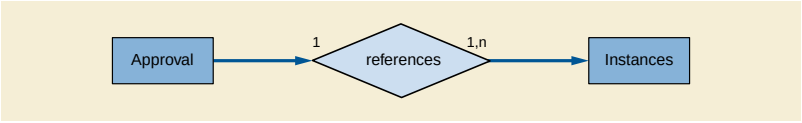


Figure 7.13.5-1. DICOM Model of the Real World - Approval

7.14 Extension of The DICOM Model of The Real-world for Radiotherapy Second Generation Information Objects

For the purpose of RT Second Generation SOP Classes the DICOM Model of the Real-World is described in this section. This subset of the real-world model covers the requirements for transferring information about planned and performed radiotherapeutic treatments and associated data.

Figure 7.14-1 describes the most important elements involved in the radiotherapy domain in DICOM.

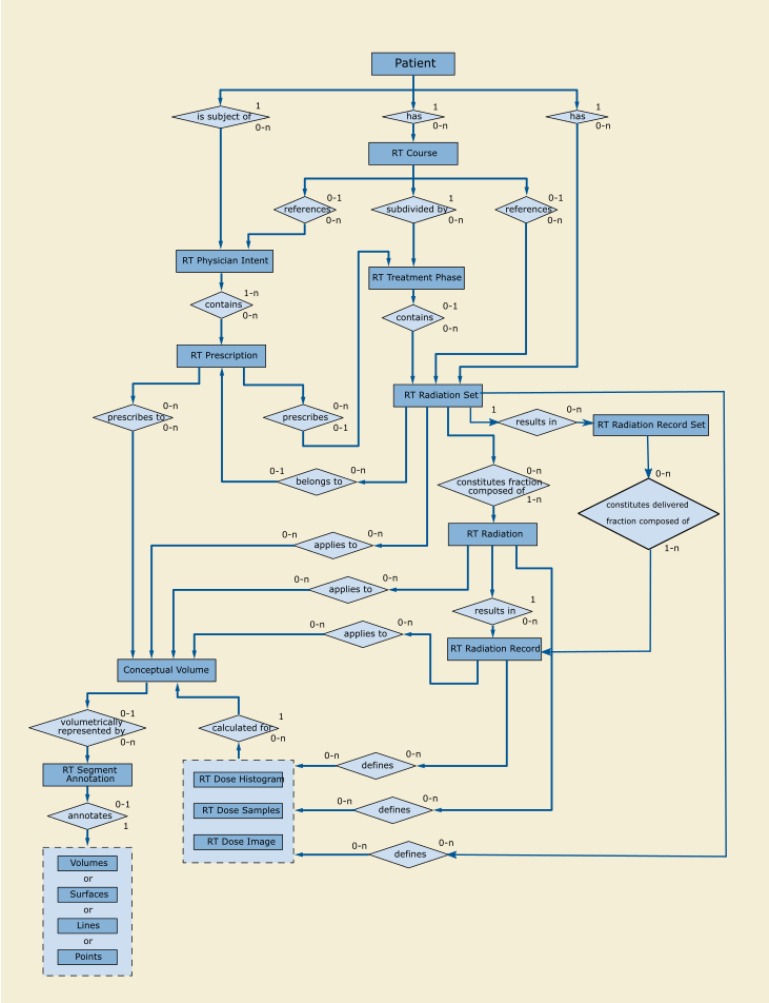


Figure 7.14-1. DICOM Model of the Real World - Radiotherapy

Note

1. IODs which contain a representation of Volumes, Surfaces, Lines, Points can be annotated by an RT Segment Annotation.
2. For better readability the diagram only contains the most important relationships, e.g. all objects have a relation to the Patient, but not all of these relationships are part of this diagram.

7.14.1 RT Course

The RT Course is a top-level entity that represents a radiotherapy treatment course, usually specified in one or more RT Prescriptions, generally for a defined tumor or group of tumors. A patient undergoing treatments of radiotherapy has one treatment course at a time. The RT Course may consist of several RT Treatment Phases (possibly with breaks of treatment in between them). Each treatment phase may consist of one or more RT Treatment Sessions. An RT Treatment Session is delivered in one patient visit to a venue with a treatment machine and will typically deliver a fraction of one or more RT Radiation Sets. A new RT Course is administered, when the patient is treated for a re-occurrence or a new tumor site - typically after a period of a year or more after the previous RT Course has been finished.

The RT Course can be thought of as a container collecting all major objects which are relevant to this course. The RT Physician Intent and RT Radiation Sets reference other companion objects necessary to prepare, conduct and review the treatment. Timing information (start dates and phasing of treatment, breaks etc.) are also part of the RT Course information. Additionally it contains information of

the ongoing status in treatment planning and delivery. The RT Course is a dynamic object that represents the current status of the patient"s treatment.

The RT Course may also include information about previously conducted treatments by referencing previous RT Course objects or by directly recording the information in Attributes.

7.14.2 RT Physician Intent

The RT Physician Intent describes how the physician wishes to achieve curative or palliative therapy. This information includes, but is not limited to the use of external radiation therapy or brachytherapy, total and fractional doses and fractionation schemes, treatment sites, Dosimetric Objectives, envisioned treatment technique, beam energy or isotopes, and patient setup notes.

7.14.3 Conceptual Volume

The Conceptual Volume is a reference to a certain anatomical region or point. Conceptual Volumes may or may not have a representation in segmented images. In most cases they will be related to one or more volumetric representations in various image sets taken at different times.

For example, during a radiotherapy course at the time of prescription, physicians specify regions to which dose is prescribed. Subsequently these regions are referenced in other objects in order to track calculated and delivered dose in the course of treatment. This referencing capability is provided by the Conceptual Volume.

7.14.4 RT Segment Annotation

The RT Segment Annotation annotates segmented regions defined in other SOP Instances with radiotherapy-specific information about the role and RT-specific types of the regions (e.g. clinical target volume, organ at risk, bolus) , and other information such as density definitions. An RT Segment Annotation SOP Instance may reference any geometric general-purpose representation entity defined by DICOM.

7.14.5 RT Radiation Set

An RT Radiation Set is a collection of RT Radiations. An RT Radiation Set defines a Radiotherapy treatment fraction, which will be applied one or more times. The RT Radiation Set is delivered by delivering the radiation of all referenced RT Radiations.

Parallel and intermittent fractionation schemes, e.g. treatment of several target sites with different timing schemes, are represented by multiple RT Radiation Sets.

7.14.6 RT Radiation

An RT Radiation is a contiguous set of Control Points, describing machine and positioning parameters to be applied during treatment delivery. An RT Radiation describes one portion of an RT Radiation Set and represents an single-fraction delivery of therapeutic radiation intended to be delivered in an indivisible manner. An RT Radiation is typically referred to in end-user terminology as a beam (in external beam treatment) or a catheter (in brachytherapy).

7.14.7 RT Radiation Record

The RT Radiation Record records actual treatment parameters that have been applied during the delivery of an RT Radiation in the context of a specific fraction. Typically, those parameters are the same as those described within an RT Radiation, but may differ due to therapist decisions and/or circumstances of the delivery technology and/or for various other reasons.

7.14.8 RT Treatment Phase

An RT Course may be divided into multiple RT Treatment Phases. Each RT Treatment Phase represents a period of time during which a defined number of RT Treatment Fractions are delivered by RT Radiation Sets in order to reach a specific treatment goal (see Section 7.14.9 and Section 7.14.10).

An RT Treatment Phase also defines the chronological relationship between RT Radiation Sets that are concurrently and/or subsequently treated.

7.14.9 RT Fractionation, RT Fractionation Scheme

Fractionation describes the splitting of a course of therapeutic radiation delivery into multiple sessions. Each session may consist of the delivery of one or more RT Radiation Sets. The temporal pattern of session is called a fractionation scheme.

Further descriptions and examples of this such schemes can seen in Section 7.14.10.

7.14.10 RT Treatment Session, RT Treatment Fraction

An RT Treatment Session is a collection of RT treatment events which are performed in a contiguous manner without any break in-between (other than time needed for required preparations) during a single Visit. It denotes the time period between the patient entering the treatment room and leaving the treatment room. In a treatment session one or more RT Radiation Sets (RSet in Figure 7.14-2) may be treated. An RT Treatment Session may also include imaging. A group of radiation deliveries that are separated by an intentional delay to accommodate radiobiological recovery effects are considered separate Treatment Sessions.

Each treatment of an RT Radiation Set is labeled as an RT Treatment Fraction (often abbreviated as Fx) with a fraction number starting with 1 at the first RT Treatment Session in which the RT Radiation Set is delivered, incremented by 1 at each subsequent treatment session.

An RT Treatment Fraction is the delivery of a portion of the total dose (whose delivery is defined by an RT Radiation Set) which has been divided equally into smaller doses to be delivered over a period of time (e.g. daily for 4-6 weeks). In radiotherapy, this division of dose over a period of time is known as dose fractionation.

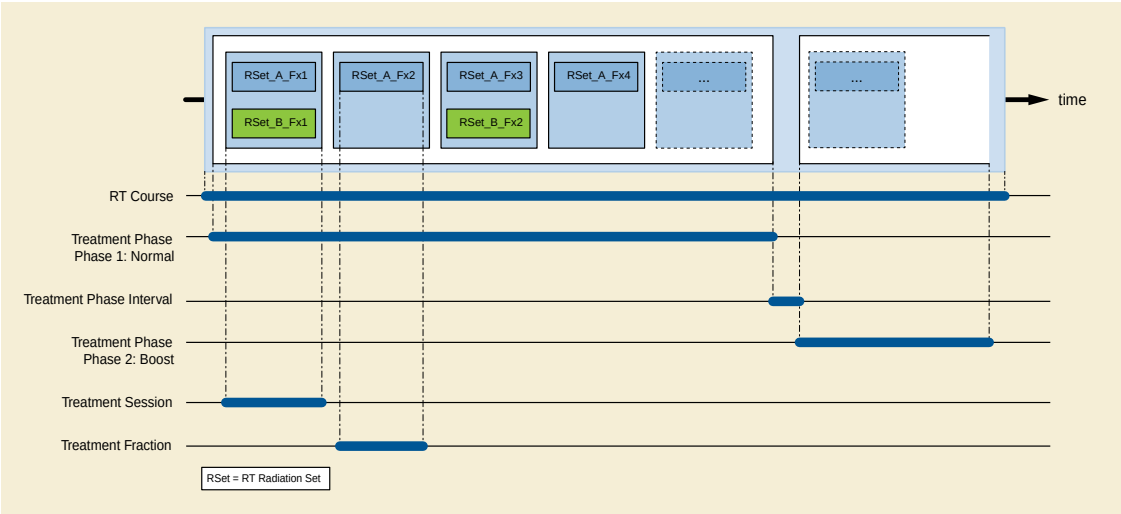


Figure 7.14-2. RT Treatment Phase, RT Treatment Session, RT Treatment Fraction

Partial treatments annotate RT Treatment Fractions, that are not completely performed for any reason (e.g. patient sickness, delivery device breakdown). The remainder of the RT Treatment Session is usually delivered at a later ~~time.This~~time. This remaining portion has the same fraction number as the one of the Partial Treatment Session. Further treatments will start a new RT Treatment Fraction with an incremented fraction number.

In Figure 7.14-3, the shaded areas of each Radiation Set represent the portion where dose is actually delivered. Partially shaded Radiation Sets therefore represents a partial treatment.

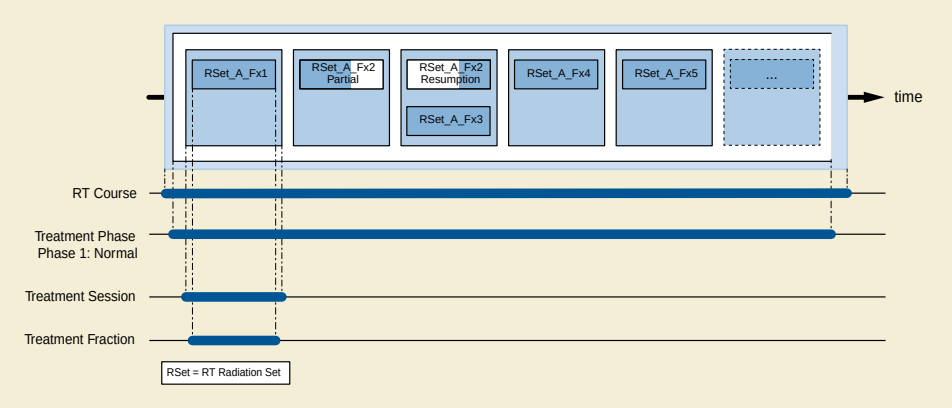


Figure 7.14-3. Partial RT Treatment Fraction and Resumption

7.14.11 Dosimetric Objective

The Dosimetric Objective Macro specifies an intended goal to be used in the definition of the dosimetric plan for plan optimization etc. Dosimetric Objectives may define limits which affect the dose, such as dose volume constraints, minimum or maximum dose, treatment time or MU limits, and radiobiologic effects.

8 Encoding of Coded Entry Data

The primary method of incorporating coded entry data in DICOM IODs is the Code Sequence Attribute. Code Sequence Attributes are encoded as a Sequence of Items using a Macro that is described in this section. These Attributes typically include the string "Code Sequence" in the Attribute Name. Their purpose is to encode terms by using codes from coding schemes.

Note

In this Standard, Code Sequence Attributes are defined for a variety of concepts, for example: Primary Anatomic Structure Sequence (0008,2228) and other Attributes to describe anatomy; and Intervention Drug Code Sequence (0018,0029), to document administration of drugs that have special significance in Imaging Procedures.

Each Item of a Code Sequence Attribute contains the triplet of Coding Scheme Designator (0008,0102), the Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)), and Code Meaning (0008,0104). Other optional and conditional Attributes may also be present.

For any particular Code Sequence Attributes, the range of codes that may be used for that Attribute (the Value Set) may be suggested or constrained by specification of a Context Group. The Module or Template in which the Attribute is used will specify whether or not the context group is baseline or defined. A Baseline Context Group lists codes for terms that are suggested and may be used, but are not required to be used. A Defined Context Group lists codes for terms that shall be used if the term is used.

Context Groups are defined in a Mapping Resource, such as the DICOM Content Mapping Resource (DCMR) specified in PS3.16. Context Groups consist of lists of contextually related coded concepts, including Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)) and Coding Scheme Designator (0008,0102). Each concept is unique within the Context Group and identified by its Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)) and Coding Scheme Designator (0008,0102). The Context Group specification identifies whether it is extensible, i.e., whether it may be modified in an Application to use additional terms (see PS3.16). Whether a Context Group is used as a Baseline or Defined Context Group is defined not in the mapping resource, but rather in the Template or Module in which the Code Sequence Attribute is used.

Context Groups are identified by labels referred to as Context Identifiers (CID). Formally, the Context Identifier specifies the context of use, not the specific list of coded values selected for that context of use in the Context Group. The set of values specified in the Standard for a particular context may change over time, and set of values used by an Application Entity for a particular context may include a local or private extension beyond the Standard value set.

Note

1. A specific set of coded values used by an Application Entity is therefore identified by the Mapping Resource Identifier, plus the Context Identifier, plus the Context Group Version, plus the identifiers for any private extension.
2. The use by an Application Entity of coded terms not in the Standard specified Context Group does not require the explicit identification of a private extension. The Application Entity is then the implicit source of the extension.
3. For the purpose of harmonization with HL7 vocabulary concepts, Context Groups are equivalent to HL7 Value Sets.

8.1 Code Value

Code Value (0008,0100) is an identifier that is unambiguous within the Coding Scheme denoted by Coding Scheme Designator (0008,0102) and Coding Scheme Version (0008,0103).

The Long Code Value (0008,0119) or URN Code Value (0008,0120) is only used for codes that exceed the 16 character size limit of Code Value (0008,0100). If the code value length exceeds 16, the Code Value (0008,0100) shall not be present. If the code value length is 16 characters or less, the Code Value (0008,0100) shall contain the code and neither Long Code Value (0008,0119) nor URN Code Value (0008,0120) shall be present. The URN Code Value (0008,0120) shall be used for codes that are represented using URN or URL notation. The Long Code Value (0008,0119) shall be used for codes that are represented using other notations and that exceed 16 characters in length.

Note

The Code Value is typically not a natural language string, e.g., "76752008".

8.2 Coding Scheme Designator and Coding Scheme Version

The Attribute Coding Scheme Designator (0008,0102) identifies the coding scheme in which the code for a term is defined. Standard coding scheme designators used in DICOM information interchange are listed in PS3.16. Other coding scheme designators, for both private and public coding schemes, may be used, in accordance with PS3.16. Further identification of the coding scheme designators used in a SOP Instance may be provided in the Coding Scheme Identification Sequence (0008,0110) (see Section C.12.1).

Note

1. Typical coding schemes used in DICOM include "DCM" for DICOM defined codes, "SCT" for SNOMED CT, and "LN" for LOINC. See Annex 8 “Coding Schemes” in PS3.16.
2. Coding scheme designators beginning with "99" and the coding scheme designator "L" are defined in HL7 V2 to be private or local coding schemes.
3. Most IODs that define the use of coded terms provide for the use of private codes and coding schemes through replacement of Baseline Context Groups or extension of Defined Context Groups. Systems supporting such private code use must provide a mechanism for the configuration of sets of Coding Scheme Designator (0008,0102), Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)), and Code Meaning (0008,0104) to support interoperation of the private codes with other systems.
4. It is highly recommended that local or non-standard coding schemes be identified in the Coding Scheme Identification Sequence (0008,0110). Documents or machine readable representations of the coding scheme (e.g., CSV or OWL files) can be linked to via a Coding Scheme URL (0008,010E). For appropriate values, see Table 8-1 “Coding Schemes” in PS3.16.
5. URN and URL codes usually lack a Coding Scheme Designator (0008,0102).

The Attribute Coding Scheme Version (0008,0103) may be used to identify the version of a coding scheme if necessary to resolve ambiguity in Code Value (0008,0100), Long Code Value (0008,0119) or URN Code Value (0008,0120). Coding Scheme Version (0008,0103) is not required for backward-compatible revisions of a coding scheme, as the Coding Scheme Designator (0008,0102) identifies the coding scheme as a whole as currently published by the responsible organization.

Note

1. See PS3.16 for a discussion of SNOMED Coding Scheme Designators 99SDM, SNM3, SRT and SCT.
2. ICD-10, for example, is not a backward-compatible revision of ICD-9, and hence it has a different Coding Scheme Designator, not simply a different Coding Scheme Version.

8.3 Code Meaning

Code Meaning (0008,0104) is text that has meaning to a human and conveys the meaning of the term defined by the combination of Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)), and Coding Scheme Designator (0008,0102). Though such a meaning can be "looked up" in the dictionary for the coding scheme, it is encoded for the convenience of applications that do not have access to such a dictionary.

It should be noted that for a particular Coding Scheme Designator (0008,0102) and Code Value (0008,0100) or Long Code Value (0008,0119), or URN Code Value (0008,0120), several alternative values for Code Meaning (0008,0104) may be defined. These may be synonyms in the same language or translations of the Coding Scheme into other languages. Hence the value of Code Meaning (0008,0104) shall never be used as a key, index or decision value, rather the combination of Coding Scheme Designator (0008,0102) and Code Value (0008,0100), Long Code Value (0008,0119), or URN Code Value (0008,0120) may be used. Code Meaning (0008,0104) is a purely annotative, descriptive Attribute.

This does not imply that Code Meaning (0008,0104) can be filled with arbitrary free text. Available values from the Coding Scheme or translation in the chosen language shall be used.

8.4 Mapping Resource

The value of Mapping Resource (0008,0105) denotes the message/terminology Mapping Resource that specifies the Context Group that specifies the Value Set. The Defined Terms for the value of Mapping Resource (0008,0105) shall be:

Defined Terms:

DCMR DICOM Content Mapping Resource
SDM SNOMED DICOM Microglossary (Retired)

PS3.16 specifies the DICOM Content Mapping Resource (DCMR).

Note

Unless otherwise specified, the DCMR is the source of all Context Groups and Templates specified in this Standard.

Mapping Resources may be uniquely identified by Mapping Resource UID (0008,0118).

Private Mapping Resources (those not listed amongst the Defined Terms in this section), may be identified by the prefix "99".

Mapping Resource Name (0008,0122) may contain the name of the Mapping Resource. The value may e.g., denote the Institution or organization that has specified the Value Set.

8.5 Context Group Version

Context Group Version (0008,0106) conveys the version of the Context Group identified by Context Identifier (0008,010F). This Attribute uses VR DT, but for Context Groups defined in PS3.16 the precision of Context Group Version is limited to the day, and the time zone offset is not used.

8.6 Context Identifier and Context UID

The value of Context Identifier (0008,010F) identifies the Context Group defined by Mapping Resource (0008,0105) from which the values of Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)) and Code Meaning (0008,0104) were selected, or to which Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)) and Code Meaning (0008,0104) have been added as a private Context Group extension (see Section 8.7). The Context Identifier Attribute uses VR CS, and for Context Groups defined in PS3.16 the value shall be the Context Group Identifier as a string of digits without leading zeros, and does not include the string "CID".

The value of Context UID (0008,0117) uniquely identifies the Context Group. See PS3.6.

Note

Privately defined Context Groups may be identified by Context Identifier and Mapping Resource.

8.7 Context Group Extensions

Context Group Extension Flag (0008,010B) may be used to designate a pair of Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120)) and Code Meaning (0008,0104) as a selection from a private extension of a Context Group. If the Context Group Extension Flag is present, and has a value of "Y", Context Group Extension Creator UID (0008,010D) shall be used to identify the person or organization who created the extension to the Context Group. Context Group Local Version (0008,0107) conveys an implementation-specific private version DateTime of a Context Group that contains private extensions

Note

1. These Attributes provide the means for implementations to extend code sets conveniently, while preserving referential integrity with respect to the original Context Group Version.

2. The locally-defined (private) value of Context Group Local Version (0008,0107) typically would be a more recent date than the standard value of Context Group Version (0008,0106) specified in the standard message/terminology Mapping Resource that defines the Context Group.

8.8 Standard Attribute Sets for Code Sequence Attributes

Table 8.8-1 specifies the default set of Attributes encapsulated in the Items of Code Sequence Attributes. These Attributes comprise the Code Sequence Macro.

Note

The instruction "*Include Table 8.8-1 “Code Sequence Macro Attributes”* " may be used in an Information Object Definition as a concise way to indicate that the Attributes of Table 8.8-1 are included in the specification of the Attribute Set of a Sequence of Items. Additional constraints on the Code Sequence Data Element (such as a Context Group that defines the value set) may be appended to the "*Include Table 8.8-1 “Code Sequence Macro Attributes”* " instruction.

The default specifications of this Section are overridden within the scope of a Sequence Item or Code Sequence Attribute or IOD by corresponding specifications defined within the scope of that Sequence Item or Code Sequence Attribute or IOD. Additional Attributes may also be specified by the instantiation of the Macro.

The Basic Coded Entry Attributes fully define a Coded Entry. If it is desired to convey the list from which a code has been chosen, then the optional Enhanced Encoding Mode Attributes may also be present.

Table 8.8-1a. Basic Code Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
BASIC CODED ENTRY ATTRIBUTES			
Code Value	(0008,0100)	1C	The identifier of the Coded Entry. See Section 8.1. Shall be present if the code value length is 16 characters or less, and the code value is not a URN or URL.
Coding Scheme Designator	(0008,0102)	1C	The identifier of the coding scheme in which the Coded Entry is defined. See Section 8.2. Shall be present if Code Value (0008,0100) or Long Code Value (0008,0119) is present. May be present otherwise.
Coding Scheme Version	(0008,0103)	1C	An identifier of the version of the coding scheme if necessary to resolve ambiguity. See Section 8.2. Required if the value of Coding Scheme Designator (0008,0102) is present and is not sufficient to identify the Code Value (0008,0100) or Long Code Value (0008,0119) unambiguously. Shall not be present if Coding Scheme Designator (0008,0102) is absent. May be present otherwise.
Code Meaning	(0008,0104)	1	Text that conveys the meaning of the Coded Entry. See Section 8.3.
Long Code Value	(0008,0119)	1C	The identifier of the Coded Entry. See Section 8.1. Shall be present if Code Value (0008,0100) is not present and the Code Value is not a URN or URL.
URN Code Value	(0008,0120)	1C	The identifier of the Coded Entry. See Section 8.1. Shall be present if Code Value (0008,0100) is not present and the Code Value is a URN or URL.

Table 8.8-1b. Enhanced Code Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Context Identifier	(0008,010F)	3	The identifier of the Context Group from which the Coded Entry was selected. See Section 8.6.
Context UID	(0008,0117)	3	The unique identifier of the Context Group from which the Coded Entry was selected. See Section 8.6.
Mapping Resource	(0008,0105)	1C	The identifier of the Mapping Resource that defines the Context Group from which Coded Entry was selected. See Section 8.4. Required if Context Identifier (0008,010F) is present.
Mapping Resource UID	(0008,0118)	3	The unique identifier of the Mapping Resource that defines the Context Group from which Coded Entry was selected. Note The unique identifier for the DICOM Content Mapping Resource "DCMR" is defined in PS3.6.
Mapping Resource Name	(0008,0122)	3	The name of the Mapping Resource that defines the Context Group from which Coded Entry was selected. See Section 8.4.
Context Group Version	(0008,0106)	1C	The identifier of the version of the Context Group from which the Coded Entry was selected. See Section 8.5. Required if Context Identifier (0008,010F) is present.
Context Group Extension Flag	(0008,010B)	3	Indicates whether the triplet of Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120))/Coding Scheme Designator (0008,0102)/Code Meaning (0008,0104) is selected from a private extension of the Context Group identified in Context Identifier (0008,010F). See Section 8.7. Enumerated Values: **Y** **N**
Context Group Local Version	(0008,0107)	1C	An implementation-specific version of a Context Group that contains private extensions. See Section 8.7. Required if the value of Context Group Extension Flag (0008,010B) is "Y".
Context Group Extension Creator UID	(0008,010D)	1C	Identifies the person or organization who created an extension to the Context Group. See Section 8.7. Required if the value of Context Group Extension Flag (0008,010B) is "Y".

Table 8.8-1. Code Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
BASIC CODED ENTRY ATTRIBUTES			

Attribute Name	Tag	Type	Attribute Description
Include Table 8.8-1a			
Equivalent Code Sequence	(0008,0121)	3	Codes that are considered equivalent by the creating system. One or more Items are permitted in this Sequence. See Section 8.9.
>Include Table 8.8-1a			
>Include Table 8.8-1b			
ENHANCED ENCODING MODE			
Include Table 8.8-1b			

8.9 Equivalent Code Sequence

The Equivalent Code Sequence (0008,0121) Attribute may optionally be used to convey different codes for the same concept.

Equivalence is defined as having the same or similar meaning, and requires that equivalent concepts do not include different aspects, properties, features, characteristics, or parameters.

Note

E.g., the SNOMED and FMA codes for a structure of the breast, (76752008, SCT, "Breast") and (57983, FMA, "Breast") would be considered equivalent. Neither would be equivalent to concepts that pre-coordinated other aspects such as laterality, e.g., (80248007, SCT, "Left breast"), or entire body organ, e.g., (181131000, SCT, "Entire breast").

Some scenarios in which it is helpful for the creating system to send equivalent codes include:

- when different representations of the same concept are present in a standard coding scheme, such as the SNOMED-CT and SNOMED-RT and CTV3 style identifiers,
- when the same concept is present in different standard coding schemes, but considered by the creating system to be synonymous, such as anatomical concepts from SNOMED and FMA, and
- when the same concept is present in a local as well as a standard coding scheme, but considered by the creating system to be synonymous, such as a local private procedure code and the same concept in LOINC or SNOMED or RADLEX.

The Table 8.8-1b may be used to identify a Context Group from which the codes were selected, such as for a particular cross-institutional, cross-application context for trials, research and knowledge-based applications.

8.10 Coded Entry Data Examples

An example of a long SNOMED CT code encoding as an Item in a Sequence:

Nesting	Attribute Name	Tag	VR	Value
%item				
>	Coding Scheme Designator	(0008,0102)	SH	SCT
>	Code Meaning	(0008,0104)	LO	Invasive diagnostic procedure
>	Long Code Value	(0008,0119)	UC	621566751000087104
%enditem				

Note

SCT:621566751000087104 is not included in the SNOMED CT DICOM Subset and is not present in the SNOMED CT INT release. It is from the Canadian National Extension and is used here only as an example.

An example of a short SNOMED CT with equivalent SNOMED SRT and CTV3 (Read) codes as an Item in a Sequence:

Nesting	Attribute Name	Tag	VR	Value
%item				
>	Code Value	(0008,0100)	SH	406400000
>	Coding Scheme Designator	(0008,0102)	SH	SCT
>	Code Meaning	(0008,0104)	LO	Dimeglumine gadopentetate 469.01mg/mL inj soln 15mL pfld syr
>	Equivalent Code Sequence	(0008,0121)	SQ	
%sequence				
%item				
>>	Code Value	(0008,0100)	SH	C-B0478
>>	Coding Scheme Designator	(0008,0102)	SH	SRT
>>	Code Meaning	(0008,0104)	LO	Dimeglumine gadopentetate 469.01mg/mL inj soln 15mL pfld syr
%enditem				
%item				
>>	Code Value	(0008,0100)	SH	XUaZB
>>	Coding Scheme Designator	(0008,0102)	SH	CTV3
>>	Code Meaning	(0008,0104)	LO	Dimeglumine gadopentetate 469.01mg/mL inj soln 15mL pfld syr
%enditem				
%endseq				
%enditem				

Note

SCT:406400000 is not included in the SNOMED CT DICOM Subset and is used here only as an example.

An example of encoding a long URN as an Item in a Sequence.

Nesting	Attribute Name	Tag	VR	Value
%item				
>	Code Meaning	(0008,0104)	LO	HIPAA Privacy Rule
>	URN Code Value	(0008,0120)	UR	urn:lex:us:federal:codified.regulation:2013-04-25;45CFR164
%enditem				

8.11 Retired Codes and Expected Behavior

As this Standard and external coding schemes are maintained, the codes specified as Values for Attributes and in Conditions may change. The previous codes are considered Retired but implementations may continue to send them and receivers will be expected to be able to continue to recognize the Retired codes, including the Code Value and Coding Scheme Designator, even if the current Standard does not publish them.

A notable example is the change throughout the Standard from using "SNOMED-RT style" code values with a Coding Scheme Designator of "SRT", "SNM3" or "99SDM", to the use of SNOMED CT numeric code values with a Coding Scheme Designator of "SCT". Those retired codes may be found in PS3.3 2019a. A mapping of retired to new SNOMED codes is found in Annex O “SNOMED Concept ID to SNOMED ID Mapping” in PS3.16.

9 Template Identification Macro (Retired)

Section 9 was defined in a previous version of the DICOM Standard (see PS3.3-2004). The Section is now retired, and its contents have been consolidated into Section C.18.8.

10 Miscellaneous Macros

10.1 Person Identification Macro

This Macro may be invoked to specify a coded representation of a person such as a healthcare worker, and the organization to which they are responsible.

Note

1. This Macro is typically invoked within a Sequence Item used to identify an individual such as a physician or a device operator.
2. The free-text name of the individual is not included in this Macro since there are already widely used specific Attributes to hold such values.
3. No Baseline, Defined or Enumerated CIDs are defined nor is any particular coding scheme specified. In practice, workers are usually identified by using a locally or nationally specific coding scheme. For example, a local Coding Scheme Designator might be used and the individual's internal hospital ID number user in Code Value.
4. The organization is specified by either a coded Sequence or a free text name but not both. A Baseline CID of standard organizations is provided for the purpose of identifying standard organizations responsible for creation of Well Known Instances.

Table 10-1. Person Identification Macro Attributes Description

Attribute Name	Tag	Type	Attribute Description
Person Identification Code Sequence	(0040,1101)	1	A coded entry that identifies a person. The Code Meaning Attribute, though it will be encoded with a VR of LO, may be encoded according to the rules of the PN VR (e.g., caret '^' delimiters shall separate name components), except that a single component (i.e., the whole name unseparated by caret delimiters) is not permitted. Name component groups for use with multi-byte character sets are permitted, as long as they fit within the 64 characters (the length of the LO VR). One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Person's Address	(0040,1102)	3	Person's mailing address
Person's Telephone Numbers	(0040,1103)	3	Person's telephone number(s)
Person's Telecom Information	(0040,1104)	3	The person's telecommunication contact information, including telephone, email, or other telecom addresses. Note 1. This Attribute may have internal format or structure in accordance with local agreement or profile. In the absence of such agreement or prior formatting, use of ITU-T E.123 is suggested. 2. It is recommended that this Attribute be treated as equivalent to HL7v2 (v2.5 or later) field ROL-12, and be formatted in accordance with the HL7v2 XTN data type (without escapes for HL7 message structure reserved characters). See additional notes in the Module invoking this Macro.

Attribute Name	Tag	Type	Attribute Description
Institution Name	(0008,0080)	1C	Institution or organization to which the identified individual is responsible or accountable. Required if Institution Code Sequence (0008,0082) is not present.
Institution Address	(0008,0081)	3	Mailing address of the institution or organization to which the identified individual is responsible or accountable.
Institution Code Sequence	(0008,0082)	1C	Institution or organization to which the identified individual is responsible or accountable. Required if Institution Name (0008,0080) is not present. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 5002 "Organizations".*
Institutional Department Name	(0008,1040)	3	The Department, Unit or Service within the healthcare facility.
Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Note This might be obtained from a corresponding HL7v2 message containing PV1:10 Hospital Service. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7030 "Institutional Departments, Units and Services".*

10.2 Content Item Macro

A Content Item is a flexible means of encoding attribute identifiers and attribute values using the Code Sequence Macro (see Section 8) for coded terminology defined by a coding scheme. The Content Item provides a name-value pair, i.e., a Concept Name, encoded as a Code Sequence, and a Concept Value. The Concept Value may be encoded by any of a set of generic Attributes, as specified by a Value Type, including text, personal name, numeric, and coded concept (Code Sequence) values.

Note

1. Comparing a Content Item to a native DICOM Data Element, the Concept Name Code Sequence corresponds to the Data Element Tag and Attribute Name, the Value Type to the Value Representation, and the Concept Value to the Data Element Value Field. See PS3.5.

2. The IMAGE Value Type of this Macro does not include the Type 3 Attributes of the IMAGE Value Type defined in Section C.17.3, as they are not required for Acquisition Context or Protocol Context Content Items.

Specific uses of the Content Item may invoke the Content Item Macro defined in this Section, the Document Content Macro of Section C.17.3, or another similar construct. An invocation of the Content Item Macro may constrain the allowed values of Value Type (0040,A040).

Note

1. The NUMERIC Value Type of this Macro differs from the NUM Value Type defined in Section C.17.3, since the encoding of the Concept Value is different.

2. The Value Type uses Enumerated Values so as to assure that non-standard Value Types are not used, and to prevent the nefarious use, for example, of a CONTAINER Value Type in an SR-like manner to create nested content, which is not the intent.

3. Some invocations of this Macro may use the Content Item Modifier Sequence (0040,0441) to achieve a single level of "nesting". That Attribute is not included in this Macro itself, to prevent recursive inclusion.

See Section 5.4 for the meaning of the Type column in this Macro when applied to Normalized IODs.

Table 10-2. Content Item Macro Attributes Description

Attribute Name	Tag	Type	Attribute Description
Value Type	(0040,A040)	1	The type of the value encoded in this name-value Item. Enumerated Values: **DATE** **TIME** **DATETIME** **PNAME** **UIDREF** **TEXT** **CODE** **NUMERIC** **COMPOSITE** **IMAGE**
Observation DateTime	(0040,A032)	3	The date and time on which this Item was completed. For the purpose of recording measurements or logging events, completion time is defined as the ending time of data acquisition of the measurement, or the ending time of occurrence of the event.
Concept Name Code Sequence	(0040,A043)	1	Coded concept name of this name-value Item. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
DateTime	(0040,A120)	1C	DateTime value for this name-value Item. Required if Value Type (0040,A040) is DATETIME.
Date	(0040,A121)	1C	Date value for this name-value Item. Required if Value Type (0040,A040) is DATE.
Time	(0040,A122)	1C	Time value for this name-value Item. Required if Value Type (0040,A040) is TIME.
Person Name	(0040,A123)	1C	Person name value for this name-value Item. Required if Value Type (0040,A040) is PNAME.
UID	(0040,A124)	1C	UID value for this name-value Item. Required if Value Type (0040,A040) is UIDREF.
Text Value	(0040,A160)	1C	Text value for this name-value Item. Required if Value Type (0040,A040) is TEXT.
Concept Code Sequence	(0040,A168)	1C	Coded concept value of this name-value Item. Only a single Item shall be included in this Sequence. Required if Value Type (0040,A040) is CODE.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Numeric Value	(0040,A30A)	1C	Numeric value for this name-value Item. Only a single value shall be present. Required if Value Type (0040,A040) is NUMERIC.

Attribute Name	Tag	Type	Attribute Description
Floating Point Value	(0040,A161)	1C	The floating point representation of Numeric Value (0040,A30A). The same number of values as Numeric Value (0040,A30A) shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent the value as a string. May be present otherwise.
Rational Numerator Value	(0040,A162)	1C	The integer numerator of a rational representation of Numeric Value (0040,A30A). Encoded as a signed integer value. The same number of values as Numeric Value (0040,A30A) shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent a rational value as a string. May be present otherwise.
Rational Denominator Value	(0040,A163)	1C	The integer denominator of a rational representation of Numeric Value (0040,A30A). Encoded as a non-zero unsigned integer value. The same number of values as Numeric Value (0040,A30A) shall be present. Required if Rational Numerator Value (0040,A162) is present.
Measurement Units Code Sequence	(0040,08EA)	1C	Units of measurement for a numeric value in this name-value Item. Only a single Item shall be included in this Sequence. Required if Value Type (0040,A040) is NUMERIC.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 82 “Units of Measurement”.*
Referenced SOP Sequence	(0008,1199)	1C	Composite SOP Instance Reference value for this name-value Item. Only a single Item shall be included in this Sequence. Required if Value Type (0040,A040) is COMPOSITE or IMAGE.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Referenced Frame Number	(0008,1160)	1C	Identifies the frame numbers within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Note This Attribute may be multi-valued. Required if the Referenced SOP Instance is a multi-frame image and the reference does not apply to all frames, and Referenced Segment Number (0062,000B) is not present.
>Referenced Segment Number	(0062,000B)	1C	Identifies the segments to which the reference applies identified by Segment Number (0062,0004). Required if the Referenced SOP Instance is a Segmentation or Surface Segmentation and the reference does not apply to all segments and Referenced Frame Number (0008,1160) is not present.

10.2.1 Content Item With Modifiers Macro

Content Item with Modifiers is a means of describing structured content which needs a Content Item with single optional level of modifiers, i.e. a two-level structure of Content Items. An invocation of the Content Item with Modifiers Macro will usually specify the allowed values using a Protocol Context Template in PS3.16, which allows a single Nesting Level (see in Section 6.1.2 “Nesting Level (NL)” in PS3.16). Constraints on the use of this Macro may be specified in PS3.16 Annex C, which may be invoked in IODs in PS3.3.

Table 10.2.1-1. Content Item with Modifiers Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-2 "Content Item Macro Attributes Description"			*No Baseline TID is defined.*
Content Item Modifier Sequence	(0040,0441)	3	Specifies modifiers for the Content Item. One or more Items are permitted in this Sequence.
>Include Table 10-2 "Content Item Macro Attributes Description"			*No Baseline TID is defined.*

10.3 Image SOP Instance Reference Macro

Table 10-3. Image SOP Instance Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Referenced Frame Number	(0008,1160)	1C	Identifies the frame numbers within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Note This Attribute may be multi-valued. Required if the Referenced SOP Instance is a multi-frame image and the reference does not apply to all frames, and Referenced Segment Number (0062,000B) is not present.
Referenced Segment Number	(0062,000B)	1C	Identifies the Segment Number to which the reference applies. Required if the Referenced SOP Instance is a Segmentation or Surface Segmentation and the reference does not apply to all segments and Referenced Frame Number (0008,1160) is not present.

Table 10-3b "Referenced Instances and Access Macro Attributes" contains identifiers and access details for a collection of Instances. It is intended to provide sufficient information to retrieve the referenced Instances.

Table 10-3b. Referenced Instances and Access Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Type of Instances	(0040,E020)	1	Type of object Instances referenced. Defined Terms: **DICOM** **CDA**
Study Instance UID	(0020,000D)	1C	Unique identifier for the Study. Required if Type of Instances (0040,E020) is DICOM and the Information Model of the referenced Instance contains the Study IE
Series Instance UID	(0020,000E)	1C	Unique identifier for the Series that is part of the Study identified in Study Instance UID (0020,000D), if present, and contains the referenced object Instance(s). Required if Type of Instances (0040,E020) is DICOM and the Information Model of the referenced Instance contains the Series IE

Attribute Name	Tag	Type	Attribute Description
Referenced SOP Sequence	(0008,1199)	1	References to object Instances. One or more Items shall be included in this Sequence
>Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
>HL7 Instance Identifier	(0040,E001)	1C	Instance Identifier of the encapsulated HL7 Structured Document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier). Required if Type of Instances (0040,E020) is CDA.
>Referenced Frame Number	(0008,1160)	1C	Identifies the frame numbers within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Note This Attribute may be multi-valued. Required if the Referenced SOP Instance is a multi-frame image and the reference does not apply to all frames, and Referenced Segment Number (0062,000B) is not present.
>Referenced Segment Number	(0062,000B)	1C	Identifies the Segment Number to which the reference applies. Required if the Referenced SOP Instance is a Segmentation and the reference does not apply to all segments and Referenced Frame Number (0008,1160) is not present.
DICOM Retrieval Sequence	(0040,E021)	1C	Details for retrieving Instances via the DICOM Retrieve Service. Required if DICOM Media Retrieval Sequence (0040,E022), WADO Retrieval Sequence (0040,E023), WADO-RS Retrieval Sequence (0040,E025) and XDS Retrieval Sequence (0040,E024) are not present. May be present otherwise. This Sequence shall only identify sources known to have Instances referenced in Referenced SOP Sequence (0008,1199). One or more Items shall be included in this Sequence.
>Retrieve AE Title	(0008,0054)	1	Title of a DICOM Application Entity where the referenced Instance(s) may be retrieved on the network.
DICOM Media Retrieval Sequence	(0040,E022)	1C	Details for retrieving Instances from Media. Required if DICOM Retrieval Sequence (0040,E021), WADO Retrieval Sequence (0040,E023), and WADO-RS Retrieval Sequence (0040,E025) and XDS Retrieval Sequence (0040,E024) are not present. May be present otherwise. This Sequence shall only identify media known to have Instances referenced in Referenced SOP Sequence (0008,1199). One or more Items shall be included in this Sequence.
>Storage Media File-Set ID	(0088,0130)	2	The user or implementation specific human readable identifier that identifies the Storage Media on which the referenced Instance(s) reside.
>Storage Media File-Set UID	(0088,0140)	1	Uniquely identifies the Storage Media on which the referenced Instance(s) reside.

Attribute Name	Tag	Type	Attribute Description
WADO Retrieval Sequence	(0040,E023)	1C	Details for retrieving Instances available via WADO-URI. Note This Sequence addresses use of the URI-based Web Access to DICOM Objects. Retrieval via the IHE XDS-I.b RAD-69 Transaction is addressed in the XDS Retrieval Sequence (0040,E024). Required if DICOM Retrieval Sequence (0040,E021), DICOM Media Retrieval Sequence (0040,E022), WADO-RS Retrieval Sequence (0040,E025) and XDS Retrieval Sequence (0040,E024) are not present. May be present otherwise. One or more Items shall be included in this Sequence.
>Retrieve URI	(0040,E010)	1	URI/URL specifying the location of the referenced Instance(s). Includes fully specified scheme, authority, path, and query in accordance with [RFC3986]. Note The VR of this Data Element has changed from UT to UR.
XDS Retrieval Sequence	(0040,E024)	1C	Details for retrieving Instances using the IHE XDS-I.b RAD-69 Transaction. Note Retrieval via WADO-URI is addressed by the WADO Retrieval Sequence (0040,E023). Retrieval via WADO-RS is addressed by the WADO-RS Retrieval Sequence (0040,E025). Required if DICOM Retrieval Sequence (0040,E021), DICOM Media Retrieval Sequence (0040,E022), WADO-RS Retrieval Sequence (0040,E025) and WADO Retrieval Sequence (0040,E023) are not present. May be present otherwise. This Sequence shall only identify repositories known to have Instances referenced in Referenced SOP Sequence (0008,1199). One or more Items shall be included in this Sequence.
>Repository Unique ID	(0040,E030)	1	Uniquely identifies a Repository from which the referenced Instances can be retrieved.
>Home Community ID	(0040,E031)	3	Uniquely identifies a Community to which requests for the referenced Instances can be directed.
WADO-RS Retrieval Sequence	(0040,E025)	1C	Details for retrieving Instances via WADO-RS. Note Retrieval via WADO-URI is addressed in the WADO Retrieval Sequence (0040,E023). Retrieval via the IHE XDS-I.b RAD-69 Transaction is addressed in the XDS Retrieval Sequence (0040,E024). Required if DICOM Retrieval Sequence (0040,E021), DICOM Media Retrieval Sequence (0040,E022), WADO Retrieval Sequence (0040,E023) and XDS Retrieval Sequence (0040,E024) are not present. May be present otherwise. One or more Items shall be included in this Sequence.
>Retrieve URL	(0008,1190)	1	URL specifying the location of the referenced Instance(s).

Table 10-3c “Storage Macro Attributes” contains details for where and how to store Instances. It is intended to provide sufficient information to store Instances to the correct location.

This Macro mirrors Table 10-3b “Referenced Instances and Access Macro Attributes”.

Table 10-3c. Storage Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if the storage request only applies to a specific SOP Class.
DICOM Storage Sequence	(0040,4071)	1C	Details for storing Instances via the DICOM Storage Service. Required if STOW-RS Storage Sequence (0040,4072) or XDS Storage Sequence (0040,4074) is not present. May be present otherwise. One or more Items shall be included in this Sequence.
>Destination AE	(2100,0140)	1	Title of a DICOM Application Entity to which Instances will be stored.
STOW-RS Storage Sequence	(0040,4072)	1C	Details for storing Instances via STOW-RS. Required if DICOM Storage Sequence (0040,4071) and XDS Storage Sequence (0040,4074) are not present. May be present otherwise. One or more Items shall be included in this Sequence.
>Storage URL	(0040,4073)	1	URI/URL specifying the location of the STOW-RS storage service to which Instances will be stored. The value shall be a fully specified URI with protocol, authority and path, in accordance with [RFC3986] and Section 10.5 “Store Transaction” in PS3.18.
XDS Storage Sequence	(0040,4074)	1C	Details for storing Instances via the IHE Provide and Register Document Set-b (ITI-41) transaction [IHE ITI-TF 2.b]. Required if STOW-RS Storage Sequence (0040,4072) and DICOM Storage Sequence (0040,4071) are not present. May be present otherwise. One or more Items shall be included in this Sequence.
>Repository Unique ID	(0040,E030)	1	Uniquely identifies a Repository from which the referenced Instances can be retrieved.
>Home Community ID	(0040,E031)	3	Uniquely identifies a Community to which requests for the referenced Instances can be directed.

10.4 Series and Instance Reference Macro

Table 10-4 defines the Attributes that list Series and SOP Instances within those Series.

Table 10-4. Series and Instance Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Series Sequence	(0008,1115)	1	Sequence of Items each of which includes the Attributes of one Series. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	1	Unique identifier of the Series containing the referenced Instances.

Attribute Name	Tag	Type	Attribute Description
>Referenced Instance Sequence	(0008,114A)	1	Sequence of Items each providing a reference to an Instance that is part of the Series defined by Series Instance UID (0020,000E) in the enclosing Item. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

10.5 General Anatomy Macros

Table 10-5, Table 10-6, Table 10-7 and Table 10-7b describe the Attributes for identifying the general region of the Patient anatomy examined using coded terminology, as well as the principal structure(s) within that region that is the target of the current SOP Instance. The only differences between the Macros are the Type and Number of Items of the Anatomic Region Sequence (0008,2218) Attribute. Table 10-8 describe the Attributes for the coding of the principal structure only.

The invocation of these Macros may specify Baseline or Defined CIDs for the Anatomic Region Sequence (0008,2218), the Anatomic Region Modifier Sequence (0008,2220), and/or the Primary Anatomic Structure Sequence (0008,2228).

The general region of the body (e.g., the anatomic region, organ, or body cavity being examined) is identified by the Anatomic Region Sequence (0008,2218). Characteristics of the anatomic region being examined, such as sub-region (e.g., medial, lateral, superior, inferior, lobe, quadrant) and laterality (e.g., right, left, both), may be refined by the Anatomic Region Modifier Sequence (0008,2220).

Note

These Attributes allow the specification of the information encoded by the Body Part Examined (0018,0015) in the General Series Module in a more robust, consistent way.

The specific anatomic structures of interest within the image (e.g., a particular artery within the anatomic region) is identified by the Primary Anatomic Structure Sequence (0008,2228). Characteristics of the anatomic structure, such as its location (e.g., subcapsular, peripheral, central), configuration (e.g., distended, contracted), and laterality (e.g., right, left, both), and so on, may be refined by the Primary Anatomic Structure Modifier Sequence (0008,2230).

Note

1. Laterality is often encoded in a separate Attribute, Image Laterality (0020,0062) or Frame Laterality (0020,9072), rather than in Anatomic Region Modifier Sequence (0008,2220) or Primary Anatomic Structure Modifier Sequence (0008,2230). The correspondence between the values is as follows:

Image Laterality (0020,0062) or Frame Laterality (0020,9072)	Coded Modifier
L	(7771000, SCT, "Left")
R	(24028007, SCT, "Right")
U	(66459002, SCT, "Unilateral")
B	(51440002, SCT, "Bilateral")

   The codes illustrated are from CID 244 “Laterality”.

2. Whether or not various anatomical structures may be paired or unpaired (have laterality) is illustrated in Table L-5 “Pairedness of Anatomic Concepts” in PS3.16.

Table 10-5. General Anatomy Mandatory Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Anatomic Region Sequence	(0008,2218)	1	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this Instance. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 2 “Anatomic Modifier”, unless otherwise defined in the Macro invocation.*
Include Table 10-8 “Primary Anatomic Structure Macro Attributes”			*CID may be defined in the Macro invocation.*

Table 10-6. General Anatomy Required Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Anatomic Region Sequence	(0008,2218)	2	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this Instance One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 2 “Anatomic Modifier”, unless otherwise defined in the Macro invocation.*
Include Table 10-8 “Primary Anatomic Structure Macro Attributes”			*CID may be defined in the Macro invocation.*

Table 10-7. General Anatomy Optional Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Anatomic Region Sequence	(0008,2218)	3	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this Instance One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 2 “Anatomic Modifier”, unless otherwise defined in the Macro invocation.*
Include Table 10-8 “Primary Anatomic Structure Macro Attributes”			*CID may be defined in the Macro invocation.*

Table 10-7b. Multiple Site General Anatomy Optional Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Anatomic Region Sequence	(0008,2218)	3	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the Macro invocation.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest in this Instance One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 2 "Anatomic Modifier", unless otherwise defined in the Macro invocation.*
Include Table 10-8 "Primary Anatomic Structure Macro Attributes"			*CID may be defined in the Macro invocation.*

Table 10-8. Primary Anatomic Structure Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Primary Anatomic Structure Sequence	(0008,2228)	3	Sequence of Items that identifies the primary anatomic structure(s) of interest in this Instance. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the Macro invocation.*
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of Items that modifies the primary anatomic structure of interest in this Instance. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 2 "Anatomic Modifier".*

10.6 Request Attributes Macro

Table 10-9. Request Attributes Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Requested Procedure ID	(0040,1001)	1C	Identifier that identifies the Requested Procedure in the Imaging Service Request. Required if procedure was scheduled. May be present otherwise. Note The condition is to allow the contents of this Macro to be present (e.g., to convey the reason for the procedure, such as whether a mammogram is for screening or diagnostic purposes) even when the procedure was not formally scheduled and a value for this identifier is unknown, rather than making up a dummy value.
Accession Number	(0008,0050)	3	An identifier of the Imaging Service Request for this Requested Procedure.

Attribute Name	Tag	Type	Attribute Description
Issuer of Accession Number Sequence	(0008,0051)	3	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item is permitted in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”			
Study Instance UID	(0020,000D)	3	The unique identifier for the Study provided for this Requested Procedure.
Referenced Study Sequence	(0008,1110)	3	Uniquely identifies the Study SOP Instances associated with this SOP Instance. One or more Items are permitted in this Sequence. See Section 10.6.1.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Requested Procedure Description	(0032,1060)	3	Institution-generated administrative description or classification of Requested Procedure.
Requested Procedure Code Sequence	(0032,1064)	3	A Sequence that conveys the Procedure Type of the requested procedure. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Reason for the Requested Procedure	(0040,1002)	3	Reason for requesting this procedure.
Reason for Requested Procedure Code Sequence	(0040,100A)	3	Coded Reason for requesting this procedure. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
Scheduled Procedure Step ID	(0040,0009)	1C	Identifier that identifies the Scheduled Procedure Step. Required if procedure was scheduled. Note The condition is to allow the contents of this Macro to be present (e.g., to convey the reason for the procedure, such as whether a mammogram is for screening or diagnostic purposes) even when the procedure step was not formally scheduled and a value for this identifier is unknown, rather than making up a dummy value.
Scheduled Procedure Step Description	(0040,0007)	3	Institution-generated description or classification of the Scheduled Procedure Step to be performed.
Scheduled Protocol Code Sequence	(0040,0008)	3	Sequence describing the Scheduled Protocol following a specific coding scheme. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
>Protocol Context Sequence	(0040,0440)	3	Sequence that specifies the context for the Scheduled Protocol Code Sequence (0040,0008) Item. One or more Items are permitted in this Sequence.
>>Include Table 10-2 “Content Item Macro Attributes Description”			*CID may be defined in the Macro invocation.*

Attribute Name	Tag	Type	Attribute Description
>>Content Item Modifier Sequence	(0040,0441)	3	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items are permitted in this Sequence. See Section C.4.10.1.
>>>Include Table 10-2 "Content Item Macro Attributes Description"			*CID may be defined in the Macro invocation.*

10.6.1 SOP Class UID in Referenced Study Sequence

Since Referenced Study Sequence (0008,1110) is Type 2 or 3 in each usage, the Attribute may be zero length or omitted, respectively.

If Referenced Study Sequence (0008,1110) is present with an Item, the SOP Class UID of the Detached Study Management SOP Class (Retired) may be used in Referenced SOP Class UID (0008,1150).

10.7 Basic Pixel Spacing Calibration Macro

Table 10-10 defines the Attributes for the Basic Pixel Spacing Calibration Macro.

Table 10-10. Basic Pixel Spacing Calibration Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0028,0030)	1C	Physical distance in the Patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.1 and Section 10.7.1.3. Required if the image has been calibrated. May be present otherwise.
Pixel Spacing Calibration Type	(0028,0A02)	3	The type of correction for the effect of geometric magnification or calibration against an object of known size, if any. See Section 10.7.1.2.
Pixel Spacing Calibration Description	(0028,0A04)	1C	A free text description of the type of correction or calibration performed. Note 1. In the case of correction, the text might include description of the assumptions made about the body part and geometry and depth within the Patient. 2. in the case of calibration, the text might include a description of the fiducial and where it is located (e.g., "XYZ device applied to the skin over the greater trochanter"). 3. Though it is not required, the Device Module may be used to describe the specific characteristics and size of the calibration device. Required if Pixel Spacing Calibration Type (0028,0A02) is present.

10.7.1 Basic Pixel Spacing Calibration Macro Attribute Descriptions

10.7.1.1 Pixel Spacing

Pixel Spacing (0028,0030) specifies the physical distance in the Patient between the center of each pixel.

If Pixel Spacing (0028,0030) is present and the image has not been calibrated to correct for the effect of geometric magnification, the values of this Attribute shall be the same as in Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), if either of those Attributes are present.

If Pixel Spacing (0028,0030) is present and the values are different from those in Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), then the image has been corrected for known or assumed geometric magnification or calibrated with respect to some object of known size at known depth within the Patient.

If Pixel Spacing Calibration Type (0028,0A02) and Imager Pixel Spacing (0018,1164) and Nominal Scanned Pixel Spacing (0018,2010) are absent, then it cannot be determined whether or not correction or calibration have been performed.

Note

1. Imager Pixel Spacing (0018,1164) is a required Attribute in DX family IODs.
2. Nominal Scanned Pixel Spacing (0018,2010) is a required Attribute in Multi-frame SC family IODs

10.7.1.2 Pixel Spacing Calibration Type

The Pixel Spacing Calibration Type (0028,0A02) Attribute specifies the type of correction for the effect of geometric magnification or calibration against an object of known size, if any.

Enumerated Values:

GEOMETRY The Pixel Spacing (0028,0030) values account for assumed or known geometric magnification effects and correspond to some unspecified depth within the Patient; the Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and at the same depth.

FIDUCIAL The Pixel Spacing (0028,0030) values have been calibrated by the operator or image processing software by measurement of an object (fiducial) that is visible in the pixel data and is of known size and is located close to the central ray; the Pixel Spacing (0028,0030) values may thus be used for measurements of objects located close to the central ray and located at the same depth within the Patient as the fiducial.

10.7.1.3 Pixel Spacing Value Order and Valid Values

All pixel spacing related Attributes are encoded as the physical distance between the centers of each two-dimensional pixel, specified by two numeric values.

The first value is the row spacing in mm, that is the spacing between the centers of adjacent rows, or vertical spacing.

The second value is the column spacing in mm, that is the spacing between the centers of adjacent columns, or horizontal spacing.

To illustrate, consider the example shown in Figure 10.7.1.3-1.

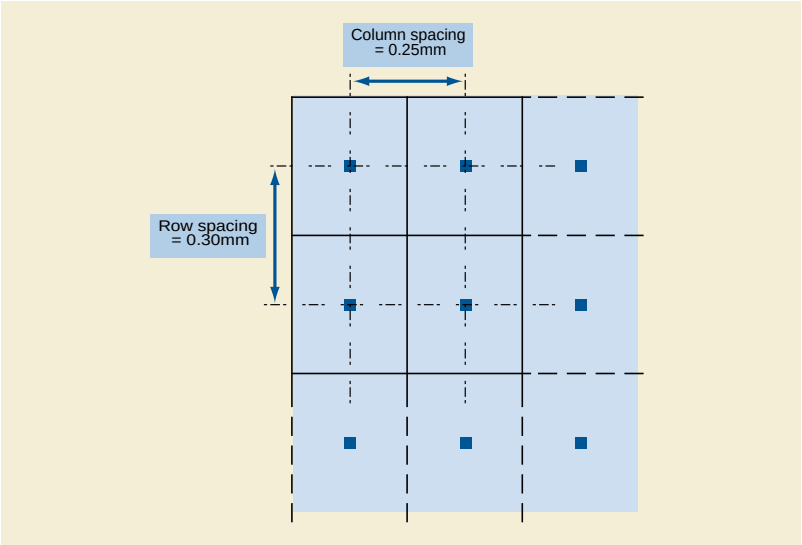


Figure 10.7.1.3-1. Example of Pixel Spacing Value Order

Pixel Spacing = Row Spacing \ Column Spacing = 0.30\0.25.

All pixel spacing related Attributes shall have positive non-zero values, except when there is only a single row or column or pixel of data present, in which case the corresponding value may be zero.

Note

A single row or column or "pixel" may occur in MR Spectroscopy Instances.

This description applies to:

- Pixel Spacing (0028,0030)
- Imager Pixel Spacing (0018,1164)
- Nominal Scanned Pixel Spacing (0018,2010)
- Image Plane Pixel Spacing (3002,0011)
- Compensator Pixel Spacing (300A,00E9)
- Detector Element Spacing (0018,7022)
- Presentation Pixel Spacing (0070,0101)
- Printer Pixel Spacing (2010,0376)
- Object Pixel Spacing in Center of Beam (0018,9404)

10.8 SOP Instance Reference Macro

Table 10-11 specifies the Attributes that reference an SOP Instance.

Table 10-11. SOP Instance Reference Macro Attributes

Attribute Name	Tag	Type	Description
Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.

10.9 Content Identification Macro

Table 10-12 describe the Attributes for identifying a SOP Instance potentially created by a human user interacting with an application.

Table 10-12. Content Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies this SOP Instance.
Content Label	(0070,0080)	1	A label that is used to identify this SOP Instance.
Content Description	(0070,0081)	2	A description of the content of the SOP Instance.
Concept Name Code Sequence	(0040,A043)	3	A coded description of the content of the SOP Instance. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*

Attribute Name	Tag	Type	Attribute Description
Alternate Content Description Sequence	(0070,0087)	3	A Sequence containing alternate descriptions suitable for presentation to the user, e.g., in different languages. One or more Items are permitted in this Sequence. Note The values of Specific Character Set for the entire Data Set need to be sufficient to encode all Items of this Sequence correctly, e.g., using a single value with broad support such as UTF-8, or multiple values with escape sequences.
>Content Description	(0070,0081)	1	An alternate description that is used to identify this SOP Instance.
>Language Code Sequence	(0008,0006)	1	The language in which Content Description (0070,0081) within this Item is written. A single Item shall be present.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 5000 “Languages”.*
>Concept Name Code Sequence	(0040,A043)	3	An alternate coded description of the content of the SOP Instance. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Content Creator's Name	(0070,0084)	2	Name of operator (such as a technologist or physician) creating the content of the SOP Instance.
Content Creator's Identification Code Sequence	(0070,0086)	3	Identification of the person who created the content. Only a single Item is permitted in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”			

10.9.1 Enhanced Content Identification Macro

The Enhanced Content Identification Macro identifies content using a label supporting lower case characters and specified character sets. If a Code String is required, see Section 10.9 “Content Identification Macro”.

Table 10.9.1-1. Enhanced Content Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
User Content Label	(3010,0033)	1	User-defined label for this SOP Instance. See Section 10.9.1.1.1.
Content Description	(0070,0081)	2	User-defined description for the content of this SOP Instance. See Section 10.9.1.1.1.
Content Creator"s Name	(0070,0084)	2	Name of operator (such as a technologist or physician) creating the content of the SOP Instance.
Content Creator"s Identification Code Sequence	(0070,0086)	3	Identification of the person who created the content. Only a single Item is permitted in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”			

10.9.1.1 Enhanced Content Identification Macro Attribute Descriptions

10.9.1.1.1 User Content Label and Content Description

User Content Label (3010,0033) shall represent a user-defined short free text providing the primary identification of this entity to other users. Content Description (0070,0081) allows a longer string containing additional descriptive identifying text.

This information is intended for display to human readers. Shall not be used for structured processing.

10.9.2 Extended Content Identification Macro

The Extended Content Identification Macro identifies content using a label supporting lower case characters and specified character sets. If a Code String is required, see Section 10.9 “Content Identification Macro”.

Table 10.9.2-1. Extended Content Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
User Content Long Label	(3010,0034)	1	User-defined label for the content of this SOP Instance. See Section 10.9.2.1.1.
Content Description	(0070,0081)	2	User-defined description for the content of this SOP Instance. See Section 10.9.2.1.1.
Content Creator's Name	(0070,0084)	2	Name of operator (such as a technologist or physician) creating the content of the SOP Instance.
Content Creator's Identification Code Sequence	(0070,0086)	3	Identification of the person who created the content. Only a single Item is permitted in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”			

10.9.2.1 Extended Content Identification Macro Attribute Descriptions

10.9.2.1.1 User Content Long Label and Content Description

User Content Long Label (3010,0034) shall represent a user-defined free text providing the primary identification of this entity to other users. Content Description (0070,0081) allows a longer string containing additional descriptive identifying text.

This information is intended for display to human readers. Shall not be used for structured processing.

10.10 General Contributing Sources Macro

Table 10-13 contains IOD Attributes that describe the general characteristics of the contributing sources used to create a new SOP Instance.

Table 10-13. General Contributing Sources Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Contributing SOP Instances Reference Sequence	(0020,9529)	1C	A Sequence that identifies the contributing SOP Instances. Required if this SOP Instance is created from other DICOM SOP Instances. Note The Attribute is absent in the case where the sources used to create this SOP Instance are not SOP Instances, e.g., a volume that was directly generated by an acquisition system. One or more Items shall be included in this Sequence.
>Study Instance UID	(0020,000D)	1	Unique identifier for the Study of the Contributing SOP Instances.
>Referenced Series Sequence	(0008,1115)	1	Sequence of Items each of which includes the Attributes of one Series. One or more Items shall be included in this Sequence.
>>Series Instance UID	(0020,000E)	1	Unique identifier of the Series containing the referenced Instances.
>>Series Number	(0020,0011)	2	A number that identifies this Series.
>>Referenced Instance Sequence	(0008,114A)	1	Sequence of Items each providing a reference to an Instance that is part of the Series defined by Series Instance UID (0020,000E) in the enclosing Item. One or more Items shall be included in this Sequence.
>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>>>Instance Number	(0020,0013)	2	A number that identifies this Instance.
Manufacturer	(0008,0070)	2	Manufacturer of the equipment that produced the sources.
Manufacturer's Model Name	(0008,1090)	1C	Manufacturer's model name of the equipment that produced the sources. Required if present and consistent in the contributing SOP Instances.
Device Serial Number	(0018,1000)	1C	Manufacturer's serial number of the equipment that produced the sources. Required if present and consistent in the contributing SOP Instances.
Software Versions	(0018,1020)	1C	Manufacturer's designation of software version of the equipment that produced the sources. See Section C.7.5.1.1.3. Required if present and consistent in the contributing SOP Instances.

Attribute Name	Tag	Type	Attribute Description
Acquisition DateTime	(0008,002A)	1C	The time the acquisition of data that resulted in sources started. The value shall be the start date and time of the first contributing SOP Instance of the group specified by the Contributing SOP Instances Reference Sequence (0020,9529). Required if present and consistent in the contributing SOP Instances. Note The Acquisition DateTime may be created by combining the values of Acquisition Date (0008,0022) and Acquisition Time (0008,0032) Attributes in the contributing SOP Instances.
Station Name	(0008,1010)	1C	User defined name identifying the machine that produced the sources. Required if present and consistent in the contributing SOP Instances.
Operators' Name	(0008,1070)	1C	Name(s) of the operator(s) supporting the Series. Required if present and consistent in the contributing SOP Instances.
Operator Identification Sequence	(0008,1072)	1C	Identification of the operator(s) supporting the Series. One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Operators' Name (0008,1070), if present. Required if present and consistent in the contributing SOP Instances.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Protocol Name	(0018,1030)	1C	User-defined description of the conditions under which the Series was performed. Required if present and consistent in the contributing SOP Instances. Note This Attribute conveys Series-specific protocol identification and may or may not be identical to the one presented in the Performed Protocol Code Sequence (0040,0260).
Performed Protocol Code Sequence	(0040,0260)	1C	Sequence describing the Protocol performed for the Procedure Step creating the sources. One or more Items shall be included in this Sequence. Required if present and consistent in the contributing SOP Instances.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Acquisition Protocol Name	(0018,9423)	1C	User defined name of the protocol used to acquire this image. Required if present and consistent in the contributing SOP Instances.

Note

The Attributes at the first level of the General Contributing Sources Macro contain information that is common to all the Referenced SOP Instances included in the Contributing SOP Instances Reference Sequence. This allows to not duplicate information when the contributing Instances are single-frame objects and/or when they are in different Series with the same protocol and manufacturer information.

Typically the General Contributing Sources Macro is invoked from inside another Sequence. Therefore, if the "common" Attributes of the Macro are different among the Referenced SOP Instances, like different acquisition protocols, software versions etc., the invoking Sequence will contain several Items.

10.11 Contributing Image Sources Macro

Table 10-14 contains IOD Attributes that describe the image related characteristics of the contributing image sources used to create a new SOP Instance (e.g., a volume SOP Instance).

Table 10-14. Contributing Image Sources Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Rows	(0028,0010)	1	Number of rows in the images.
Columns	(0028,0011)	1	Number of columns in the images.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See PS3.5 for further explanation.
Lossy Image Compression	(0028,2110)	1C	Specifies whether the Source Images have undergone lossy compression (at a point in their lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. See Section C.7.6.1.1.5. Required if it is known whether or not Lossy Compression has been performed on the Images. Note In some SOP Class definitions the Lossy Image Compression Attribute is optional.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to the source images. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".

10.12 Patient Orientation Macro

This section describes Attributes of the Patient Orientation Macro by specifying the Patient orientation related to gravity and equipment. Table 10-15 contains IOD Attributes that describe the Patient Orientation related to gravity and equipment.

Table 10-15. Patient Orientation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Orientation Code Sequence	(0054,0410)	1	Sequence that describes the orientation of the Patient with respect to gravity. See Section C.8.11.5.1.2 for further explanation. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 19 "Patient Orientation".*
>Patient Orientation Modifier Code Sequence	(0054,0412)	1C	Patient orientation modifier. Required if needed to fully specify the orientation of the Patient with respect to gravity. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 20 "Patient Orientation Modifier".*
Patient Gantry Relationship Code Sequence	(0054,0414)	3	Sequence that describes the orientation of the Patient with respect to the head of the table. See Section C.8.4.6.1.3 for further explanation. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 21 "Patient Equipment Relationship".*

10.12.1 Relation With Other Positioning Attributes

The Attributes of this Macro may be used to correlate the Patient-Based Coordinate System (see Section C.7.6.2) and the equipment.

Note

The Patient Orientation Code Sequence (0054,0410) allows a more precise and comprehensive positioning than Patient Position (0018,5100). If this Sequence is present Patient Position (0018,5100) is not used.

10.13 Performed Procedure Step Summary Macro

Table 10-16. Performed Procedure Step Summary Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Performed Procedure Step ID	(0040,0253)	3	User or equipment generated identifier of that part of a Procedure that has been carried out within this step.
Performed Procedure Step Start Date	(0040,0244)	3	Date on which the Performed Procedure Step started.
Performed Procedure Step Start Time	(0040,0245)	3	Time on which the Performed Procedure Step started.
Performed Procedure Step End Date	(0040,0250)	3	Date on which the Performed Procedure Step ended.
Performed Procedure Step End Time	(0040,0251)	3	Time at which the Performed Procedure Step ended.
Performed Procedure Step Description	(0040,0254)	3	Institution-generated description or classification of the Procedure Step that was performed.
Performed Protocol Code Sequence	(0040,0260)	3	Sequence describing the Protocol performed for this Procedure Step. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the Macro invocation.*

Attribute Name	Tag	Type	Attribute Description
>Protocol Context Sequence	(0040,0440)	3	Sequence that specifies the context for the Performed Protocol Code Sequence (0040,0260) Item. One or more Items are permitted in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes Description"			*CID may be defined in the Macro invocation.*
>>Content Item Modifier Sequence	(0040,0441)	3	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items are permitted in this Sequence. See Section C.4.10.1.
>>>Include Table 10-2 "Content Item Macro Attributes Description"			*CID may be defined in the Macro invocation.*
Comments on the Performed Procedure Step	(0040,0280)	3	User-defined comments on the Performed Procedure Step.

10.14 HL7v2 Hierarchic Designator Macro

Table 10-17 describes the Attributes for identifying an entity (system, organization, agency, or department) that has responsibility for managing or assigning a defined set of instance identifiers (such as placer or filler number, Patient identifiers, provider identifiers, etc.). This entity could be a particular health care application such as a registration system that assigns Patient identifiers, a governmental entity such as a licensing authority that assigns professional identifiers or drivers' license numbers, or a facility where such identifiers are assigned.

Note

This definition is identical to HL7 v2.5, Section 2.A.33, with only minor changes for editorial style.

These Attributes are equivalent to the components of the HL7 v2 Hierarchic Designator (HD) and Entity Identifier (EI) data types (see HL7 v2 Chapter 2.A).

If both Local Namespace Entity ID (0040,0031) and Universal Entity ID (0040,0032) are present, they shall refer to the same entity.

Table 10-17. HL7v2 Hierarchic Designator Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Local Namespace Entity ID	(0040,0031)	1C	Identifies an entity within the local namespace or domain. Required if Universal Entity ID (0040,0032) is not present; may be present otherwise.
Universal Entity ID	(0040,0032)	1C	Universal or unique identifier for an entity. Required if Local Namespace Entity ID (0040,0031) is not present; may be present otherwise.
Universal Entity ID Type	(0040,0033)	1C	Standard defining the format of the Universal Entity ID. Required if Universal Entity ID (0040,0032) is present. Enumerated Values: **DNS** An Internet dotted name. Either in ASCII or as integers **EUI64** An IEEE Extended Unique Identifier **ISO** An International Standards Organization Object Identifier **URI** Uniform Resource Identifier **UUID** The DCE Universal Unique Identifier **X400** An X.400 MHS identifier **X500** An X.500 directory name

10.15 Issuer of Patient ID Macro

Table 10-18 describes the Attributes for identifying the source of Patient ID (0010,0020).

These Attributes are equivalent to components of the HL7 v2 Extended Composite ID with Check Digit (CX) data type (see HL7 v2 Chapter 2.A.14), as used in the HL7 v2 PID-3 Patient Identifier List field.

Table 10-18. Issuer of Patient ID Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Issuer of Patient ID	(0010,0021)	3	Identifier of the Assigning Authority (system, organization, agency, or department) that issued the Patient ID. Note Equivalent to HL7 v2 CX component 4 subcomponent 1.
Issuer of Patient ID Qualifiers Sequence	(0010,0024)	3	Attributes specifying or qualifying the identity of the issuer of the Patient ID, or scoping the Patient ID. Only a single Item is permitted in this Sequence.
>Universal Entity ID	(0040,0032)	3	Universal or unique identifier for the Patient ID Assigning Authority. The authority identified by this Attribute shall be the same as that of Issuer of Patient ID (0010,0021), if present. Note Equivalent to HL7 v2 CX component 4 subcomponent 2 (Universal ID).
>Universal Entity ID Type	(0040,0033)	1C	Standard defining the format of the Universal Entity ID (0040,0032). Required if Universal Entity ID (0040,0032) is present. Note Equivalent to HL7 v2 CX component 4 subcomponent 3 (Universal ID Type). See Section 10.14 for Defined Terms.
>Identifier Type Code	(0040,0035)	3	Type of Patient ID. Refer to HL7 v2 Table 0203 for Defined Terms. Note Equivalent to HL7 v2 CX component 5 (Identifier Type Code).
>Assigning Facility Sequence	(0040,0036)	3	The place or location identifier where the identifier was first assigned to the Patient. This component is not an inherent part of the identifier but rather part of the history of the identifier. Only a single Item is permitted in this Sequence. Note Equivalent to HL7 v2 CX component 6 (Assigning Facility).
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Assigning Jurisdiction Code Sequence	(0040,0039)	3	The geo-political body that assigned the Patient identifier. Typically a code for a country or a state/province. Only a single Item is permitted in this Sequence. Note Equivalent to HL7 v2 CX component 9 (Assigning Jurisdiction).

Attribute Name	Tag	Type	Attribute Description
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 5001 “Countries” for country codes.*
>Assigning Agency or Department Code Sequence	(0040,003A)	3	The agency or department that assigned the Patient identifier. Only a single Item is permitted in this Sequence. Note Equivalent to HL7 v2 CX component 10 (Assigning Agency or Department).
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*

10.16 Algorithm Identification Macro

Table 10-19 describes the Attributes for encoding the algorithm used to create or derive a SOP Instance contents. An algorithm is described by the Algorithm Family, a specific Algorithm Name, and an Algorithm Version. A character string containing parameters that were used in the algorithm can be included.

Table 10-19. Algorithm Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Algorithm Family Code Sequence	(0066,002F)	1	The family of algorithm(s) that best describes the software algorithm used. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
Algorithm Name Code Sequence	(0066,0030)	3	The code assigned by a manufacturer to a specific software algorithm. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Algorithm Name	(0066,0036)	1	The name assigned by a manufacturer to a specific software algorithm.
Algorithm Version	(0066,0031)	1	The software version identifier assigned by a manufacturer to a specific software algorithm.
Algorithm Parameters	(0066,0032)	3	The input parameters used by a manufacturer to configure the behavior of a specific software algorithm.
Algorithm Source	(0024,0202)	3	Source of the algorithm, e.g., the name of the manufacturer, researcher, university, etc.

10.17 Selector Attribute Macro

Table 10-20 specifies the Attributes that identify either a particular value of an Attribute, all values of an Attribute, a specific Item in a Sequence, or all Items in a Sequence. The Attribute or Item may be nested within one or more Sequences, and/or a Private Attribute.

The invocation of the Selector Attribute Macro may define additional semantics. E.g., if the Selector Attribute Macro is used to select "all" values of an Attribute and then test that set of value against some condition, then an invocation might define whether it is required that at least one value in the set meet the condition or whether all values in the set must meet the condition.

Table 10-20a extends the Selector Attribute Macro with additional Attribute descriptors.

Table 10-20. Selector Attribute Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Selector Attribute	(0072,0026)	1C	Data Element Tag of the Attribute to be referenced. Required if the selected content is not a Sequence Item.
Selector Value Number	(0072,0028)	1C	Non-negative integer identifying which value of a multi-valued Attribute identified by Selector Attribute (0072,0026) is to be referenced. The value 1 identifies the first value. The value 0 identifies all values. When the Value Multiplicity of the Selector Attribute (0072,0026) is 1 then the value of this Attribute shall be 1. Required if the selected content is a single Attribute of any VR other than SQ.
Selector Sequence Pointer	(0072,0052)	1C	Contains the Data Element Tags of the path to the Sequence that contains the Attribute that is identified by Selector Attribute (0072,0026) or to the Item(s) to be selected in Selector Sequence Pointer Items (0074,1057). This Attribute shall have the same number of values as the level of nesting of Selector Attribute (0072,0026) or the selected Item(s). Required if Selector Attribute (0072,0026) is nested in one or more Sequences or is absent. See Section 10.17.1.1.
Selector Sequence Pointer Private Creator	(0072,0054)	1C	Identification of the creator of a group of Private Data Elements used to encode Attributes in the Selector Sequence Pointer (0072,0052). This Attribute shall have the same number of values as Selector Sequence Pointer (0072,0052). For values of the Selector Sequence Pointer (0072,0052) that are not the Data Element Tag of a Private Attribute, the corresponding value in Selector Sequence Pointer Private Creator (0072,0054) shall be empty. Required if Selector Sequence Pointer (0072,0052) is present and one or more of the values of Selector Sequence Pointer (0072,0052) is the Data Element Tag of a Private Attribute. See Section 10.17.1.2.
Selector Sequence Pointer Items	(0074,1057)	1C	Identification of the Item indices in the Selector Sequence Pointer (0072,0052). This Attribute shall have the same number of values as the Selector Sequence Pointer (0072,0052). The value 1 identifies the first Item of the corresponding Sequence. The value 0 identifies all Items of the corresponding Sequence. Required if Selector Sequence Pointer (0072,0052) is present. See Section 10.17.1.1.
Selector Attribute Private Creator	(0072,0056)	1C	Identification of the creator of a group of Private Data Elements. Required if the Selector Attribute (0072,0026) value is the Data Element Tag of a Private Attribute. See Section 10.17.1.2.

Table 10-20a. Extended Selector Attribute Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Selector Attribute Name	(0082,0018)	1	Name of the Selector Attribute (0072,0026). For Standard Data Elements, this shall be the value in the Name column of Table 6-1 in PS3.6.
Selector Attribute Keyword	(0082,0019)	3	Keyword of the Selector Attribute (0072,0026). For Standard Data Elements, this shall be the value in the Keyword column of Table 6-1 in PS3.6.
Selector Attribute VR	(0072,0050)	1	Value Representation of the Selector Attribute (0072,0026). For Standard Data Elements, this shall be the value in the VR column of Table 6-1 in PS3.6.
Include Table 10-20 “Selector Attribute Macro Attributes”			

10.17.1 Selector Attribute Macro Attribute Descriptions

10.17.1.1 Referencing Nested Elements

Examples of use are shown in Table 10-21.

The examples include the selection of a top level Attribute, a nested Attribute, one Item in a top level Sequence, all Items in a nested Sequence or a specific Item in all Items of a parent Sequence.

Table 10-21. Selector Attribute Macro Example

Example	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)
Patient's Name (0010,0010)	(0010,0010)	1	absent	absent
Second value (e.g., PRIMARY or SECONDARY) in Image Type (0008,0008)	(0008,0008)	2	absent	absent
RT Beam Limiting Device Type (300A,00B8) for the second jaw in Beam Limiting Device Sequence (300A,00B6) specified for the first Beam in the Beam Sequence (300A,00B0) of an RT Plan	(300A,00B8)	1	(300A,00B0)\(300A,00B6)	1\2
Code Value (0008,0100) for the first Item in View Code Sequence (0054,0220)	(0008,0100)	1	(0054,0220)	1
The second Item in the Patient Setup Sequence (300A,0180) in the top level Data Set	absent	absent	(300A,0180)	2
The second Item in the Beam Limiting Device Sequence (300A,00B6) in third Item in the Beam Sequence (300A,00B0) of an RT Plan	absent	absent	(300A,00B0)\(300A,00B6)	3\2
All Items in the Beam Limiting Device Sequence (300A,00B6) in third Item in the Beam Sequence (300A,00B0) of an RT Plan	absent	absent	(300A,00B0)\(300A,00B6)	3\0
The second Item in the Beam Limiting Device Sequence (300A,00B6) in all Items in the Beam Sequence (300A,00B0) of an RT Plan	absent	absent	(300A,00B0)\(300A,00B6)	0\2

10.17.1.2 Private Attribute References

The Selector Sequence Pointer Private Creator (0072,0054) and the Selector Attribute Private Creator (0072,0056) each have a value that corresponds to the Private Creator Data Element numbers (gggg,00pp), where gggg is odd and pp ranges from 10 to FF. These identify a block of Private Data Elements within the block (gggg,ppxx). When Selector Attribute (0072,0026) or Selector Sequence Pointer (0072,0052) points to a Private Data Element (gggg,ppxx), it shall have the value (gggg,00xx).

10.18 Externally-Sourced Data Set Identification Macro

Table 10-22 describes the Attributes for the identification of an Externally-Sourced Data Set.

Table 10-22. Externally-Sourced Data Set Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Data Set Name	(0024,0306)	1	The name assigned to the Externally-Sourced Data Set.
Data Set Version	(0024,0307)	1	The software version identifier assigned to the Externally-Sourced Data Set.
Data Set Source	(0024,0308)	1	Source of the Externally-Sourced Data Set. E.g., the name of the manufacturer, researcher, university, etc.
Data Set Description	(0024,0309)	3	Description of the Externally-Sourced Data Set.

10.19 Exposure Index Macro

Table 10-23 describes the Attributes for describing the Exposure Index for single projection X-Ray images, as described by IEC 62494-1 and the report of AAPM Task Group 116.

Table 10-23. Exposure Index Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Exposure Index	(0018,1411)	3	Measure of the detector response to radiation in the relevant image region of an image acquired with a digital X-Ray imaging system as defined in IEC 62494-1. Note 1. A string rather than binary Value Representation is used for this Attribute, in order to allow the sender to control the precision of the value as suggested in the report of AAPM Task Group 116. 2. This index value is scaled as defined by IEC 62494-1.
Target Exposure Index	(0018,1412)	3	The target value used to calculate Deviation Index (0018,1413) as defined in IEC 62494-1.
Deviation Index	(0018,1413)	3	A scaled representation of the difference of the Exposure Index compared to the Target Exposure Index as defined in IEC 62494-1 and the report of AAPM TG 116.

10.20 Mandatory View and Slice Progression Direction Macro

Table 10-24 specifies the Attributes that describe the view, and in the case of cardiac views, the direction of the slices relative to the cardiac anatomy.

Table 10-24. Mandatory View and Slice Progression Direction Macro Attributes

Attribute Name	Tag	Type	Attribute Description
View Code Sequence	(0054,0220)	1	Sequence that describes the projection of the anatomic region of interest. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 26 "Nuclear Medicine Projections" unless otherwise specified in invocation.*
>View Modifier Code Sequence	(0054,0222)	2C	View Modifier. Required if needed to fully specify the View. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 23 "Cranio-Caudad Angulation" unless otherwise specified in invocation.*
Slice Progression Direction	(0054,0500)	1C	Describes the anatomical direction in which a set of slices is progressing (see Section 10.20.1.1). Meaningful only for cardiac images. Enumerated Values are defined in Section 10.20.1.1. Required if View Code Sequence (0054,0220) equals (103340004, SCT, "Short Axis") or (131185001, SCT, "Vertical Long Axis") or (131186000, SCT, "Horizontal Long Axis"). May be present otherwise.

10.20.1 Mandatory View and Slice Progression Direction Macro Attributes

10.20.1.1 Slice Progression Direction

The image or frame order to which the Slice Progression Direction (0054,0500) applies depends on the IOD:

- In the case of Enhanced Multi-frame IODs, in which a Stack ID (0020,9056) may be defined, Stack ID (0020,9056) shall be used, and the slices are considered in order by In Stack Position Number (0020,9057)
- In the case of Multi-frame IODs that are not Enhanced, the slices are considered in encoded frame order
- In the case of single-frame IODs, the order is defined by increasing values of Instance Number

The Enumerated Values depend on the view:

- If View Code Sequence (0054,0220) indicates a short axis view, such as when it equals (103340004, SCT, "Short Axis"):

  Enumerated Values
  APEX_TO_BASE
  BASE_TO_APEX

- If View Code Sequence (0054,0220) indicates a vertical long axis view, such as when it equals (131185001, SCT, "Vertical Long Axis"):

  Enumerated Values
  ANT_TO_INF Anterior to Inferior
  INF_TO_ANT Inferior to Anterior

- If View Code Sequence (0054,0220) indicates a horizontal long axis view, such as when it equals (131186000, SCT, "Horizontal Long Axis"):

  Enumerated Values
  SEPTUM_TO_WALL Septum to Lateral Wall

WALL_TO_SEPTUM Lateral Wall to Septum

Note

The conditions on the choice of Enumerated Values are relatively general, rather than specific to a single coded view, in order to accommodate the echocardiography views defined in CID 12226 “Echocardiography Image View” in PS3.16, in addition to the views for CT, MR, NM and PET defined in CID 26 “Nuclear Medicine Projections” in PS3.16.

10.21 Optional View and Slice Progression Direction Macro

Table 10-25 specifies the Attributes that describe the view, and in the case of cardiac views, the direction of the slices relative to the cardiac anatomy.

Table 10-25. Optional View and Slice Progression Direction Macro Attributes

Attribute Name	Tag	Type	Attribute Description
View Code Sequence	(0054,0220)	3	Sequence that describes the projection of the anatomic region of interest. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 26 “Nuclear Medicine Projections” unless otherwise specified in invocation.*
>View Modifier Code Sequence	(0054,0222)	3	View Modifier. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 23 “Cranio-Caudad Angulation” unless otherwise specified in invocation.*
Slice Progression Direction	(0054,0500)	3	Describes the anatomical direction in which a set of slices is progressing (see Section 10.20.1.1). Meaningful only for cardiac images. Enumerated Values are defined in Section 10.20.1.1.

10.22 Numeric Value Macro

Table 10-26 describes the Attributes used to relate and convey a numeric value to a coded concept.

Table 10-26. Numeric Value Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Concept Name Code Sequence	(0040,A043)	1	Coded concept name of this name-value Item. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Context ID is defined.*
Numeric Value	(0040,A30A)	1	Numeric value for this name-value Item.
Measurement Units Code Sequence	(0040,08EA)	1	Units of Numeric Value (0040,A30A) in this name-value Item. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 82 “Units of Measurement”.*

10.23 RT Equipment Correlation Macro

Table 10-27. RT Equipment Correlation Macro Attributes Description

Attribute Name	Tag	Type	Attribute Description
Patient Support Angle	(300A,0122)	3	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
Table Top Pitch Angle	(300A,0140)	3	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
Table Top Roll Angle	(300A,0144)	3	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
Table Top Longitudinal Position	(300A,0129)	3	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm).
Table Top Lateral Position	(300A,012A)	3	Table Top Lateral position in IEC TABLE TOP coordinate system (mm).

10.24 Device Motion Control Macro

Table 10-28 specifies the Attributes that describe requirements on performing the movement of a device from an actual to a desired position.

Table 10-28. Device Motion Control Macro Attributes Description

Attribute Name	Tag	Type	Attribute Description
Device Motion Control Sequence	(300A,0450)	3	Device Motion Control Definitions for each degree of freedom. One or more Items are permitted in this Sequence.
>Device Motion Parameter Code Sequence	(300A,0453)	1	The parameter for which the Device Motion Control shall be applied.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 9401 “IEC61217 Device Position Parameters”*
>Device Motion Execution Mode	(300A,0451)	1C	Permitted Motion Execution Mode for movement. Required if Device Motion Observation Mode (300A,0452) is absent. May be present otherwise. See Section 10.24.1.1.
>Device Motion Observation Mode	(300A,0452)	1C	Required Motion Observation Mode for movement. Required if Device Motion Execution Mode (300A,0451) is absent. May be present otherwise. See Section 10.24.1.2.

10.24.1 Device Motion Control Macro Attributes

10.24.1.1 Device Motion Execution Mode

Device Motion Execution Mode (300A,0451) identifies how the operator invokes and controls the motion.

Enumerated Values:

CONTINUOUS The device must be moved while the operator is activating one or more switches on the machine during the whole period of movement to prevent any uncontrolled movement.

TRIGGERED The device can be moved automatically to the desired position, triggered by a one-time command of the operator, without the need to constantly activate any switch.

AUTOMATIC The device movement can be initiated and performed automatically by the device to the desired position.

10.24.1.2 Device Motion Observation Mode

Device Motion Observation Mode (300A,0452) describes the presence of the operator in the room, observing the motion.

Enumerated Values:

INROOM The movement of the device is only allowed when the operator is present in the treatment room.

REMOTE The device can be moved by a command of the operator not being present in the treatment room, that is, from a device outside the treatment room.

10.25 Attribute Value Constraint Macro

Table 10.25-1 allows an Attribute to be identified and to have constraints placed on acceptable values for that Attribute. An Attribute being constrained is ~~refered~~referred to in the Macro as a Selector Attribute.

Note

1. This Macro does not handle mutual constraints between multiple Attributes. For example constraining the ratio between two Attributes to a specific value is not possible unless there is a third Attribute that encodes that ratio so the third Attribute could then be constrained.

2. The SOP Instance containing this Macro defines the purpose of the constraints, which may include constraining Attribute values in other SOP Instances.

Table 10.25-1. Attribute Value Constraint Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-20a “Extended Selector Attribute Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Constraint Type	(0082,0032)	1	Describes how the value(s) specified in the Constraint Value Sequence (0082,0034) shall be used to determine the acceptability of a given value for the Attribute identified by Selector Attribute (0072,0026) See Section 10.25.1. Enumerated Values: **RANGE_INCL** **RANGE_EXCL** **GREATER_OR_EQUAL** **LESS_OR_EQUAL** **GREATER_THAN** **LESS_THAN** **EQUAL** **MEMBER_OF** **NOT_MEMBER_OF** **MEMBER_OF_CID** **UNCONSTRAINED**
Constraint Violation Significance	(0082,0036)	3	Level of significance of a Selector Attribute value exceeding this constraint. See Section 10.25.2. Enumerated Values: **FAILURE** **WARNING** **INFORMATIVE**
Constraint Violation Condition	(0082,0037)	1C	Conditionality of the constraint violation significance. If the condition is not met, the violation has no significance. The condition may be expressed as a mathematical expression, a human readable text or other form. Required if Constraint Violation Significance (0082,0036) is only significant under certain conditions.

Attribute Name	Tag	Type	Attribute Description
Constraint Value Sequence	(0082,0034)	1C	Value(s) used to constrain the contents of the Attribute referenced by the Selector Attribute (0072,0026). Required if Constraint Type (0082,0032) is not UNCONSTRAINED. If the Constraint Type (0082,0032) is GREATER_OR_EQUAL, LESS_OR_EQUAL, GREATER_THAN, LESS_THAN, EQUAL or MEMBER_OF_CID only a single Item shall be included in this Sequence. If the Constraint Type (0082,0032) is RANGE_INCL or RANGE_EXCL, exactly two Items shall be included in this Sequence, the first of which is less than or equal to the second. If the Constraint Type (0082,0032) is MEMBER_OF or NOT_MEMBER_OF, one or more Items shall be included in this Sequence.
>Include Table 10.26-1 "Attribute Value Macro Attributes"			Any sub-Sequences in the Constraint Value Sequence (0082,0034) shall only contain one Item. Any Attribute in the Sequence Item(s) shall contain a single value. If Constraint Type (0082,0032) is MEMBER_OF_CID, this shall be a Selector UI Value (0072,007F), despite the Selector Attribute VR (0072,0050) being SQ. See Section 10.25.1.1
Recommended Default Value Sequence	(0082,0035)	3	Contains a default value for the contents of the Selector Attribute (0072,0026). Only a single Item is permitted in this Sequence.
>Include Table 10.26-1 "Attribute Value Macro Attributes"			
Measurement Units Code Sequence	(0040,08EA)	3	Units of measurement for the values in the Item(s) in the Constraint Value Sequence (0082,0034) and the Recommended Default Value Sequence (0082,0035). Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 82 "Units of Measurement".*
Specification Selection Guidance	(0082,0033)	3	Brief guidance that a human operator may consider when selecting an appropriate value for the Selector Attribute (0072,0026) within the constraints defined.

10.25.1 Constraint Type

The use of the specified value(s) in the Constraint Value Sequence (0082,0034) to constrain the value of the Attribute referenced by the Selector Attribute (0072,0026) shall depend on the value of Constraint Type (0082,0032) as follows:

RANGE_EXCL the value is constrained to lie outside (i.e., not between) the specified values

GREATER_OR_EQUAL the value is constrained to be greater than or equal to the specified value

LESS_OR_EQUAL the value is constrained to be less than or equal to the specified value

GREATER_THAN the value is constrained to be greater than the specified value

LESS_THAN the value is constrained to be less than the specified value

EQUAL the value is constrained to be equal to the specified value

MEMBER_OF the value is constrained to be equal to one of the specified values

NOT_MEMBER_OF the value is constrained to be not equal to any of the specified values

MEMBER_OF_CID the value is constrained to be equal to a member of the specified CID

UNCONSTRAINED the value of the Selector Attribute (0072,0026) is not constrained

For MEMBER_OF_CID, Constraint Value Sequence (0082,0034) shall contain a single Selector UI Value (0072,007F) , containing a Context Group UID (see PS 3.6, Table A-3. Context Group UID Values).

RANGE_INCL, RANGE_EXCL, GREATER_OR_EQUAL, LESS_OR_EQUAL, GREATER_THAN or LESS_THAN shall only be specified if the Selector Attribute (0072,0026) is AS, DA, DS, DT, FD, FL, IS, SL, SS, TM, UL or US.

See Section C.2.2.2 in PS3.4 for further guidance on value comparison.

Note

MEMBER_OF with a single Item in the Constraint Value Sequence (0082,0034) is valid and is equivalent to EQUAL.

10.25.1.1 Multi-valued Attribute Constraints

If the Attribute referenced by the Selector Attribute (0072,0026) has a value multiplicity of greater than 1 and the value of Selector Value Number (0072,0028) is 0, all values in the selected Attribute shall be compared to the single specified value. The constraint is violated if any of the multiple values do not satisfy the comparison.

10.25.2 Constraint Violation Significance

The violation of some constraints may be more significant than others. Constraint Violation Significance (0082,0036) differentiates three levels of ~~signficance~~significance.

Specific behaviors associated with each level may be defined by the SOP Class or may be left to implementations. For example, violation of a constraint with a significance of FAILURE might require operator intervention, special auditing or rejection of the target Instance being evaluated; violation of a constraint with a significance of WARNING might require the operator be notified or a warning message be logged; violation of a constraint with a significance of INFORMATIVE might require an informational message be logged, or nothing at all if the constraint represents a preference not a ~~signficant~~significant concern.

Note

Violation of a constraint does not imply that the Selector Attribute value is non-conformant to the Standard or is not clinically appropriate.

10.26 Attribute Value Macro

Table 10.26-1 includes an Attribute to store a value of a specified VR.

Table 10.26-1. Attribute Value Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Selector AE Value	(0072,005E)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is AE.
Selector AS Value	(0072,005F)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is AS.

Attribute Name	Tag	Type	Attribute Description
Selector AT Value	(0072,0060)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is AT.
Selector CS Value	(0072,0062)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is CS.
Selector DA Value	(0072,0061)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is DA. See Note 2.
Selector DS Value	(0072,0072)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is DS. See Note 1 and Note 2.
Selector DT Value	(0072,0063)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is DT. See Note 1 and Note 2.
Selector FD Value	(0072,0074)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is FD. See Note 2.
Selector FL Value	(0072,0076)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is FL. See Note 2.
Selector IS Value	(0072,0064)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is IS.
Selector LO Value	(0072,0066)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is LO.
Selector LT Value	(0072,0068)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is LT.
Selector OB Value	(0072,0065)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is OB.
Selector OD Value	(0072,0073)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is OD.

Attribute Name	Tag	Type	Attribute Description
Selector OF Value	(0072,0067)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is OF.
Selector OL Value	(0072,0075)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is OL.
Selector OW Value	(0072,0069)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is OW.
Selector PN Value	(0072,006A)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is PN.
Selector SH Value	(0072,006C)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SH.
Selector SL Value	(0072,007C)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SL.
Selector SS Value	(0072,007E)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SS.
Selector ST Value	(0072,006E)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is ST.
Selector TM Value	(0072,006B)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is TM. See Note 1 and Note 2.
Selector UC Value	(0072,006F)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UC.
Selector UI Value	(0072,007F)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UI.
Selector UL Value	(0072,0078)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UL.
Selector UN Value	(0072,006D)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UN.

Attribute Name	Tag	Type	Attribute Description
Selector UR Value	(0072,0071)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UR.
Selector US Value	(0072,007A)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is US.
Selector UT Value	(0072,0070)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UT.
Selector Code Sequence Value	(0072,0080)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). One or more Items shall be included in this Sequence. See Section C.23.4.2.1.2. Required if Selector Attribute VR (0072,0050) is present and the value is SQ and the Attribute referenced by the Selector Attribute (0072,0026) is a Code Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*

Note

1. For string Value Representations, the meaning of the Value in the Standard shall be used, not the literal string. E.g. "1.0E+3" equals "1000" and "1000.0".
2. Some leniency will be required by the application in precision when matching this selector value to an Attribute value.

10.27 Reference Location Macro

This Macro allows a reference location in the context of a Patient or scan to be identified and described. E.g., the Macro may describe an anatomically defined location along the axis of a CT scan to prescribe the extent of a scan or reconstruction. The location might be internal to the Patient (and appear on a localizer image) or might be an external landmark (on which a laser is aligned).

Table 10.27-1. Reference Location Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Reference Location Label	(0018,9900)	1	Brief user-readable label for the location.
Reference Location Description	(0018,9901)	3	Further elaboration of the Reference Location. The value may include a description of the relative anatomical location, the appearance of the feature or landmark, or how it can be identified.
Reference Basis Code Sequence	(0018,9902)	1	The anatomical feature or point of reference on which the reference location is based. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
Reference Geometry Code Sequence	(0018,9903)	1	Characterizes the geometry of the reference location (e.g., a plane or point). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*

Attribute Name	Tag	Type	Attribute Description
Offset Distance	(0018,9904)	3	Positive offset (in mm) from the Reference Basis to the actual Reference Location. See Section 10.27.1.
Offset Direction	(0018,9905)	1C	Direction of the offset (in terms of patient position) from the Reference Basis to the Reference Location. Enumerated Values: **SUPERIOR** **INFERIOR** **ANTERIOR** **POSTERIOR** **LEFT** **RIGHT** **PROXIMAL** **DISTAL** **MEDIAL** **LATERAL** Required if Offset Distance (0018,9904) is present.

10.27.1 Offset Distance and Direction

An example of the use of offsets might be:

Reference Location Label	(0018,9900)	"1cm above Liver"
Reference Location Description	(0018,9901)	"1cm above the uppermost extent of the liver"
Reference Basis Code Sequence	(0018,9902)	(10200004, SCT, "Liver")
Reference Geometry Code Sequence	(0018,9903)	(128120, DCM, "Plane through Superior Extent")
Offset Distance	(0018,9904)	10
Offset Direction	(0018,9905)	SUPERIOR

10.28 Protocol Element Identification Macro

This Macro identifies and describes an element in a protocol such as an acquisition protocol, a reconstruction protocol or a storage protocol.

Table 10.28-1. Protocol Element Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Protocol Element Number	(0018,9921)	1	Identifies the protocol element and the order in which the elements are performed in the Protocol. The value shall start at 1 and increase monotonically by 1.
Protocol Element Name	(0018,9922)	2	Name for this protocol element.

Attribute Name	Tag	Type	Attribute Description
Protocol Element Purpose	(0018,9924)	3	Description of the purpose this element serves in the protocol. Note 1. This is intended for use by the radiologist, technologist and/or physicist during management of the Protocol to understand the purpose the Protocol Element serves in the Protocol. 2. It is not intended to be copied into the Series Description. Rather there is an Attribute in the Performed Storage Module called Requested Series Description (0018,9937) that is intended to be copied into the Series Description of the stored Instances.
Protocol Element Characteristics Summary	(0018,9923)	3	Summary description of characteristics of this element. Note 1. This is intended for use by the radiologist, technologist and/or physicist during management of the Protocol to understand the characteristics of the Protocol Element. 2. It is not intended to be copied into the Series Description. Rather there is an Attribute in the Performed Storage Module called Requested Series Description (0018,9937) that is intended to be copied into the Series Description of the stored Instances.

10.29 UDI Macro

This Macro records details associated with a Unique Device Identifier (UDI).

Table 10.29-1. UDI Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Unique Device Identifier	(0018,1009)	1	The entire Human Readable Form of the UDI as defined by the Issuing Agency. See Section 10.29.1.
Device Description	(0050,0020)	3	Further description in free form text describing the device. This can be used to distinguish between Items when multiple UDIs are recorded in a Sequence.

10.29.1 Unique Device Identifier

The UDI is a combination of the Device Identifier and the Production Identifier.

The format of the string is defined by a corresponding Issuing Agency, such as:

- GS1 - http://www.gs1.org
- HIBCC - http://www.hibcc.org
- ICCBBA - http://www.iccbba.org

Details for encoding a valid device identifier are managed by the Issuing Agency. For full documentation, refer to issuer materials.

The United States FDA requires the Issuing Agency to use only characters and numbers from the invariant character set of ISO/IEC 646 (ISO 7-bit coded character set also known as ISO IR 6). DICOM puts no constraints on the length of the string or the character sets beyond the UT Value Representation. Implementations should be prepared to handle very large strings and unusual characters.

10.30 Assertion Macro

This Macro is used to record Assertions made by a person or device about the content of a SOP Instance. The nature of the Assertion is defined by the Assertion Code.

The scope of the Assertion (e.g., whether it applies to the whole Instance, to a specific Item in a Sequence, etc.) is described at the point where the Macro is included. It is also expected that when this Macro is included, the Baseline CID for the Assertion Code Sequence (0044,0101) will be constrained.

Table 10.30-1. Assertion Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Assertion Code Sequence	(0044,0101)	1	The Assertion being made. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID defined*
Assertion UID	(0044,0102)	1	Unique identification of this Assertion.
Asserter Identification Sequence	(0044,0103)	1	The person or device making the Assertion. Only a single Item shall be included in this Sequence. Note Multiple asserters wishing to make the same Assertion may be recorded as multiple Assertions, each with a single asserter.
>Include Table C.17-3b “Identified Person or Device Macro Attributes”			*Organizational Role BCID 7452 “Organizational Roles”.*
Assertion DateTime	(0044,0104)	1	Date and time at which the Assertion was made.
Assertion Expiration DateTime	(0044,0105)	3	Date and time at which the Assertion expires. If this Attribute is absent or empty, it means the Assertion does not have a pre-determined date and time at which it expires.
Assertion Comments	(0044,0106)	3	Comments on the nature, extent or basis of the Assertion.
Pertinent Documents Sequence	(0038,0100)	3	Reference to document(s) that describe the Assertion semantics, or provide the basis for making the Assertion. Items shall not be empty. One or more Items are permitted in this Sequence.
>Referenced SOP Class UID	(0008,1150)	3	Unique identifier for the class of the referenced document.
>Referenced SOP Instance UID	(0008,1155)	3	Unique identifier for the referenced document as used in DICOM Instance references (see Section C.12.1.1.6)
>HL7 Instance Identifier	(0040,E001)	3	Instance Identifier of the referenced document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier).
>Retrieve URI	(0040,E010)	3	Retrieval access path to the referenced document. Includes fully specified scheme, authority, path, and query in accordance with [RFC3986].

Attribute Name	Tag	Type	Attribute Description
Related Assertion Sequence	(0044,0107)	3	Other Assertions which may be of interest to systems examining this Assertion. One or more Items are permitted in this Sequence. Note For example, an Assertion that overrides a previous Assertion or disapproves a previously approved protocol, could reference the prior approval Instance making it easier to find/correlate/confirm.
>Referenced Assertion UID	(0044,0108)	1	Uniquely identifies a related Assertion.

10.31 Entity Labeling Macro

The Entity Labeling Macro provides identification of an entity to a user.

This information is intended for display to human readers. Shall not be used for structured processing.

Table 10.31-1. Entity Labeling Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Entity Label	(3010,0035)	1	User-defined label for this entity. See Section 10.31.1.1.
Entity Name	(3010,0036)	3	User-defined name for this entity. See Section 10.31.1.2.
Entity Description	(3010,0037)	3	User-defined description for this entity. See Section 10.31.1.2.

10.31.1 Entity Labeling Macro Attribute Descriptions

10.31.1.1 Entity Label

The Entity Label (3010,0035) Attribute represents a user-defined short free text providing the primary identification of this entity to other users.

10.31.1.2 Entity Name and Entity Description

The optional Attribute Entity Name (3010,0036) allows a longer string containing additional descriptive identifying text. The optional Attribute Entity Description (3010,0037) provides additional information when needed.

10.32 Entity Long Labeling Macro

The Entity Long Labeling Macro provides identification of an entity to a user.

This information is intended for display to human readers. Shall not be used for structured processing.

Table 10.32-1. Entity Long Labeling Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Entity Long Label	(3010,0038)	1	User-defined label for this entity. See Section 10.32.2.1.

Attribute Name	Tag	Type	Attribute Description
Entity Description	(3010,0037)	3	User-defined description for this entity. See Section 10.31.1.2.

10.32.2 Entity Long Labeling Macro Attribute Descriptions

10.32.2.1 Entity Long Label

The Entity Long Label (3010,0038) Attribute represents a user-defined free text providing the primary identification of this entity to other users.

10.33 Conceptual Volume Macro

A Conceptual Volume is an abstract entity used to identify an anatomic region (such as a planning target volume or a combination of multiple anatomic volumes) or non-anatomic volumes such as a bolus or a marker. A Conceptual Volume can be established without necessarily defining its spatial extent (for example a Conceptual Volume for a tumor can be established prior to segmenting it). The spatial extent of a Conceptual Volume may change over time (for example as treatment proceeds the tumor volume corresponding to the Conceptual Volume will change).

The spatial extent of a Conceptual Volume may be defined by any general-purpose entity that represents geometric information (such as Segmentation, Surface Segmentation, RT Structure Set SOP Instance and alike) or a combination thereof, although the Conceptual Volume does exist independently of a specific definition of its spatial extent.

A Conceptual Volume may also be defined as a combination of other Conceptual Volumes.

Examples for Conceptual Volumes:

1. A Conceptual Volume (with a Conceptual Volume UID (3010,0006) can be used to represent the treatment target in an RT Physician Intent SOP Instance based upon a diagnostic image set, although the actual delineation of a specific target volume has not yet taken place. Later, the target volume is contoured. The RT Segment Annotation SOP Instance references the volume contours and associates it with the Conceptual Volume via the Conceptual Volume UID (3010,0006).

2. In an adaptive workflow, the anatomic volume may change over time. The Conceptual Volume on the other hand does not change. Multiple RT Segment Annotation SOP Instances, each referencing different Segmentation Instances, can be associated with the same Conceptual Volume via the Conceptual Volume UID (3010,0006) , making it possible to track the volume over time.

3. A Conceptual Volume may represent targets and/or anatomic regions for which manually calculated doses are tracked (for example, in emergency treatments). In this case, Conceptual Volumes may be instantiated first in an RT Physician Intent SOP Instance and subsequently used in RT Radiation SOP Instances, or may be first instantiated in the Radiation SOP Instances. After treatment, these Conceptual Volumes will be used in RT Radiation Records to track the delivered dose. Such Conceptual Volumes may never reference a segmentation, but serve as a key for referencing the Conceptual Volume across these different SOP Instances.

Table 10.33-1. Conceptual Volume Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Conceptual Volume UID	(3010,0006)	1	A UID identifying the Conceptual Volume.
Originating SOP Instance Reference Sequence	(3010,0007)	1C	Reference to the SOP Instance that contains the original definition of this Conceptual Volume identified by Conceptual Volume UID (3010,0006). Required when Conceptual Volume UID (3010,0006) was not issued in the current SOP Instance, but read from another SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Equivalent Conceptual Volumes Sequence	(3010,000A)	3	References one or more existing Conceptual Volumes that represent the same concept as the current Conceptual Volume. This Sequence might be used when Conceptual Volume references of existing SOP Instances are retrospectively identified as representing the same entity. One or more Items are permitted in this Sequence. See Section 10.33.1.1.
>Referenced Conceptual Volume UID	(3010,000B)	1	A UID identifying the Conceptual Volume.
>Equivalent Conceptual Volume Instance Reference Sequence	(3010,0009)	1	Reference to a SOP Instance that contains the Referenced Conceptual Volume UID (3010,000B) of the Equivalent Conceptual Volume. Only a single Item shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Derivation Conceptual Volume Sequence	(3010,0014)	3	Description of a Conceptual Volume that was used to derive this Conceptual Volume. Only a single Item is permitted in this Sequence.
>Derivation Description	(0008,2111)	3	A user-readable text description of how this Conceptual Volume was derived.
>Source Conceptual Volume Sequence	(3010,0018)	1	The set of Conceptual Volumes that were used to derive this Conceptual Volume. One or more Items shall be included in this Sequence.
>>Source Conceptual Volume UID	(3010,0015)	1	UID identifying the Conceptual Volume that was used to derive this Conceptual Volume.
>>Conceptual Volume Constituent Index	(3010,000D)	1	Index of the constituent in the Source Conceptual Volume Sequence. The value shall start at 1 and increase monotonically by 1.
>>Conceptual Volume Constituent Segmentation Reference Sequence	(3010,0012)	2	Contains the reference to the constituents of the RT Segment Annotation Instance from which Conceptual Volume is derived. Zero or one Item shall be included in this Sequence.
>>>Referenced Direct Segment Instance Sequence	(3010,004A)	1	Reference to the SOP Instance that contains the Direct Segment Reference Sequence (3010,0023). Only a single Item shall be included in this Sequence. See Section 10.34.1.3.
>>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>>>Referenced Segment Reference Index	(3010,0020)	1	The Segment Reference Index (3010,0022) in the Segment Reference Sequence (3010,0021) corresponding to the segment representing this Conceptual Volume. Shall reference only segment Items that contain the Direct Segment Reference Sequence (3010,0023).

Attribute Name	Tag	Type	Attribute Description
>Conceptual Volume Derivation Algorithm Sequence	(3010,0016)	3	Algorithm used to derive this Conceptual Volume. One or more Items are permitted in this Sequence.
>>Include Table 10-19 “Algorithm Identification Macro Attributes”			*No Baseline CID defined*

10.33.1 Conceptual Volume Macro Attribute Descriptions

10.33.1.1 Equivalent Conceptual Volumes

Conceptual Volumes can be declared to be equivalent to other Conceptual Volumes. In such cases, the Equivalent Conceptual Volumes Sequence (3010,000A) is used in derived SOP Instances which are aware of other SOP Instances defining a semantically equivalent volume, but using different Conceptual Volume UIDs (3010,0006).

10.33.1.2 Derivation Conceptual Volume Sequence

The Derivation Conceptual Volume Sequence (3010,0014) may be used to describe how a Conceptual Volume is derived from one or more other Conceptual Volumes in cases where it may not be possible to describe the method of the derivation completely. Since the Conceptual Volume cannot be mathematically constructed from a derivation description, it will be defined explicitly by a segmentation.

The specification of derivation is different from combining Conceptual Volumes as defined in Section 10.34 “Conceptual Volume Segmentation Reference and Combination Macro”.

10.34 Conceptual Volume Segmentation Reference and Combination Macro

This Macro allows the combination of Conceptual Volumes as constituents of a combined volume. A representative example is to have the Left Lung and the Right Lung segmented, and then to declare the Lungs as a combined Conceptual Volume, for which prescription constraints can be defined.

The Macro also allows reference to RT Segment Annotation SOP Instances, which contain a segmented representation of the Conceptual Volume. At the invocation of this Macro it is declared, whether this segmented representation is required or not.

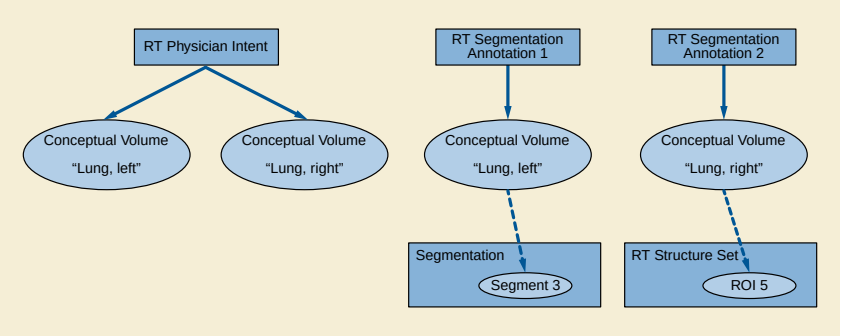


Figure 10.34-1. Conceptual Volume References

Figure 10.34-1 describes an RT Physician Intent Instance where Conceptual Volumes "Lung, left" and "Lung, right" are referenced, but not defined. In this example, the RT Segmentation Annotation Instances then define the volumetric information of the Conceptual Volumes by referencing a specific segment of a Segmentation Instance and a specific ROI in an RT Structure Set Instance.

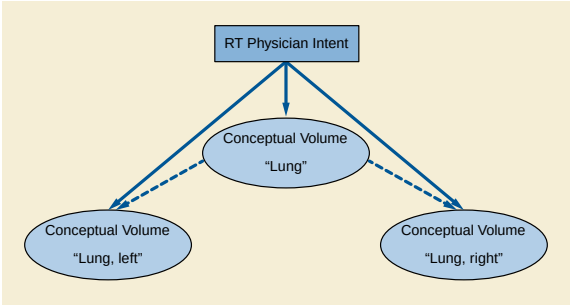


Figure 10.34-2. Conceptual Volume Combination References

Figure 10.34-1 describes an RT Physician Intent Instance defining Conceptual Volumes "Lung, left" and "Lung, right" and Conceptual Volume "Lung" as a combination of the first two without a direct reference to a volume definition.

Table 10.34-1. Conceptual Volume Segmentation Reference And Combination Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.33-1 "Conceptual Volume Macro Attributes"			
Conceptual Volume Combination Flag	(3010,000E)	1	Indication that this Conceptual Volume is a combination of other Conceptual Volumes. Enumerated Values: **YES** **NO**
Conceptual Volume Constituent Sequence	(3010,0008)	1C	References to Conceptual Volumes which are constituents of this Conceptual Volume. See Section 10.34.1.1. Required if Conceptual Volume Combination Flag (3010,000E) equals YES. One or more Items shall be included in this Sequence. The combined Conceptual Volume UID shall not be included in the Sequence.
>Conceptual Volume Constituent Index	(3010,000D)	1	An index referenced in the Conceptual Volume Combination Expression (3010,000C) identifying the Conceptual Volume Constituent. The value shall start at 1 and increase monotonically by 1.
>Constituent Conceptual Volume UID	(3010,0013)	1	UID identifying the Conceptual Volume that is a constituent of the combined Conceptual Volume.
>Originating SOP Instance Reference Sequence	(3010,0007)	1	Reference to the SOP Instance that contains the original definition of the Conceptual Volume constituent identified by Constituent Conceptual Volume UID (3010,0013) in this Sequence. If this Conceptual Volume ~~orginated~~originated in the current SOP Instance, then the referenced SOP Instance UID is the current SOP Instance UID. Only a single Item shall be included in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Conceptual Volume Constituent Segmentation Reference Sequence	(3010,0012)	1C	Contains a segmented representation of the Conceptual Volume constituent. Required if the Conceptual Volume Segmentation Defined Flag (3010,0010) equals YES and the Conceptual Volume is not a Combination of other Conceptual Volumes. Only a single Item shall be included in this Sequence. See Section 10.34.1.2.
>>Referenced Direct Segment Instance Sequence	(3010,004A)	1	Reference to the SOP Instance that contains the Direct Segment Reference Sequence (3010,0023). Only a single Item shall be included in this Sequence. See Section 10.34.1.3.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Referenced Segment Reference Index	(3010,0020)	1	The Segment Reference Index (3010,0022) in the Segment Reference Sequence (3010,0021) corresponding to the segment representing this Conceptual Volume. Shall reference only segment Items that contain the Direct Segment Reference Sequence (3010,0023).
Conceptual Volume Combination Expression	(3010,000C)	1C	Symbolic expression specifying the combination of Conceptual Volumes as a text string consisting of Conceptual Volume Constituent Index (3010,000D) values, combination operators and parentheses. Required if Conceptual Volume Combination Flag (3010,000E) equals YES. See Section 10.34.1.1.
Conceptual Volume Combination Description	(3010,000F)	2C	Human-readable description of the combination of Conceptual Volumes. This information is intended for ~~displayand~~display and shall not be used for structured processing. Required if Conceptual Volume Combination Flag (3010,000E) equals YES.
Conceptual Volume Segmentation Defined Flag	(3010,0010)	1	Indication that there are defined segmentations for this Conceptual Volume. Enumerated Values: **YES** **NO**
Conceptual Volume Segmentation Reference Sequence	(3010,0011)	1C	Contains a segmented representation of the Conceptual Volume. Required when Conceptual Volume Segmentation Defined Flag (3010,0010) equals YES and Conceptual Volume Combination Flag Indicator (3010,000E) equals NO. Only a single Item shall be included in this Sequence. See Section 10.34.1.4.

Attribute Name	Tag	Type	Attribute Description
>Referenced Direct Segment Instance Sequence	(3010,004A)	1	Reference to the SOP Instance that contains the Segment Reference Sequence (3010,0021) in which the segment is defined. Only a single Item shall be included in this Sequence. See Section 10.34.1.3.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Segment Reference Index	(3010,0020)	1	The Segment Reference Index (3010,0022) in the Segment Reference Sequence (3010,0021) corresponding to the segment representing this Conceptual Volume. In the segment Item referenced, the Direct Segment Reference Sequence (3010,0023) shall be present.

10.34.1 Conceptual Volume Segmentation Reference and Combination Macro Attribute Description

10.34.1.1 Conceptual Volume Combination Expression

For Conceptual Volumes specified as a combination of other Conceptual Volumes, the combination logic is specified by the text string value of the Conceptual Volume Combination Expression (3010,000C).

A nested list notation is used to apply geometric operators to a set of Conceptual Volumes.

The first element of the list shall be one of the following geometric operators:

UNION geometric union of two or more arguments

INTERSECTION geometric intersection of two or more arguments

NEGATION geometric inverse of a single argument

SUBTRACTION geometric subtraction of second argument from the first

XOR geometric exclusive disjunction of two arguments

Note

The result of a NEGATION operation is well-defined only if used as an operand to an INTERSECTION. NEGATION without context to an INTERSECTION results in an infinite Volume.

Subsequent elements shall specify arguments of the geometric operator. An argument is either a Conceptual Volume Constituent Index (3010,000D) value (i.e., positive integer) or a parenthesized list of operations.

The grammar for the Conceptual Volume Combination Expression (<sexpr>) is shown below in BNF (Backus Naur Form) :

```
<sexpr>         :: <cv> | <list>
<cv>            :: 1 | 2 | 3 | ⋯
<list>          :: ( <op1><sp><sexpr> ) |
                   ( <op2><sp><sexpr><sp><sexpr> ) |
                   ( <op3><sp><args> )
<args>          :: <sexpr><sp><sexpr> | <args><sp><sexpr>
<op1>           :: NEGATION
<op2>           :: SUBTRACTION | XOR
<op3>           :: UNION | INTERSECTION
<sp>            :: 0x20
```

Examples:

1. Union of paired organs 1 and 2 (disjoint)

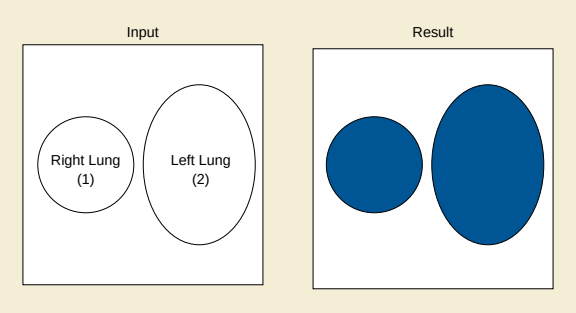


Figure 10.34.1.1-1. Conceptual Volume Example of Union of Disjoint Volumes

Conceptual Volume Combination Expression (3010,000C):

(UNION 1 2)

Items in Conceptual Volume Constituent Sequence (3010,0008):

Table 10.34.1.1-1. Conceptual Volume Example of Union of Disjoint Volumes

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	Right Lung
2	Left Lung

2. Union of paired organs 1 and 2 (non-disjoint)

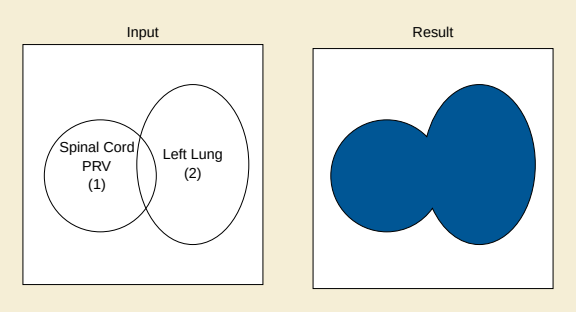


Figure 10.34.1.1-2. Conceptual Volume Example of Union of Non-disjoint Volumes

Conceptual Volume Combination Expression (3010,000C):

(UNION 1 2)

Items in Conceptual Volume Constituent Sequence (3010,0008) :

Table 10.34.1.1-2. Conceptual Volume Example of Union of non-disjoint Volumes

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	Spinal Cord PRV
2	Left Lung

3. Union of two organs 1 and 2 with excluded volume 3 using NEGATION

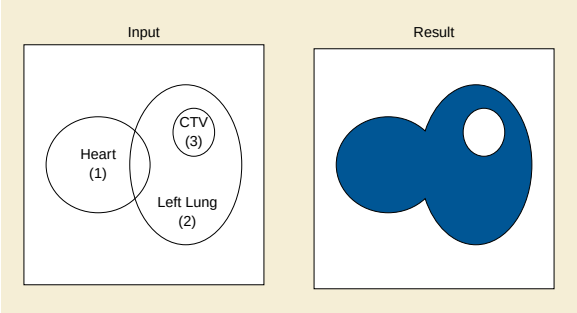


Figure 10.34.1.1-3. Conceptual Volume Example of Intersection and Negation

Conceptual Volume Combination Expression (3010,000C):

(INTERSECTION (UNION 1 2) (NEGATION 3))

Items in Conceptual Volume Constituent Sequence (3010,0008):

Table 10.34.1.1-3. Conceptual Volume Example of Intersection and Negation

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	Heart
2	Left Lung
3	CTV

4. Union of paired organs 1 and 2, with exclusion of multiple volumes 3, 4 and 5

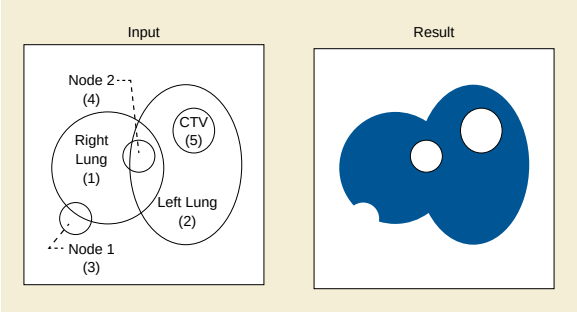


Figure 10.34.1.1-4. Conceptual Volume Example of Intersection and Union

Conceptual Volume Combination Expression (3010,000C):

(INTERSECTION (UNION 1 2) (NEGATION (UNION 3 4 5)))

Note

This combination can be expressed alternatively as:

(SUBTRACTION (UNION 1 2) (UNION 3 4 5))

Items in Conceptual Volume Constituent Sequence (3010,0008):

Table 10.34.1.1-4. Conceptual Volume Example of Intersection and Union

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	R Lung
2	L Lung
3	Node 1
4	Node 2
5	CTV

5. Intersection of overlapping volumes 1 and 2

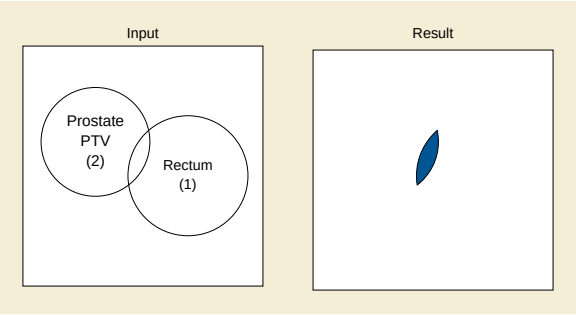


Figure 10.34.1.1-5. Conceptual Volume Example of Intersection of Non-disjunct Volumes

Conceptual Volume Combination Expression (3010,000C):

(INTERSECTION 1 2)

Items in Conceptual Volume Constituent Sequence (3010,0008):

Table 10.34.1.1-5. Conceptual Volume Example of Intersection of non-disjunct Volumes

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	Rectum
2	Prostate PTV

6. Intersection of disjoint volumes 1 and 2

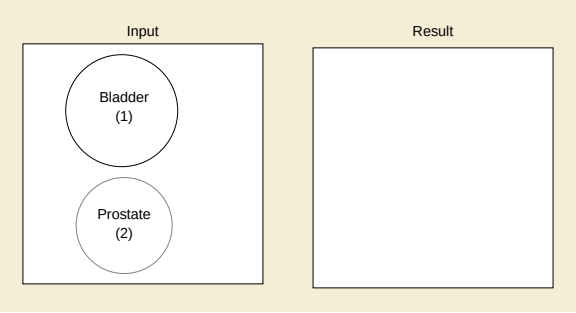


Figure 10.34.1.1-6. Conceptual Volume Example of Intersection of Non-disjunct Volumes

Conceptual Volume Combination Expression (3010,000C):

(INTERSECTION 1 2)

Items in Conceptual Volume Constituent Sequence (3010,0008):

Table 10.34.1.1-6. Conceptual Volume Example of Intersection of disjunct Volumes

Conceptual Volume Constituent Index (3010,000D)	Conceptual Volume
1	Bladder
2	Prostate

10.34.1.2 Conceptual Volume Segmentation Reference Sequence

The Conceptual Volume Constituent Segmentation Reference Sequence (3010,0012) contains a reference to a segmentation which represents the volume of this ~~consituent~~constituent geometrically. The referenced segmentations of the constituents of a combined Conceptual Volume may be in one or more Frames of References.

The Conceptual Volume constituents shall not include the combined Conceptual Volume being defined. Applications that wish to combine existing segmentations within the same Conceptual Volume must create a new Segmentation Instance.

10.34.1.3 Referenced Direct Segment Instance Sequence

A SOP Instance may only be referenced in this Sequence if it belongs to a SOP Class that includes the Section C.36.9 Segment Reference Module.

10.34.1.4 Conceptual Volume Segmentation Reference Sequence

The Conceptual Volume Segmentation Reference Sequence (3010,0011) contains a reference to a segmentation which represents this volume geometrically.

10.35 Device Model Macro

The Device Model Macro contains general Attributes needed to specify a device model other than the device creating the SOP Instance.

Table 10.35-1. Device Model Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	2	Manufacturer of the device.
Manufacturer's Model Name	(0008,1090)	2	Manufacturer's model name of the device.
Manufacturer's Model Version	(3010,001A)	2	A version number of the Manufacturer's model of the device.

10.36 Device Identification Macro

The Device Identification Macro identifies a (physical or virtual) device.

Table 10.36-1. Device Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Device Type Code Sequence	(3010,002E)	1	The type of the device. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
Device Label	(3010,002D)	1	User-defined label for this device.
Long Device Description	(0050,0021)	3	User-defined description for this device.

Attribute Name	Tag	Type	Attribute Description
Device Serial Number	(0018,1000)	2	Manufacturer"s serial number of the device.
Software Versions	(0018,1020)	2	Manufacturer's designation of software version of the equipment.
UDI Sequence	(0018,100A)	3	Unique Device Identifier (UDI) of the device. One or more Items are permitted in this Sequence. Note Multiple Items may be present if the entire equipment has UDIs issued by different Issuing Authorities.
>Include Table 10.29-1 “UDI Macro Attributes”			
Manufacturer's Device Identifier	(3010,0043)	2	An identifier issued by the manufacturer. See Note.
Device Alternate Identifier	(3010,001B)	2	An identifier intended to be read by a device such as a bar code reader.
Device Alternate Identifier Type	(3010,001C)	1C	Defines the type of Device Alternate Identifier. Required if Device Alternate Identifier (3010,001B) is present. Defined Terms: **BARCODE** **RFID**
Device Alternate Identifier Format	(3010,001D)	1C	Description of the format in which the Device Alternate Identifier (3010,001B) is issued. Required if Device Alternate Identifier (3010,001B) is present. See Section 10.36.1.1.

Note

Typically, the Device Identifier is a code which can be electronically read by the machine utilizing that device, e.g. to verify the presence of that device.

10.36.1 Device Component Identification Macro Attribute Descriptions

10.36.1.1 Device Alternate Identifier Format

The Device Alternate Identifier Format (3010,001D) specifies the format of the value of the Device Alternate Identifier (3010,001B).

If the value of Device Alternate Identifier Type (3010,001C) is RFID, a big variety of RFID formats exists (some examples are DOD-96, DOD-64 UID, GID-96, sgtin-96). Supported format values shall be defined in the Conformance Statement.

For Device Alternate Identifier Type (3010,001C) = BARCODE, see Section C.22.1.1.

10.37 Related Information Entities Macro

This Macro defines references to entities and their purpose of reference. References can be made at the Study level, Series level, Instance level or Frame Level.

The attributes Pertinent SOP Classes in Study (3010,0052) and Pertinent SOP Classes in Series (3010,0053) allow the specification of the relevant SOP Classes for the given purpose. These attributes support filtering for certain SOP Classes, specification of corresponding query keys, and allowing the receiving application to assess its capabilities to handle the specified objects.

All referenced Studies, Series and Instances share the same single Purpose of Reference.

Table 10.37-1. Related Information Entities Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the references are made. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the Macro invocation.*
Referenced Study Sequence	(0008,1110)	1	Studies which are relevant for the invocation context. One or more Items shall be included in this Sequence.
>Study Instance UID	(0020,000D)	1	Uniquely identifies the referenced Study.
>Pertinent SOP Classes in Study	(3010,0052)	3	The SOP Classes in the Study which are relevant for the invocation context. If not present, all SOP Instances included in the referenced Study are considered relevant.
>Referenced Series Sequence	(0008,1115)	3	Series which are relevant for the invocation context. One or more Items are permitted in this Sequence.
>>Series Instance UID	(0020,000E)	1	Uniquely identifies the referenced Series.
>>Pertinent SOP Classes in Series	(3010,0053)	3	The SOP Classes in the Series which are relevant for the invocation context. If not present, all SOP Instances included in the referenced Series are considered relevant.
>>Referenced Image Sequence	(0008,1140)	3	Image SOP Instances which are relevant in the invocation context. One or more Items are permitted for this Sequence.
>>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>>Referenced Instance Sequence	(0008,114A)	3	Non-Image SOP Instances which are relevant in the invocation context. One or more Items are permitted for this Sequence.
>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

10.38 Outline Definition Macro

The Outline Definition Macro describes a 2D outline in a given coordinate system.

Table 10.38-1. Outline Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Outline Shape Type	(0018,1630)	1	Type of shape of the outline. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL** See Section 10.38.1.1.
Outline Left Vertical Edge	(0018,1631)	1C	X-coordinate in mm of the left edge of the rectangular outline (parallel to the y-axis of the coordinate system). Required if Outline Shape Type (0018,1630) is RECTANGULAR. See Section 10.38.1.2.
Outline Right Vertical Edge	(0018,1632)	1C	X-coordinate in mm of the right edge of the rectangular outline (parallel to the y-axis of the coordinate system). Required if Outline Shape Type (0018,1630) is RECTANGULAR. See Section 10.38.1.2.
Outline Upper Horizontal Edge	(0018,1633)	1C	Y-coordinate in mm of the upper edge of the rectangular outline (parallel to the x-axis of the coordinate system). Required if Outline Shape Type (0018,1630) is RECTANGULAR. See Section 10.38.1.2.
Outline Lower Horizontal Edge	(0018,1634)	1C	Y-coordinate in mm of the lower edge of the rectangular outline (parallel to the x-axis of the coordinate system). Required if Outline Shape Type (0018,1630) is RECTANGULAR. See Section 10.38.1.2.
Center of Circular Outline	(0018,1635)	1C	Location (x,y) in mm of the center of the circular outline. Required if Outline Shape Type (0018,1630) is CIRCULAR. See Section 10.38.1.2.
Diameter of Circular Outline	(0018,1636)	1C	Diameter in mm of the circular outline. Required if Outline Shape Type (0018,1630) is CIRCULAR. See Section 10.38.1.2.
Number of Polygonal Vertices	(0018,1637)	1C	Number of Vertices in Vertices of the Polygonal Outline (0018,1638). Required if Outline Shape Type (0018,1630) is POLYGONAL.

Attribute Name	Tag	Type	Attribute Description
Vertices of the Polygonal Outline	(0018,1638)	1C	A data stream of pairs of x and y in mm. Polygonal outlines are implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices. Any given vertex shall occur only once in the data stream. Required if Outline Shape Type (0018,1630) is POLYGONAL. The number of ~~pairsin~~pairs in this data stream shall equal the value ~~ofNumber~~of Number of Polygonal Vertices (0018,1637). See Section 10.38.1.2.

10.38.1 Outline Definition Macro Attribute Description

10.38.1.1 Outline Shape Type

When outline shape is a rectangle or a circle per design, the Outline Shape Type (0018,1630) shall have the value RECTANGULAR or CIRCULAR respectively and the outline shall not be represented as a polyline.

10.38.1.2 Coordinate Definitions

The values are defined in a plane that is declared in the invocation of the Macro.

10.39 Patient to Equipment Relationship Macro

The Patient to Equipment Relationship Macro describes a position of the patient with respect to a device. The position is defined by means of a transformation matrix between a Patient Frame of Reference and an Equipment Frame of Reference.

Table 10.39-1. Patient to Equipment Relationship Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Image to Equipment Mapping Matrix	(0028,9520)	1	A rigid, homogeneous 4x4 transformation matrix that maps the patient coordinate space in the Frame of Reference used for the patient model to the coordinate system defined by the equipment. Matrix elements shall be listed in row-major order. See Section 10.39.1.1, Section 10.39.1.2 and Section C.7.6.21.1.
Frame of Reference Transformation Comment	(3006,00C8)	3	Comments entered by a human operator about the relationship between the patient frame of reference and the equipment. For display purposes only, shall not be used for other purposes.
Patient Location Coordinates Sequence	(3006,00C9)	2	Specific points in the patient coordinate system which further characterize the position of the patient with respect to the equipment. Zero or more Items shall be included in this Sequence.
>3D Point Coordinate	(0068,6590)	1	Coordinate (x,y,z) in mm describing the location in the patient Frame of Reference that will be transformed to the Equipment Frame of Reference by using the Image to Equipment Mapping Matrix (0028,9520).
>Patient Location Coordinates Code Sequence	(3006,00CA)	1	Identifies the type of Patient Location Coordinate. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*CID is specified at invocation.*

Attribute Name	Tag	Type	Attribute Description
Patient Support Position Sequence	(3006,00CB)	2	Actual Patient Support Position parameters. Shall be consistent with the Image to Equipment Mapping Matrix (0028,9520). See Section 10.39.1.2. Zero or one Item shall be included in this Sequence.
>Include Table 10.40-1 "Patient Support Position Macro Attributes".			

10.39.1 Patient to Equipment Relationship Macro Attributes Description

10.39.1.1 Equipment Coordinate System

A piece of equipment has an Equipment Coordinate System which can be used for expressing geometric concepts such as locations and ~~orientations.The~~orientations. The coordinate system is characterized by the location of the origin and the orientation of coordinate axes with respect to the equipment. The Equipment Coordinate System is a right-handed coordinate system.

Equipment Coordinate Systems are typically based on a standardized definition of axes. The choice of origin is often device-specific or device-type-specific. It may be any significant location on the machine such as the manufacturer-dependent machine isocenter.

The Equipment Coordinate System can be used as the parent for derived coordinate systems.

10.39.1.2 Image to Equipment Mapping Matrix and Patient Support Position Macro

The Image to Equipment Mapping Matrix (0028,9520) describes the relationship between the Patient-oriented coordinate system and an Equipment Coordinate System. This matrix ${}^{A}M_{B}$describes a rigid transformation of a point (${}^{B}x$, ${}^{B}y$, ${}^{B}z$) with respect to the Patient coordinate system into (${}^{A}x$, ${}^{A}y$, ${}^{A}z$) with respect to the Equipment Coordinate System as defined in Section C.7.6.21.1.

The Equipment Coordinate System is identified by the Equipment Frame of Reference UID (300A,0675). For further information on the definition of the Equipment Frame of Reference, see Section 10.39.1.1. The patient-oriented coordinate system is identified by the Frame of Reference UID (0020,0052) of the SOP Instance it is used within. Both coordinate systems are expressed in millimeters.

The Patient Support Position Macro invoked by Patient Support Position Sequence (3006,00CB) allows the exchange of device-specific parameters for the patient support device. Applications designed to guide a specific patient support device will be able to de-compose the transformation into device-specific parameters or derive a transformation matrix out of these parameters. Applications that are unable to know the decomposition of the transformation to those parameters and vice versa will still be able to display the native labels and numerical values of those parameters to human readers.

The Patient Support Position Sequence (3006,00CB) may be present to annotate the matrix and display the decomposed matrix contents. The content of the Patient Support Position Macro shall be used for display purposes only. It shall not be used for other purposes. The content of this Macro shall not be used as a substitute for the Image to Equipment Mapping Matrix (0028,9520). In general, there is more than one way to reach the point in space that is described by the Image to Equipment Mapping Matrix (0028,9520). Hence it is explicitly not implied how this position is reached.

In some cases (e.g., emergency treatments in Radiotherapy), the Patient Frame of Reference is not defined by an image series. In this case an arbitrary Frame of Reference is used for the patient coordinate system in the Frame of Reference Module of the SOP Instance. The Image to Equipment Mapping Matrix (0028,9520) has the same meaning as in the case of image-based Patient Frame of Reference.

If the Image to Equipment Mapping Matrix (0028,9520) and the Patient Support Position Sequence (3006,00CB) are both present, the information in both locations shall be consistent.

10.40 Patient Support Position Macro

This Macro provides the device-specific geometric settings for the Patient Support device.

The information is intended for display to human readers and to support non-image-based patient positioning; however, the definition of the patient position with respect to the device is contained in the Image to Equipment Mapping Matrix (0028,9520).

Table 10.40-1. Patient Support Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Support Position Specification Method	(300A,065C)	1	Method of specification for patient support parameters. Enumerated Values: **ABSENT** ~~INo~~No parameters are specified. **GLOBAL** Parameters are specified using a globally known method, irrespective of the device in use. **DEVICE_SPECIFIC** Parameters are specified using a device-specific method.
Patient Support Position Device Parameter Sequence	(300A,065D)	1C	Translational and rotational parameters for Patient Support devices. Required if Patient Support Position Specification Method (300A,065C) does not equal ABSENT. One or more Items shall be included in this Sequence if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. Only one Item shall be included in this Sequence if Patient Support Position Specification Method (300A,065C) equals GLOBAL.
>Referenced Device Index	(300A,0607)	1C	The value of Device Index (3010,0039) in Patient Support Devices Sequence (300A,0686) corresponding to the Patient Support Device in use. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC.
>Device Order Index	(300A,065E)	1C	Index defining the order in which the Items in the Patient Support Position Device Parameter Sequence (300A,065D) are applied. The value shall start at 1 and increase monotonically by 1. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. See Section 10.40.1.
>Patient Support Position Parameter Sequence	(300A,065B)	1	Translational and rotational parameters for a particular Patient Support device. One or more Items shall be included in this Sequence.
>>Patient Support Position Parameter Order Index	(300A,065F)	1C	Index defining the order in which the Items in the Patient Support Position Parameter Sequence (300A,065B) are applied. The value shall start at 1 and increase monotonically by 1. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. See Section 10.40.1.
>>Include Table 10-2 "Content Item Macro Attributes Description".			*DTID 15302 "Patient Support Position Parameters".*

10.40.1 Position Parameters and Order Index

The Device Order Index (300A,065E) and ~~thePatient~~the Patient Support Position Parameter Order Index (300A,065F) are applied sequentially, meaning all the Items in a Patient Support Position Parameter Sequence (300A,065B) are applied before proceeding to the Item in the Patient Support Position Device Parameter Sequence (300A,065D) specified by the next Device Order Index (300A,065E) value.

A vendor may specify codes that are not included in TID 175001 and/or a set of codes which is not identical with the set defined in Section 10.40.1.1 or Section 10.40.1.2. The vendor shall document the codes used in this Macro in the Conformance Statement, as well as the corresponding parameters, their geometric interpretation, and the order in which they will be applied. These parameters shall use UCUM units of mm for lengths and degrees for angles.

10.40.1.1 IEC 61217 Patient Support Device

Devices using the IEC 61217 coordinate systems to define geometric settings for the Patient Support device shall use the codes in Table 10.40-2 in the order specified in column Patient Support Position Parameter Order Index (300A,065F). Other codes shall not be used.

Table 10.40-2. Isocentric Patient Support Position Parameter Order Index

Code Value (0008,0100)	Code Meaning (0008,0104)	Patient Support Position Parameter Order Index (300A,065F)
126801	IEC61217 Patient Support Continuous Yaw Angle	1
126806	IEC61217 Table Top Lateral Position	2
126807	IEC61217 Table Top Longitudinal Position	3
126808	IEC61217 Table Top Vertical Position	4
126802	IEC61217 Table Top Support Continuous Pitch Angle	5
126803	IEC61217 Table Top Support Continuous Roll Angle	6

10.40.1.2 Isocentric Patient Support Device

Devices using an isocentric representation to define geometric settings for the Patient Support device shall use the codes in Table 10.40-3 in the order specified in column Patient Support Position Parameter Order Index (300A,065F). Other codes shall not be used.

Table 10.40-3. Isocentric Patient Support Position Parameter Order Index

Code Value (0008,0100)	Code Meaning (0008,0104)	Patient Support Position Parameter Order Index (300A,065F)
126814	Isocentric Patient Support Continuous Yaw Angle	1
126812	Isocentric Patient Support Continuous Pitch Angle	2
126813	Isocentric Patient Support Continuous Roll Angle	3
126815	Isocentric Patient Support Lateral Position	4
126816	Isocentric Patient Support Longitudinal Position	5
126817	Isocentric Patient Support Vertical Position	6

A Composite Information Object Definitions (Normative)

A.1 Elements of An Information Object Definition

Each Composite Information Object Definition is composed of the following Sections

a. IOD Description

b. IOD Entity-Relationship Model

c. IOD Module Table

d. Optionally, a Functional Group Macros Table used by the Multi-frame Functional Groups Module

Section A.1.1, Section A.1.2 and Section A.1.3 define the requirements of a) through d) above.

A.1.1 IOD Description

This Section provides a brief description of the IOD. Specifically, this description includes:

- The Real-World Object that is represented by the IOD
- Information as to the scope of the represented object if appropriate

A.1.2 IOD Entity-Relationship Model

This Section of an IOD provides the Entity-Relationship (E-R) Model that depicts the relationships of the components or Information Entities (IE) of the specified IOD. It forms an IOD specific information model. This E-R model provides the complete context of how the Composite Instance information shall be interpreted when a Composite Instance is exchanged between two DICOM Application Entities; in particular, an IOD will specify a single IE at the level below the Series IE.

Even though Composite Instances are encoded as discrete individual components, each Composite Instance IOD E-R Model requires that all Composite Instances that are part of a specific Study shall share the same context. That is, all Composite Instances within a specific Patient Study share the same Patient and Study information; all Composite Instances within the same Series share the same Series information; etc.

Figure A.1-1 is the DICOM Composite Instance IOD Information Model. It applies to all Patient-related Composite Instance IODs defined in Annex A. However, a subset of this model may be specified by each individual Composite Instance IOD to accurately define the context for specific Composite Instance exchange.

The sub-sections of this Section describe the Information Entities (IE) that comprise the Composite Instance IODs defined in this Annex.

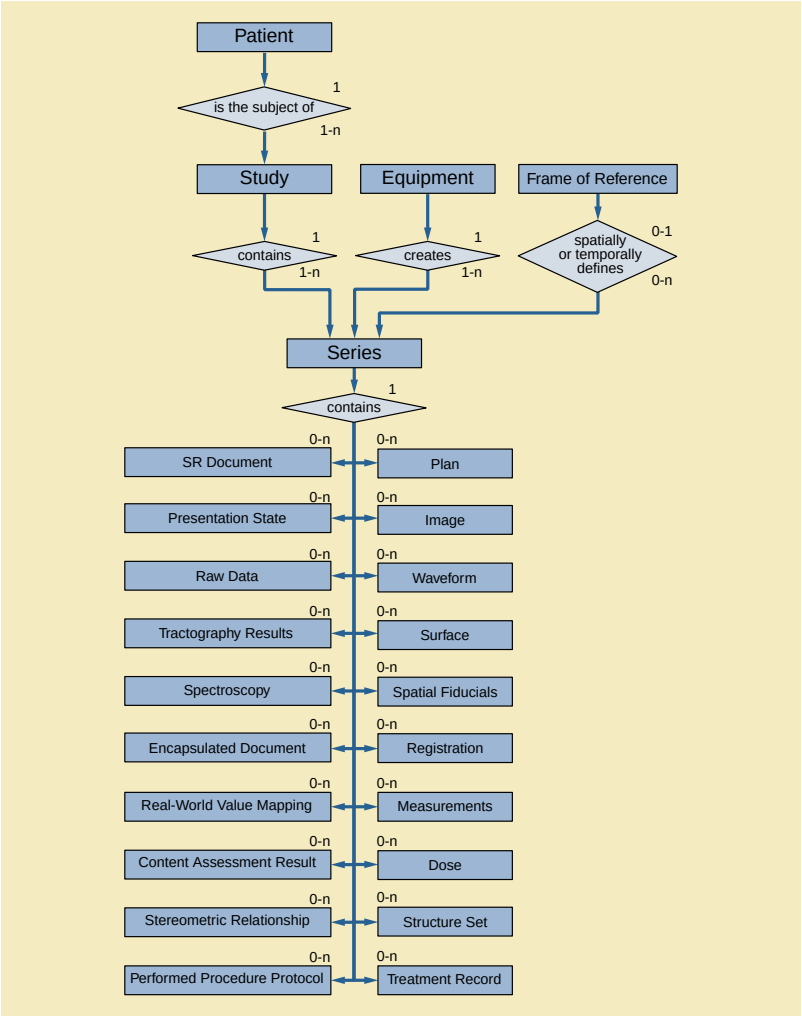


Figure A.1-1. DICOM Composite Instance IOD Information Model

A.1.2.1 Patient IE

The Patient IE defines the characteristics of a Patient who is the subject of one or more medical Studies.

Note

A Patient may be a human or an animal.

The Patient IE is modality independent.

A.1.2.2 Study IE

The Study IE defines the characteristics of a medical Study performed on a Patient. A Study is a collection of one or more Series of medical images, presentation states, and/or SR documents that are logically related for the purpose of diagnosing a Patient. Each Study is associated with exactly one Patient.

A Study may include Composite Instances that are created by a single modality, multiple modalities or by multiple devices of the same modality.

The Study IE is modality independent.

A.1.2.3 Series IE

The Series IE defines the Attributes that are used to group Composite Instances into distinct logical sets. Each Series is associated with exactly one Study.

The following criteria group Composite Instances into a specific Series:

a. All Composite Instances within a Series must be of the same modality

b. Each Series may be associated with exactly one Frame of Reference IE, and if so associated all Composite Instances within the Series shall be spatially or temporally related to each other

c. All Composite Instances within the Series shall be created by the same equipment; therefore, each Series is associated with exactly one Equipment IE

d. All Composite Instances within a Series shall have the same Series information

Presentation States shall be grouped into Series without Images (i.e., in a different Series from the Series containing the Images to which they refer).

Note

The Series containing Grayscale, Color and Pseudo-Color Softcopy Presentation States and the Series containing the Images to which they refer are both contained within the same Study, except for Blended Presentation States, which may refer to images from different Studies.

Waveforms shall be grouped into Series without Images. A Frame of Reference IE may apply to both Waveform Series and Image Series.

SR Documents shall be grouped into Series without Images. The Frame of Reference IE may apply to SR Document Series, for SR Documents that contain 3D spatial coordinates relative to one or more spatial Frames of Reference, or temporal coordinates that require a temporal Frame of Reference.

A.1.2.4 Equipment IE

The Equipment IE describes the particular device that produced the Series of Composite Instances. A device may produce one or more Series within a Study. The Equipment IE does not describe the data acquisition or image creation Attributes used to generate the Composite Instances within a Series. These Attributes are described in the Composite Instance specific IEs (e.g., the Image IE).

A.1.2.5 Frame of Reference IE

The Frame of Reference IE identifies the coordinate system that conveys spatial and/or temporal information of Composite Instances in a Series.

When present, a Frame of Reference IE may be related to one or more Series. In this case, it provides the ability to spatially or temporally relate multiple Series to each other. In such cases, the Series may share the UID of the Frame of Reference, or alternatively, a Registration SOP Instance may specify the spatial relationship explicitly, as a spatial transformation. A Frame of Reference IE may also spatially register a Frame of Reference to an atlas.

A.1.2.6 Image IE

The Image IE defines the Attributes that describe the pixel data of an image. The pixel data may be generated as a direct result of Patient scanning (termed an Original Image) or the pixel data may be derived from the pixel data of one or more other images (termed a Derived Image). An image is defined by its image plane, pixel data characteristics, gray scale and/or color mapping characteristics and modality specific characteristics (acquisition parameters and image creation information).

An image is related to a single Series within a single Study.

The pixel data within an Image IE may be represented as a single frame of pixels or as multiple frames of pixel data. The frames of a Multi-frame image (a cine run or the slices of a volume) are sequentially ordered and share a number of common properties. A few

Attributes may vary between frames (e.g., Time, Angular Displacement, Slice Increment). All common Image IE Attributes refer to the first frame of a multiple frame image.

Overlay, Modality and Value of Interest Lookup Table and Real World Value Mapping data may be included within an Image IE only if this information is directly associated with the image.

A.1.2.6.1 Overlay Data

Overlay data represents graphics or text in a bit-map format, and is used to indicate such items as region of interest, reference marks and annotations.

A.1.2.6.2 Modality LUT Data

Modality LUT data describes the transformation of manufacturer dependent pixel values into pixel values that are manufacturer independent (e.g., Hounsfield units for CT, Optical Density for film digitizers, etc.). The transformation may be linear, described by Rescale Slope and Rescale Intercept, or non-linear, described by a Lookup Table (LUT).

A.1.2.6.3 Value of Interest LUT Data

The Value of Interest (VOI) LUT data describes the transformation of the modality pixel values into pixel values that are meaningful for print, display, etc. This transformation is applied after any Modality LUT. The transformation may be linear, described by Window Center and Window Width, or non-linear, described by a Lookup Table. A non-linear interpretation of Window Center and Window Width may be defined by VOI LUT Function.

A.1.2.6.4 Real World Value Mapping Data

The Real World Value Mapping data describes the transformation of the image pixel values into real world values in defined units. There may be multiple transformations, each scoped by a range of input pixel values. Each transformation may be linear, described by Slope and Intercept, or non-linear, described by a Lookup Table.

A.1.2.7 Overlay IE

Retired. See PS3.3-2016a.

Note

Overlays were previously modeled as independent Information Entities; in the current model they are considered Attributes within the Image IE or Presentation State IE. See A.1.2.6.1.

A.1.2.8 Curve IE

Retired. See PS3.3-2004.

A.1.2.9 Modality LUT IE

Retired. See PS3.3-2016a.

Note

Modality LUTs were previously modeled as independent Information Entities; in the current model they are considered Attributes within the Image IE or Presentation State IE. See A.1.2.6.2.

A.1.2.10 VOI LUT IE

Retired. See PS3.3-2016a.

Note

VOI LUTs were previously modeled as independent Information Entities; in the current model they are considered Attributes within the Image IE or Presentation State IE. See A.1.2.6.3.

A.1.2.11 Presentation State IE

The Presentation State IE defines how a referenced image (or images) will be presented (e.g., displayed) in a device independent grayscale space (i.e., in P-Values) or color space (i.e., in PCS-values), and what graphical annotations and spatial and grayscale contrast transformations will be applied to the referenced image pixel data.

Overlay, Modality LUT, and VOI LUT data (see A.1.2.6.1, A.1.2.6.2, and A.1.2.6.3) may be included within a Presentation State IE if this information is to be applied to the referenced image(s).

A.1.2.12 Waveform IE

The Waveform IE represents a multi-channel time-based digitized waveform. The waveform consists of measurements of some physical qualities (e.g., electrical voltage, pressure, gas concentration, or sound), sampled at constant time intervals. The measured qualities may originate, for example, in any of the following sources:

a. the anatomy of the Patient,

b. therapeutic equipment (e.g., a cardiac pacing signal or a radio frequency ablation signal),

c. equipment for diagnostic synchronization (e.g., a clock or timing signal used between distinct devices),

d. the physician's voice (e.g., a dictated report).

The sample data within a Waveform IE may represent one or more acquired channels. Several signal channels acquired at the same sampling rate can be multiplexed (by interleaving samples) in a single multiplex group. (see also Annex C “Waveforms (Informative)” in PS3.17.)

A.1.2.13 SR Document IE

The SR Document IE defines the Attributes that describe the content of an SR Document. These include semantic context as well as Attributes related to document completion, verification and other characteristics. An SR Document SOP Instance is related to a single Series within a single Study.

A.1.2.14 Spectroscopy IE

The Spectroscopy IE defines the Attributes that describe the data of a spectroscopy acquisition created by a magnetic resonance spectroscopy device.

A.1.2.15 Raw Data IE

The Raw Data IE defines the Attributes that describe a collection of data that may be used for further processing to produce image data or other data.

Note

For example, raw data may be used with CT and MR systems to reconstruct sets of images or for MR to reconstruct spectroscopic data. The format of the raw data is vendor specific.

A.1.2.16 Encapsulated Document IE

The Encapsulated Document IE defines the Attributes that describe the content of a non-DICOM formatted document that is encapsulated in a DICOM Attribute. These include Attributes related to document origin, title, and other characteristics. An Encapsulated Document SOP Instance is related to a single Series within a single Study.

A.1.2.17 Real World Value Mapping IE

The Real World Value Mapping IE defines the Attributes that describe the mapping of stored pixel data to Real World values (see A.1.2.6.4).

A.1.2.18 Surface IE

The Surface IE defines the Attributes that describe a surface in a spatial coordinate system. A surface is defined by its shape and can be further defined by normals on that shape. The surface may be reconstructed from either spatial scans (e.g., laser scanners) or based on images. A surface is described by its finite volume and manifold property, gray scale and color mapping characteristics, presentation type, opacity, and modality specific characteristics.

A surface is related to a single Series.

A.1.2.19 Measurements IE

The Measurements IE defines the Attributes that describe the measurements taken by medical instruments.

A.1.2.20 Tractography Results IE

The Tractography Results IE defines the Attributes that describe the results of a tractography application.

Note

The term tractogram is not used because it does not include all types of tractography results.

A.1.2.21 Plan IE

The Plan IE defines the parameters and instructions to deliver treatment, particularly Radiotherapy, to the Patient. The entity includes the set of machine and positioning parameters to be applied during treatment delivery and instructions guiding the treatment workflow.

A.1.2.22 Content Assessment Result IE

The Content Assessment Result IE contains the results of an assessment of the content of a SOP Instance.

An assessment is part of a process within a clinical workflow, conducted by users or devices, which have the role of assessing the validity and suitability of the content in question, based on subjective or objective criteria. The specific nature of such a process is outside of the scope of this Standard.

A.1.2.23 Spatial Fiducials IE

The Spatial Fiducials IE identifies one or more geometric locations or shapes within a Frame of Reference or image pixel/voxel space that may be correlated with similar locations or shapes within different frames of reference or image pixel/voxel spaces.

A.1.2.24 Dose IE

The Dose IE describes dose distributions calculated by radiotherapy treatment planning systems. These distributions may be represented as 2D or 3D grids, as isodose curves, or as named or unnamed dose points scattered throughout a volume.

A.1.2.25 Structure Set IE

The Structure Set IE describes Regions of Interest (ROI) within a referenced 2D (image) or 3D (volumetric) space. These ROIs may be represented as geometric contours.

A.1.2.26 Treatment Record IE

The Treatment Record IE describes treatments, particularly radiotherapy, for a Patient.

A.1.2.27 Stereometric Relationship IE

The Stereometric Relationship IE defines how referenced images are related as stereometric pairs.

A.1.2.28 Procedure Protocol IE

The Procedure Protocol IE defines the Attributes that describe a Protocol. This IE may encode a Defined Procedure Protocol or a Performed Procedure Protocol.

A.1.3 IOD Module Table and Functional Group Macro Table

This Section of each IOD defines in a tabular form the Modules comprising the IOD. The following information must be specified for each Module in the table:

- The name of the Module or Functional Group
- A reference to the Section in Annex C that defines the Module or Functional Group
- The usage of the Module or Functional Group; whether it is:
  - Mandatory (see Section A.1.3.1), abbreviated M
  - Conditional (see Section A.1.3.2), abbreviated C
  - User Option (see Section A.1.3.3), abbreviated U

The Modules referenced are defined in Annex C.

A.1.3.1 Mandatory Modules

For each IOD, Mandatory Modules shall be supported per the definitions, semantics and requirements defined in Annex C.

A.1.3.2 Conditional Modules

Conditional Modules are Mandatory Modules if specific conditions are met. If the specified conditions are not met, this Module shall not be supported; that is, no information defined in that Module shall be present.

A.1.3.3 User Option Modules

User Option Modules may or may not be supported. If an optional Module is supported, the Attribute Types specified in the Modules in Annex C shall be supported.

A.1.4 Overview of the Composite IOD Module Content

The Tables in this Section provide an overview of the Modules used throughout the Composite IODs. This table is for informative purposes only. It is based on the IOD definitions found in the remaining Sections of Annex A that are normative.

Table A.1-1a. Composite Information Object Modules Overview - Images

IODs **Modules**	**CR**	**CT**	**Enh CT**	**MR**	**Enh MR**	**Enh MR Col**	**NM**	**US**	**US MF**	**Enh US Vol**	**SC**	**SC MF SB**	**SC MF GB**	**SC MF GW**	**SC MF TC**	**PT**	**Enh PT**
Patient	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
CR Series	M																

IODs **Modules**	**CR**	**CT**	**Enh CT**	**MR**	**Enh MR**	**Enh MR Col**	**NM**	**US**	**US MF**	**Enh US Vol**	**SC**	**SC MF SB**	**SC MF GB**	**SC MF GW**	**SC MF TC**	**PT**	**Enh PT**
NM/PET Patient Orientation							M									M	
PET Series																M	
PET Isotope																M	
PET Multi-gated Acquisition																C	
Enhanced PET Series																	M
Enhanced US Series										M							
Frame of Reference		M	M	M	M	M	U	U	U	M			C	C	C	M	M
Ultrasound Frame of Reference										M							
Synchronization		C	C		C	C	C	U	U	M			U	U	U	C	C
Cardiac Synchronization			C		C	C				C							C
Respiratory Synchronization			C		C	C				C							C
Bulk Motion Synchronization					C	C											
General Equipment	M	M	M	M	M	M	M	M	M	M	U	U	U	U	U	M	M
Enhanced General Equipment			M		M	M				M							M
SC Equipment											M	M	M	M	M		
General Image	M	M		M			M	M*	M	M	M	M	M	M	M	M	
Image Plane		M		M												M	
Image Pixel	M	M	M	M	M	M	M	M*	M	M	M	M	M	M	M	M	M
NM Image Pixel							M										
Palette Color Lookup Table								C	C								
Supplemental Palette Color Lookup Table			C		C												
Enhanced Palette Color Lookup Table										U							
Contrast/Bolus	C	C		C				C*	C								
Enhanced Contrast/Bolus			C		C	C				C							
Cine									M			C	C	C	C		
Multi-frame							M		M			M	M	M	M		
NM Multi-frame							M										
Frame Pointers									U			U	U	U	U		
Multi-frame Functional Groups			M		M	M				M			U	U	U		M
Multi-frame Dimension			M		M	M				M			U	U	U		M
Excluded Intervals										U							
Display Shutter	U																
Device	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	

IODs **Modules**	**CR**	**CT**	**Enh CT**	**MR**	**Enh MR**	**Enh MR Col**	**NM**	**US**	**US MF**	**Enh US Vol**	**SC**	**SC MF SB**	**SC MF GB**	**SC MF GW**	**SC MF TC**	**PT**	**Enh PT**
Intervention																	U
Specimen	U	U	U	U	U	C	U	U	U	U	U	U	U	U	U	U	U
CR Image	M																
CT Image		M															
Enhanced CT Image			M														
MR Image				M													
Enhanced MR Image					M	M											
MR Pulse Sequence					C	C											
NM Image							M										
NM Isotope							M										
NM Detector							M										
NM TOMO Acquisition							C										
NM Multi-Gated Acquisition							C										
NM Phase							C										
NM Reconstruction							C										
US Region Calibration								U*	U								
US Image								M*	M								
Enhanced US Image										M							
IVUS Image										C							
SC Image											M	U	U	U	U		
SC Multi-frame Image												M	M	M	M		
SC Multi-frame Vector												C	C	C	C		
PET Image																M	
Enhanced PET Isotope																	M
Enhanced PET Acquisition																	M
Enhanced PET Image																	M
Overlay Plane	U	U		U			U	U*			U					U	
Multi-frame Overlay							U										
Modality LUT	U										U						
VOI LUT	U	U		U			U	U*	U		U		C	C		U	
Common Instance Reference	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Acquisition Context			M		M	M	U			M						U	M
ICC Profile			U		U	M	U	U	U	U	U				U		
SOP Common	M	M	M	M	M	M	M	M*	M*	M	M	M	M	M	M	M	M
Frame Extraction			C		C	C	C		C	C		C	C	C	C		C

* The notation next to M and U indicates a special condition for these Modules. Refer to the corresponding Information Object Definitions in this Annex for details.

Note

1. The original US Image IOD and US multi-frame IOD, and the associated US and US multi-frame Storage SOP Class UID have been retired. New US and US multi-frame Image IODs are defined, as shown in Table A.1-1a, which includes the Palette Color Lookup Table Module.

2. The original NM Image IOD and the associated NM Storage SOP Class UID have been retired. A completely new NM Image IOD is defined, as shown in Table A.1-1a.

Table A.1-1b. Composite Information Object Modules Overview - More Images

IODs **Modules**	**XA**	**Enh XA**	**RF**	**Enh RF**	**3D XA**	**3D CF**	**Br Tomo**	**Br Proj**	**RT IM**	**DX**	**MG**	**IO**	**Par Map**
Patient	M	M	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M		M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U	U	U
Enhanced Series					M	M							
RT Series									M				
DX Series								M		M	M	M	
Mammo Series											M		
Enhanced Mammo Series							M	M					
Intra-Oral Series												M	
XA/XRF Series		M		M									
Parametric Map Series													M
Frame of Reference		C		U	M	M	M	M	U	U	C	U	M
Synchronization	U	C	U	C	U		C	C					U
Cardiac Synchronization		C		C	C								
Respiratory Synchronization		C		C	C								
General Equipment	M	M	M	M	M	M	M	M	M	M	M	M	M
Enhanced General Equipment		M		M	M	M	M	M					M
General Image	M		M						M	M	M	M	M
Image Pixel	M	M	M	M	M	M	M	M	M	M	M	M	C
Floating Point Image Pixel													C
Double Floating Point Image Pixel													C
Palette Color Lookup Table													C
Contrast/Bolus	C		C						C	U	U	U	
Enhanced Contrast/Bolus		C		C	C	C	C	C					
Cine	C		C						C				
Multi-frame	C		C						C				
Frame Pointers	U		U										
Multi-frame Functional Groups		M		M	M	M	M	M					M

IODs Modules	XA	Enh XA	RF	Enh RF	3D XA	3D CF	Br Tomo	Br Proj	RT IM	DX	MG	IO	Par Map
Multi-frame Dimension		U		U	U	U	U	U					M
Mask	C	U	C	U									
Display Shutter	U		U							U	U	U	
Device	U	U	U	U	U	U	U	U	U	U	U	U	U
Intervention	U	U	U	U	U	U	U	U		U	U	U	
Specimen	U	U	U	U	U	U	U	U		U	U	U	U
Patient Orientation					U	U		M					
Image - Equipment Coordinate Relationship					U	U	U						
Cardiac Synchronization													U
Respiratory Synchronization													U
Bulk Motion Synchronization													U
X-Ray Image	M		M										
Enhanced XA/XRF Image		M		M									
X-Ray Acquisition	M		M										
XA/XRF Acquisition		C		C									
X-Ray Collimator	U		U							U	U	U	
X-Ray Table	C		U										
XRF Positioner			U										
X-Ray Tomography Acquisition			C	U						U	U	U	
X-Ray Acquisition Dose										U	U	U	
X-Ray Generation										U	U	U	
X-Ray Filtration		U		U						U	U	U	
X-Ray Grid		U		U						U	U	U	
XA Positioner	M												
X-Ray Image Intensifier		C		C									
X-Ray Detector		C		C									
XA/XRF Multi-frame Presentation		U		U									
X-Ray 3D Image					M	M	M						
X-Ray 3D Angiographic Image Contributing Sources					U								
X-Ray 3D Craniofacial Image Contributing Sources						U							
Breast Tomosynthesis Contributing Sources							U						
X-Ray 3D Angiographic Acquisition					U								
X-Ray 3D Craniofacial Acquisition						U							
Breast Tomosynthesis Acquisition							U						

IODs Modules	XA	Enh XA	RF	Enh RF	3D XA	3D CF	Br Tomo	Br Proj	RT IM	DX	MG	IO	Par Map
X-Ray 3D Reconstruction					U	U	U						
Enhanced Mammography Image								M					
Breast View							M	M					
DX Anatomy Imaged										M	M	M	
DX Image										M	M	M	
DX Detector	U		U							M	M	M	
DX Positioning										U	U	U	
Mammo Image											M		
Intra-Oral Image												M	
RT Image									M				
Parametric Map Image													M
Approval									U				
Overlay Plane	U		U							C	C	C	
Multi-frame Overlay	C		C										
Modality LUT	C*		C*						U				
VOI LUT	U		U						U	C	C	C	
Image Histogram										U	U	U	
Common Instance Reference	U	U	U	U	U	U	U	U	U	U	U	U	C
Acquisition Context		M		M	M	M	M	M		M	M	M	M
SOP Common	M	M	M	M	M	M	M	M	M	M	M	M	M
Frame Extraction	C	C	C	C	C	C	C	C	C				C

Table A.1-1c. Composite Information Object Modules Overview - More Images

IODs Modules	VL EN	VL MC	VL SL	VL WS	VL PH	Vid VL EN	Vid VL MC	Vid VL PH	IVOCT	Seg
Patient	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U
Segmentation Series										M
Whole Slide Microscopy Series				M						
Intravascular OCT Series									M	
Frame of Reference			M	M					M	C
Synchronization								U	M	
Cardiac Synchronization									C	
General Equipment	M	M	M	M	M	M	M	M	M	M
Enhanced General Equipment				M					M	M

IODs Modules	VL EN	VL MC	VL SL	VL WS	VL PH	Vid VL EN	Vid VL MC	Vid VL PH	IVOCT	Seg
General Image	M	M	M	M	M	M	M	M		M
Image Pixel	M	M	M	M	M	M	M	M	M	M
Supplemental Palette Color Lookup Table									C	
Enhanced Contrast/Bolus									M	
Cine						M	M	M		
Multi-frame						M	M	M		
Multi-frame Functional Groups				M					M	M
Multi-frame Dimension				M					M	M
Device	U	U	U		U	U	U	U	U	
Specimen	U	C	M	M	C	C	C	C		U
VL Image	M	M	M		M	M	M	M		
Slide Coordinates			M							
Whole Slide Microscopy Image				M						
Optical Path		U	U	M						
Multi-Resolution Navigation				C						
Slide Label				C						
Intravascular OCT Image									M	
Intravascular OCT Acquisition Parameters									M	
Intravascular OCT Processing Parameters									C	
Intravascular Image Acquisition Parameters									M	
Segmentation Image										M
Overlay Plane	U	U	U		U					
Common Instance Reference	U	U	U	M	U	U	U	U	M	C
Acquisition Context	M	M	M	M	M	M	M	M	M	
ICC Profile	U	U	U	U	U	U	U	U		
SOP Common	M	M	M	M	M	M	M	M	M	M
Frame Extraction				C		C	C	C	C	C

Table A.1-1d. Composite Information Object Modules Overview - More Images

IODs Modules	Oph 8 Bit	Oph 16 Bit	WF Oph St	WF Oph 3DC	OPT	OCT ENF	OCT BSV	OPM	CM
Patient	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M	M

IODs **Modules**	**Oph 8 Bit**	**Oph 16 Bit**	**WF Oph St**	**WF Oph 3DC**	**OPT**	**OCT ENF**	**OCT BSV**	**OPM**	**CM**
Clinical Trial Series	U	U	U	U	U	U	U	U	U
Ophthalmic Tomography Series					M				
Ophthalmic Tomography En Face Series						M			
Ophthalmic Tomography B-scan Volume Analysis Series							M		
Ophthalmic Thickness Map Series								M	
Corneal Topography Map Series									M
Frame of Reference			M	M	C	M	M		M
Synchronization	M	M	M	M	C				
Cardiac Synchronization					C				
General Equipment	M	M	M	M	M	M	M	M	M
Enhanced General Equipment			M	M	M	M	M	M	M
General Image	M	M	M	M		M		M	M
Image Pixel	M	M	M	M	M	M	M	M	M
Palette Color Lookup Table						C			M
Supplemental Palette Color Lookup Table								C	
Enhanced Contrast/Bolus	C	C	C	C	C				
Cine	C	C	C	C					
Multi-frame	M	M	M	M					
Multi-frame Functional Groups					M		M		
Multi-frame Dimension					M		M		
Bitmap Display Shutter								C	
Device	U	U							
Ophthalmic Photography Image	M	M	M	M					
Wide Field Ophthalmic Photography Stereographic Projection			M						
Wide Field Ophthalmic Photography 3D Coordinates				M					
Wide Field Ophthalmic Photography Quality Rating			C	C					
Ocular Region Imaged	M	M	M	M	M	M			
Ophthalmic Photography Acquisition Parameters	M	M	M	M				M	M
Ophthalmic Photographic Parameters	M	M	M	M					
Ophthalmic Tomography Image					M				
Ophthalmic Tomography Parameters					M				
Ophthalmic Tomography Acquisition Parameters					M				
Ophthalmic Thickness Map								M	
Ophthalmic Thickness Map Quality Rating								C	
Corneal Topography Map Image									M
Corneal Topography Map Analysis									M

IODs Modules	Oph 8 Bit	Oph 16 Bit	WF Oph St	WF Oph 3DC	OPT	OCT ENF	OCT BSV	OPM	CM
Ophthalmic Optical Coherence Tomography En Face Image						M			
Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image							M		
Ophthalmic Optical Coherence Tomography En Face Image Quality Rating						C			
Common Instance Reference	U	U	U	U	U	U	U	U	
Acquisition Context	U	U	U	U	M			M	M
ICC Profile	U	U	C	C		U			U
SOP Common	M	M	M	M	M	M	M	M	M
Frame Extraction	C	C	C	C	C		C		

Table A.1-2. Composite Information Object Modules Overview - Non-Images

IODs Modules	MR Spectroscopy	Raw Data	Surface Scan Point Cloud	Surface Scan Mesh	Content Assessment Result
Patient	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U
General Study	M	M	M	M	M
Patient Study	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U
General Series	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U
Optical Surface Scanner Series			M	M	
Frame of Reference	M	U			
Sync.	C	C			
Cardiac Sync.	C				
Respiratory Sync.	C				
Bulk Motion Sync.	C				
General Equip.	M	M	M	M	M
Enhanced General Equip.	M		M	M	M
Multi-frame Functional Groups	M				
Multi-frame Dim.	M				
Specimen	U	U	U	U	
Raw Data		M			
MR Spect.	M				
MR Spect. Pulse Sequence	C				
MR Spect. Data	M				
Point Cloud			M		
Surface Mesh				M	
UV Mapping			U	U	
Scan Procedure			M	M	

IODs Modules	MR Spectroscopy	Raw Data	Surface Scan Point Cloud	Surface Scan Mesh	Content Assessment Result
Content Assessment Results					M
Acquisition Context	M	M			
Common Instance Reference					M
SOP Common	M	M	M	M	M
Frame Extraction	C				

Table A.1-3. Composite Information Object Modules Overview - More Non-Images

IODs Modules	Ln Mx	Aut Ref Mx	Ker Mx	Sub Ref Mx	Vis Acy Mx	Op Ax Mx	IO Ln Cl	OPV	Reg	Def Reg	Fid	RWV	Str Rl	HP	Sfc Seg	Col Pal	Bs St Dsp	Trc Res
Patient	M	M	M	M	M	M	M	M	M	M	M	M	M		M		M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U	U		U		U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M	M		M		M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U	U		U		U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U	U		U		U	U
General Series	M	M	M	M	M	M	M	M	M	M	M		M		M		M	M
Clinical Trial Series	U	U	U	U	U	U	U	U			U		U		U		U	U
Presentation Series																	M	
Spatial Registration Series									M	M								
Spatial Fiducials Series											M							
Real World Value Mapping Series												M						
Stereometric Series													M					
Segmentation Series															M			
Lensometry Msrmnts. Series	M																	
Autorefraction Msrmnts. Series		M																
Keratometry Msrmnts. Series			M															
Subjective Refraction Msrmnts. Series				M														
Visual Acuity Msrmnts. Series					M													
Ophthalmic Axial Msrmnts. Series						M												
Intraocular Lens Calculations Series							M											
Visual Field Static Perimetry Msrmnts. Series								M										
Tractography Results Series																		M
Frame of Reference									M	M					M			M
General Equipment	M	M	M	M	M	M	M	M	M	M	M	M	M		M		M	M
Enhanced General Equipment	M	M	M	M	M	M	M	M		M					M		M	M
Specimen																		U
Palette Color LUT																M		

IODs Modules	Ln Mx	Aut Ref Mx	Ker Mx	Sub Ref Mx	Vis Acy Mx	Op Ax Mx	IO Ln Cl	OPV	Reg	Def Reg	Fid	RWV	Str Rl	HP	Sfc Seg	Col Pal	Bs St Dsp	Trc Res
Stereometric Relationship													M					
ICC Profile																M		
Spatial Registration									M									
Deformable Spatial Registration										M								
Spatial Fiducials											M							
Real World Value Mapping												M						
Surface Segmentation															M			
Surface Mesh															M			
Color Palette Definition																M		
Structured Display																	M	
Structured Display Image Box																	M	
Structured Display Annotation																	U	
General Ophthalmic Refractive Msrmnts.	M	M	M	M	M	M	M											
Lensometry Msrmnts.	M																	
Autorefraction Msrmnts.		M																
Keratometry Msrmnts.			M															
Subjective Refraction Msrmnts.				M														
Visual Acuity Msrmnts.					M													
Ophthalmic Axial Msrmnts.						M												
Intraocular Lens Calculations							M											
Visual Field Static Perimetry Test Parameters								M										
Visual Field Static Perimetry Test Reliability								M										
Visual Field Static Perimetry Test Msrmnts.								M										
Visual Field Static Perimetry Test Results								M										
Ophthalmic Patient Clinical Information and Test Lens Parameters								U										
Common Instance Reference									M	M	M	M	M		C		M	M
Hanging Protocol Definition														M				
Hanging Protocol Environment														M				
Hanging Protocol Display														M				
Tractography Results																		M
SOP Common	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

Table A.1-4. Composite Information Object Modules Overview - Radiotherapy

IODs Modules	RT Dose	RT Struc Set	RT Plan	RT Beam Rec	RT Brachy Rec	RT Sum	RT Ion Plan	RT Ion Beams Treat Rec	RT Beams Delivery Inst	RT Brachy App Setup Delivery Inst
Patient	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U
General Series									M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U
RT Series	M	M	M	M	M	M	M	M		
Frame of Reference	M	U	U				M			
General Equipment	M	M	M	M	M	M	M	M	M	M
Enhanced General Equipment										M
General Image	C									
Image Plane	C									
Image Pixel	C									
Multi-frame	C									
RT Dose	M									
RT DVH	U									
Structure Set	C	M								
ROI Contour	C	M								
RT Dose ROI	C									
RT ROI Observations		M								
RT General Treatment Record				M	M	M		M		
RT Treatment Machine Record				M	M			M		
Measured Dose Reference Record				U	U			U		
Calculated Dose Reference Record				U	U			U		
RT Beams Session Record				M						
RT Ion Beams Session Record								M		
RT Brachy Session Record					M					
RT Treatment Summary Record				U	U	M		U		
RT General Plan			M				M			
RT Prescription			U				U			
RT Tolerance Tables			U							
RT Ion Tolerance Tables							U			
RT Patient Setup			U	U	U		U	U		
RT Fraction Scheme			U				U			
RT Beams			C							
RT Ion Beams							M			

IODs Modules	RT Dose	RT Struc Set	RT Plan	RT Beam Rec	RT Brachy Rec	RT Sum	RT Ion Plan	RT Ion Beams Treat Rec	RT Beams Delivery Inst	RT Brachy App Setup Delivery Inst
RT Brachy Application Setups			C							
RT Beams Delivery Instruction									M	
RT Brachy Application Setup Delivery Instruction										M
Approval		U	U				U			
Overlay Plane	U									
Multi-frame Overlay	U									
Modality LUT	U									
Common Instance Reference	U	U	U	U	U	U	U	U	C	M
SOP Common	M	M	M	M	M	M	M	M	M	M
Frame Extraction	C									

Table A.1-4b. Composite Information Object Modules Overview - Second Generation Radiotherapy

IODs Modules	RT Physn Intent	RT Seg Annot	RT Rad Set	C-Arm P-E Rad	Tomo Rad	Rob Arm Rad	RT Rad Rec Set	RT Rad Slvg Rec	C-Arm P-E Rec	Tomo Rec	Rob Arm Rec
Patient	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U
General Series			M	M	M	M	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U
Enhanced RT Series	M	M	M	M	M	M	M	M	M	M	M
General Equipment	M	M	M	M	M	M	M	M	M	M	M
Enhanced General Equipment	M	M	M	M	M	M	M	M	M	M	M
Frame of Reference			M	M	M	M		U	M	M	M
Synchronization									C	C	C
Radiotherapy Common Instance	M	M	M	M	M	M	M	M	M	M	M
RT Physician Intent	M										
RT Prescription	U										
RT Treatment Phase Intent	C										
RT Segment Annotation		M									
RT Radiation Set			M								
RT Dose Contribution			C								
RT Radiation Record Set							M				
RT Dose Contribution Record							C				
RT Delivery Device Common				M	M	M		M	M	M	M

IODs Modules	RT Physn Intent	RT Seg Annot	RT Rad Set	C-Arm P-E Rad	Tomo Rad	Rob Arm Rad	RT Rad Rec Set	RT Rad Slvg Rec	C-Arm P-E Rec	Tomo Rec	Rob Arm Rec
RT Radiation Common				M	M	M					
RT Radiation Record Common								M	M	M	M
RT Radiation Salvage Record								M			
C-Arm Photon-Electron Delivery Device				M					M		
C-Arm Photon-Electron Beam				M					M		
Tomotherapeutic Delivery Device					M					M	
Tomotherapeutic Beam					M					M	
Robotic-Arm Delivery Device						M					M
Robotic-Arm Path						M					M
Segment Reference		M									
General Reference	M	M	M	M	M	M	M	M	M	M	M
Common Instance Reference	M	M	M	M	M	M	M	M	M	M	M
SOP Common	M	M	M	M	M	M	M	M	M	M	M

Table A.1-5. Composite Information Object Modules Overview - Implants

IODs Modules	Generic Implant Template	Implant Assembly Template	Implant Template Group
Generic Implant Template Description	M		
Generic Implant Template 2D Drawings	C		
Generic Implant Template 3D Models	C		
Generic Implant Template Mating Features	U		
Generic Implant Template Planning Landmarks	U		
Implant Assembly Template		M	
Implant Template Group			M
SOP Common	M	M	M
Surface Mesh	U		

Table A.1-6. Composite Information Object Modules Overview - Presentation States

IODs Modules	Gray Pres State	Col Pres State	Pseudo Col Pres State	Blend Pres State	XA RF Pres State	Planar MPR Vol Pres State	Vol Rend Vol Pres State	Adv Blend Pres State
Patient	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	M	M
Clinical Trial Series	U	U	U	U	U	U	U	U

IODs Modules	Gray Pres State	Col Pres State	Pseudo Col Pres State	Blend Pres State	XA RF Pres State	Planar MPR Vol Pres State	Vol Rend Vol Pres State	Adv Blend Pres State
Presn. Series	M	M	M	M	M	M	M	M
Frame of Reference						M	M	M
General Equip.	M	M	M	M	M	M	M	M
Enhanced General Equip.					M	M	M	M
Mask	C		C					
Display Shutter	C	C	C					
Bitmap Display Shutter	C	C	C		C			
Palette Color LUT			M	M				
Overlay Plane	C	C	C		C			
Disp. Area	M	M	M	M	M			U
Overlay Actvn.	C	C	C		C			
Graphic Annot.	C	C	C	C	C	U	U	U
Spatial Trans.	C	C	C	C	C			C
Graphic Layer	C	C	C	C	C	C	C	C
Graphic Group	U	U	U	U		U	U	U
Modality LUT	C		C					
Softcopy VOI LUT	C		C		C			
Softcopy Presn. LUT	M				M			
Presn. State Ident.	M	M	M	M	M			M
Presn. State Reln.	M	M	M		M			
Presn. State Shutter	M	M	M		M			
Presn. State Mask	M		M					
Presn. State Blending				M				
Adv. Presn. State Blending								M
Adv. Presn. State Display								M
XA/XRF Presn. State Mask					C			
XA/XRF Presn. State Shutter					C			
XA/XRF Presn. State Presn.					C			
Volumetric Presentation State Identification						M	M	
Volumetric Presentation State Relationship						M	M	
Volume Cropping						C	C	
Presentation View Description						M	M	
Multi-Planar Reconstruction Geometry						M		
Volume Render Geometry							M	
Render Shading							U	
MPR Volumetric Presentation State Display						M		
Render Display							M	

IODs Modules	Gray Pres State	Col Pres State	Pseudo Col Pres State	Blend Pres State	XA RF Pres State	Planar MPR Vol Pres State	Vol Rend Vol Pres State	Adv Blend Pres State
Volumetric Graphic Annotation						U	U	
Presentation Animation						U	U	
ICC Profile		M	M	M				M
Common Instance Reference						M	M	M
SOP Common	M	M	M	M	M	M	M	M

Table A.1-7. Composite Information Object Modules Overview - Structured Reports

IODs Modules	Basic Text SR	Enhd SR	Comp SR	Comp 3D SR	Extns SR	Key Obj Sel	Rend Obj Sel	Mam CAD	Ch CAD	Col CAD	Impl Plan SR	Prc Log
Patient	M	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U	U
SR Document Series	M	M	M	M	M			M	M	M	M	M
Key Object Document Series						M	M				M	
Sync.		U	U	U	U		M		U			M
General Equip.	M	M	M	M	M	M	M	M	M	M	M	M
Enhanced General Equip.					M		M			M	M	
SR Document General	M	M	M	M	M			M	M	M	M	M
SR Document Content	M	M	M	M	M	M	M	M	M	M	M	M
Key Object Document						M	M				M	
Timezone											M	
SOP Common	M	M	M	M	M	M	M	M	M	M	M	M

Table A.1-7b. Composite Information Object Modules Overview - More Structured Reports

IODs Modules	RD SR	R-RD SR	Pat RDSR	Sp Rx Rp	Mac Grd Rp	Acq Ctx SR	Simp Card Echo SR	Plan IA Admin SR	Perf IA Admin SR
Patient	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U
Clinical Trial Series	U	U	U	U	U	U	U	U	U
SR Document Series	M	M	M	M	M	M	M	M	M

IODs Modules	RD SR	R-RD SR	Pat RDSR	Sp Rx Rp	Mac Grd Rp	Acq Ctx SR	Simp Card Echo SR	Plan IA Admin SR	Perf IA Admin SR
Key Object Document Series									
Sync.	C	C	C			C	C		M
General Equip.	M	M	M	M	M	M	M	M	M
Enhanced General Equip.	M	M	M	M	M	M	M	M	M
SR Document General	M	M	M	M	M	M	M	M	M
SR Document Content	M	M	M	M	M	M	M	M	M
Key Object Document									
Timezone							M		
SOP Common	M	M	M	M	M	M	M	M	M

Table A.1-8. Composite Information Object Modules Overview - Waveforms

IODs Modules	Basic Voice Audio	12 Lead ECG	General ECG WF	Ambul ECG WF	Hemo WF	Basic Cardiac EP WF	Arterial Pulse WF	Resp WF	General Audio WF	Scalp EEG WF	EMG WF	EOG WF	Sleep EEG WF	Multi Resp WF	Body Posn WF
Patient	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Study	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Patient Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
General Series	M	M	M	M	M	M	U	U	U	U	U	U	U	U	U
Clinical Trial Series	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
Synchronization	U	U	U	U	C	C	M	M	M	M	M	M	M	M	M
General Equipment	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Enhanced General Equipment							M	M	M	M	M	M	M	M	M
Waveform Identification	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Waveform	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Waveform Annotation	U	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Acquisition Context	M	M	M	U	M	M	M	M	M	M	U	U	U	U	U
SOP Common	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

Table A.1-9. Composite Information Object Modules Overview - Protocols

IODs Modules	CT Performed Procedure Protocol	CT Defined Procedure Protocol	Protocol Approval
Patient	M		
Clinical Trial Subject	U		
General Study	M		
Patient Study	U		
Clinical Trial Study	U		
General Series	M		
Clinical Trial Series	U		
Enhanced Series	M		
CT Protocol Series	M		
Frame of Reference	M		
General Equipment	M	M	M
Enhanced General Equipment	M	M	M
Protocol Context	M	M	
Patient Protocol Context	U		
Clinical Trial Context		U	
Patient Specification		U	
Equipment Specification		M	
Instructions	U	U	
Patient Positioning	U	U	
Defined CT Acquisition		U	
Performed CT Acquisition	U		
Defined CT Reconstruction		U	
Performed CT Reconstruction	U		
Defined Storage		U	
Performed Storage	U		
Protocol Approval			M
SOP Common	M	M	M

Table A.1-10. Composite Information Object Modules Overview - Encapsulated Documents

IODs Modules	Enc PDF	Enc CDA	Enc STL	Enc OBJ	Enc MTL
Patient	M	M	M	M	M
Clinical Trial Subject	U	U	U	U	U
General Study	M	M	M	M	M
Patient Study	U	U	U	U	U
Clinical Trial Study	U	U	U	U	U
Clinical Trial Series	U	U	U	U	U
Encapsulated Document Series	M	M	M	M	M
Frame of Reference			M	M	

IODs Modules	Enc PDF	Enc CDA	Enc STL	Enc OBJ	Enc MTL
General Equipment	M	M	M	M	M
Enhanced General Equipment			M	M	M
SC Equipment	M	M			
Encapsulated Document	M	M	M	M	M
Manufacturing 3D Model			M	M	M
ICC Profile			U	U	U
SOP Common	M	M		M	M
Common Instance Reference			C	C	C

Table A.1-11. Real-Time Object Modules Overview - Images

IODs Modules	RTV EN	RTV PH
Patient	M	M
Clinical Trial Subject	U	U
General Study	M	M
Patient Study	U	U
Clinical Trial Study	U	U
General Series	M	M
Clinical Trial Series	U	U
General Equipment	M	M
Enhanced General Equipment	M	M
Frame of Reference	C	C
Synchronization	M	M
General Image	M	M
General Reference	U	U
Real-Time Bulk Data Flow	M	M
Acquisition Context	M	M
Device	U	U
Specimen	C	C
VL Image	M	M
ICC Profile	M	U
SOP Common	M	M
Common Instance Reference	M	M
Real-Time Acquisition	M	M
Current Frame Functional Groups	M	M

Table A.1-12. Real-Time Object Modules Overview - Waveforms

IODs Modules	RTV Basic Voice Audio
Patient	M

IODs Modules	RTV Basic Voice Audio
Clinical Trial Subject	U
General Study	M
Patient Study	U
Clinical Trial Study	U
General Series	M
Clinical Trial Series	U
General Equipment	M
Enhanced General Equipment	M
Synchronization	M
Waveform Identification	M
Real-Time Bulk Data Flow	M
Acquisition Context	M
SOP Common	M
Current Frame Functional Groups	M

A.2 Computed Radiography Image IOD

A.2.1 CR Image IOD Description

The Computed Radiography (CR) Image Information Object Definition specifies an image that has been created by a computed radiography imaging device.

Note

Digital Luminescence Radiography is an equivalent term for computed Radiography.

A.2.2 CR Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.2.3 CR Image IOD Module Table

Table A.2-1 specifies the Modules of the CR Image IOD.

Table A.2-1. CR Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	CR Series	C.8.1.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	CR Image	C.8.1.2	M
	Overlay Plane	C.9.2	U
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.3 CT Image IOD

A.3.1 CT Image IOD Description

The Computed Tomography (CT) Image Information Object Definition (IOD) specifies an image that has been created by a computed tomography imaging device.

A.3.2 CT Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.3.3 CT Image IOD Module Table

Table A.3-1 specifies the Modules of the CT Image IOD.

Table A.3-1. CT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
~~Frame of Reference~~	~~Frame of Reference~~	~~C.7.4.1~~	~~M~~

IE	Module	Reference	Usage
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	CT Image	C.8.2.1	M
	Multi-energy CT Image	C.8.2.2	C - Required if Multi-energy CT Acquisition (0018,9361) is YES.
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.3.3.1 CT Image IOD Content Constraints

If Multi-energy CT Acquisition (0018,9361) is YES the following constraints will apply:

- The Contrast/Bolus Module shall be present if contrast was administered even if images are processed to remove contrast information from the pixels, e.g. Virtual Non-Contrast images.
- The Real World Value Mapping Sequence (0040,9096) shall be present in the General Image Module.
- For Measurement Units Code Sequence (0040,08EA) in the Real World Value Mapping Sequence (0040,9096) DCID 301 “Multi-energy Material Units” shall be used.

A.4 MR Image IOD

A.4.1 MR Image IOD Description

The Magnetic Resonance (MR) Image Information Object Definition (IOD) specifies an image that has been created by a magnetic resonance imaging device.

A.4.2 MR Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.4.3 MR Image IOD Module Table

Table A.4-1 specifies the Modules of the MR Image IOD.

Table A.4-1. MR Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

IE	Module	Reference	Usage
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	MR Image	C.8.3.1	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.5 Nuclear Medicine Image IOD

A.5.1 NM Image IOD Description

The Nuclear Medicine (NM) Image Information Object Definition (IOD) specifies an image that has been created by a nuclear medicine imaging device. This includes data created by external detection devices that create images of the distribution of administered radioactive materials in the body. Depending on the specific radio pharmaceutical administered and the particular imaging procedure performed, problems involving changes in metabolism, function, or physiology can be investigated and various regional pathologies can be studied.

A.5.2 NM Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.5.3 NM Image IOD Module Table (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

A.5.4 NM Image IOD Module Table

Table A.5-1 specifies the Modules of the NM Image IOD.

Table A.5-1. NM Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	NM/PET Patient Orientation	C.8.4.6	M
Frame of Reference	Frame of Reference	C.7.4.1	U
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	U - See Section A.5.4.1
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	NM Image Pixel	C.8.4.7	M
	Multi-frame	C.7.6.6	M
	NM Multi-frame	C.8.4.8	M
	NM Image	C.8.4.9	M
	NM Isotope	C.8.4.10	M
	NM Detector	C.8.4.11	M
	NM TOMO Acquisition	C.8.4.12	C - Required if Image Type (0008,0008) Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO
	NM Multi-gated Acquisition	C.8.4.13	C - Required if Image Type (0008,0008) Value 3 is GATED, GATED TOMO, or RECON GATED TOMO
	NM Phase	C.8.4.14	C - Required if Image Type (0008,0008) Value 3 is DYNAMIC
	NM Reconstruction	C.8.4.15	C - Required if Image Type (0008,0008) Value 3 is RECON TOMO or RECON GATED TOMO
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	U
	VOI LUT	C.11.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

IE	Module	Reference	Usage
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.5.4.1 Acquisition Context Module

For Acquisition Context Sequence (0040,0555) DTID 3470 “NM/PET Acquisition Context” shall be used, which includes description of the cardiovascular rest or stress state.

The Acquisition Context Sequence (0040,0555) shall always apply to all frames in the Image. Patient State shall always apply to all frames in the Image, therefore, neither Referenced Frame Numbers (0040,A136) nor Referenced Frame Number (0008,1160) shall be present.

The Acquisition Context information may be entered during acquisition, or obtained from the Modality Worklist using information supplied in the Protocol Context, using TID 15101 “NM/PET Protocol Context”.

A.6 Ultrasound Image IOD

A.6.1 US Image IOD Description

The Ultrasound (US) Image Information Object Definition specifies an image that has been created by an ultrasound imaging device.

A.6.2 US Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.6.3 US Image IOD Module Table (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

A.6.4 US Image IOD Module Table

Table A.6-1 specifies the Modules of the US Image IOD.

Table A.6-1. US Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U

IE	Module	Reference	Usage
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. For the purpose of conveying ultrasound protocol data management information it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 “Ultrasound Protocol Types” may be used.

2. The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS3.3-2003.

A.6.4.1 Mutually Exclusive IEs

Note

A Curve IE was previously included in this IOD that was mutually exclusive with the Image IE, but has been retired. See PS3.3-2004.

A.7 Ultrasound Multi-frame Image IOD

A.7.1 US Image IOD Description

The Ultrasound (US) Multi-frame Image Information Object Definition specifies a Multi-frame image that has been created by an ultrasound imaging device.

A.7.2 US Multi-frame Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.7.3 US Image IOD Module Table (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

A.7.4 US Multi-frame Image IOD Module Table

Table A.7-1 specifies the Modules of the US Multi-frame Image IOD.

Table A.7-1. US Multi-frame Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	Synchronization	C.7.4.2	C - Required if Modality (0008,0060) = IVUS. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image.
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Frame Pointers	C.7.6.9	U
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	US Region Calibration	C.8.5.5	U
	US Image	C.8.5.6	M
	VOI LUT	C.11.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

1. For the purpose of conveying ultrasound protocol data management information it is recommended that the Performed Protocol Code Sequence (0040,0260) be assigned the code value(s) of the performed ultrasound protocol, if any. For Performed Protocol Code Sequence (0040,0260) BCID 12001 “Ultrasound Protocol Types” may be used.

2. The US Frame of Reference Module was previously included in this IOD, but has been retired. See PS3.3-2003.

A.7.4.1 Mutually Exclusive IEs

Note

A Curve IE was previously included in this IOD that was mutually exclusive with the Image IE, but has been retired. See PS3.3-2004.

A.8 Secondary Capture Image IOD

The Secondary Capture (SC) Image Information Object Definition (IOD) specifies images that are converted from a non-DICOM format to a modality independent DICOM format.

Examples of types of equipment that create Secondary Capture Images include:

a. Video interfaces that convert an analog video signal into a digital image

b. Digital interfaces that are commonly used to transfer non-DICOM digital images from an imaging device to a laser printer

c. Film digitizers that convert an analog film image to digital data

d. Workstations that construct images that are encoded as a screen dump

e. Scanned documents and other bitmap images including hand-drawings

f. Synthesized images that are not modality-specific, such as cine-loops of 3D reconstructions

Originally, a single, relatively unconstrained, single-frame SC Image IOD was defined in the DICOM Standard. Though this IOD is retained and not retired since it is in common use, more specific IODs for particular categories of application are also defined.

The following IODs are all multi-frame. A single-frame image is encoded as a multi-frame image with only one frame. The multi-frame SC IODs consist of:

- Multi-frame Single Bit Secondary Capture Image IOD
- Multi-frame Grayscale Byte Secondary Capture Image IOD
- Multi-frame Grayscale Word Secondary Capture Image IOD
- Multi-frame True Color Secondary Capture Image IOD

A.8.1 Secondary Capture Image IOD

A.8.1.1 Secondary Capture Image IOD Description

The Secondary Capture Image IOD specifies single-frame images that are converted from a non-DICOM format to a modality independent DICOM format, without any constraints on pixel data format.

Note

The use of this IOD is deprecated, and other more specific SC Image IODs should be used.

A.8.1.2 Secondary Capture Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.8.1.3 Secondary Capture Image IOD Module Table

Table A.8-1 specifies the Modules of the SC Image IOD.

Table A.8-1. Secondary Capture Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	SC Image	C.8.6.2	M
	Overlay Plane	C.9.2	U
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.8.2 Multi-frame Single Bit Secondary Capture Image IOD

A.8.2.1 Multi-frame Single Bit SC Image IOD Description

The Multi-frame Single Bit Secondary Capture (SC) Image Information Object Definition (IOD) specifies images that are converted from a non-DICOM format to a modality independent DICOM format.

This IOD is typically used for scanned documents and bitmap images of hand drawings.

A.8.2.2 Multi-frame Single Bit SC Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.8.2.3 Multi-frame Single Bit SC Image IOD Module Table

Table A.8-2 specifies the Modules of the Multi-frame Single Bit SC Image IOD.

Table A.8-2. Multi-frame Single Bit SC Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	C - Required if Frame Increment Pointer (0028,0009) is Frame Time (0018,1063) or Frame Time Vector (0018,1065)
	Multi-frame	C.7.6.6	M
	Frame Pointers	C.7.6.9	U
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	SC Image	C.8.6.2	U
	SC Multi-frame Image	C.8.6.3	M
	SC Multi-frame Vector	C.8.6.4	C - Required if Number of Frames is greater than 1
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.8.2.4 Multi-frame Single Bit SC Image IOD Content Constraints

In the Image Pixel Module, the following constraints apply:

- Samples per Pixel (0028,0002) shall be 1
- Photometric Interpretation (0028,0004) shall be MONOCHROME2
- Bits Allocated (0028,0100) shall be 1
- Bits Stored (0028,0101) shall be 1
- High Bit (0028,0102) shall be 0
- Pixel Representation (0028,0103) shall be 0
- Planar Configuration (0028,0006) shall not be present

Note

As a consequence of these Attribute values, single bit pixels are packed eight to a byte as defined by the encoding rules in PS3.5.

The VOI LUT Module shall not be present.

The Overlay Plane Module shall not be present.

A.8.3 Multi-frame Grayscale Byte Secondary Capture Image IOD

A.8.3.1 Multi-frame Grayscale Byte Image IOD Description

The Multi-frame Grayscale Byte Secondary Capture (SC) Image Information Object Definition (IOD) specifies Grayscale Byte images that are converted from a non-DICOM format to a modality independent DICOM format.

This IOD is typically used for screen captured images for modalities that have pixel values of 8 bits, but may also be appropriate for scanned grayscale documents.

A.8.3.2 Multi-frame Grayscale Byte SC Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.8.3.3 Multi-frame Grayscale Byte SC Image IOD Module Table

Table A.8-3 specifies the Modules of the Multi-frame Grayscale Byte SC Image IOD.

Table A.8-3. Multi-frame Grayscale Byte SC Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if Pixel Measures or Plane Position (Patient) or Plane Orientation (Patient) Functional Group Macros Present
	Synchronization	C.7.4.2	U
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	C - Required if Frame Increment Pointer (0028,0009) is Frame Time (0018,1063) or Frame Time Vector (0018,1065)
	Multi-frame	C.7.6.6	M
	Frame Pointers	C.7.6.9	U
	Device	C.7.6.12	U
	Multi-frame Functional Groups	C.7.6.16	U
	Multi-frame Dimension	C.7.6.17	U
	Specimen	C.7.6.22	U
	SC Image	C.8.6.2	U
	SC Multi-frame Image	C.8.6.3	M

IE	Module	Reference	Usage
	SC Multi-frame Vector	C.8.6.4	C - Required if Number of Frames is greater than 1
	VOI LUT	C.11.2	C - Required if the VOI LUT stage is not an identity transformation
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.8.3.4 Multi-frame Grayscale Byte SC Image IOD Content Constraints

The VOI LUT Module is required if the VOI LUT stage is not an identity transformation. Support for both window and LUT is mandatory. The output grayscale space is defined to be in P-Values.

Note

If the VOI LUT Module is absent, then the stored pixel values are in P-Values.

In the Image Pixel Module, the following constraints apply:

- Samples per Pixel (0028,0002) shall be 1
- Photometric Interpretation (0028,0004) shall be MONOCHROME2
- Bits Allocated (0028,0100) shall be 8
- Bits Stored (0028,0101) shall be 8
- High Bit (0028,0102) shall be 7
- Pixel Representation (0028,0103) shall be 0
- Planar Configuration (0028,0006) shall not be present

In the SC Multi-frame Image Module, the following constraints apply:

- Rescale Intercept shall be 0
- Rescale Slope shall be 1
- Rescale Type shall be US

The Overlay Plane Module shall not be present.

A.8.3.5 Multi-frame Grayscale Byte SC Image Functional Group Macros

Table A.8-3b specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Multi-frame Grayscale Byte SC Image IOD.

Table A.8-3b. Multi-frame Grayscale Byte SC Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Plane Position (Patient) or Plane Orientation (Patient) Macros Present
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Pixel Measures or Plane Orientation (Patient) Macros Present

Functional Group Macro	Section	Usage
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Pixel Measures or Plane Position (Patient) Macros Present

A.8.4 Multi-frame Grayscale Word Secondary Capture Image IOD

A.8.4.1 Multi-frame Grayscale Word SC Image IOD Description

The Multi-frame Grayscale Word Secondary Capture (SC) Image Information Object Definition (IOD) specifies Grayscale Word images that are converted from a non-DICOM format to a modality independent DICOM format.

This IOD is typically used for screen captured images for modalities that have pixel values greater than 8 bits.

A.8.4.2 Multi-frame Grayscale Word SC Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.8.4.3 Multi-frame Grayscale Word SC Image IOD Module Table

Table A.8-4 specifies the Modules of the Multi-frame Grayscale Word SC Image IOD.

Table A.8-4. Multi-frame Grayscale Word SC Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if Pixel Measures or Plane Position (Patient) or Plane Orientation (Patient) Functional Group Macros Present
	Synchronization	C.7.4.2	U
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	C - Required if Frame Increment Pointer (0028,0009) is Frame Time (0018,1063) or Frame Time Vector (0018,1065)
	Multi-frame	C.7.6.6	M
	Frame Pointers	C.7.6.9	U
	Device	C.7.6.12	U
	Multi-frame Functional Groups	C.7.6.16	U
	Multi-frame Dimension	C.7.6.17	U
	Specimen	C.7.6.22	U

IE	Module	Reference	Usage
	SC Image	C.8.6.2	U
	SC Multi-frame Image	C.8.6.3	M
	SC Multi-frame Vector	C.8.6.4	C - Required if Number of Frames is greater than 1
	VOI LUT	C.11.2	C - Required if the VOI LUT stage is not an identity transformation
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.8.4.4 Multi-frame Grayscale Word SC Image IOD Content Constraints

The VOI LUT Module is required if the VOI LUT stage is not an identity transformation. Support for both window and LUT is mandatory. The output grayscale space is defined to be in P-Values.

Note

If the VOI LUT Module is absent, then the stored pixel values are in P-Values.

In the Image Pixel Module, the following constraints apply:

- Samples per Pixel (0028,0002) shall be 1
- Photometric Interpretation (0028,0004) shall be MONOCHROME2
- Bits Allocated (0028,0100) shall be 16
- Bits Stored (0028,0101) shall be greater than or equal to 9 and less than or equal to 16
- High Bit (0028,0102) shall be one less than Bits Stored (0028,0101)
- Pixel Representation (0028,0103) shall be 0
- Planar Configuration (0028,0006) shall not be present

Note

Rescale Slope and Rescale Intercept are not constrained in this IOD to any particular values. E.g., they may be used to recover floating point values scaled to the integer range of the stored pixel values, Rescale Slope may be less than one, e.g., a Rescale Slope of 1.0/65535 would allow represent floating point values from 0 to 1.0.

The Overlay Plane Module shall not be present. Unused high bits shall be filled with zeroes.

A.8.4.5 Multi-frame Grayscale Word SC Image Functional Group Macros

Table A.8-4b specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Multi-frame Grayscale Word SC Image IOD.

Table A.8-4b. Multi-frame Grayscale Word SC Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Plane Position (Patient) or Plane Orientation (Patient) Macros Present

Functional Group Macro	Section	Usage
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Pixel Measures or Plane Orientation (Patient) Macros Present
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Pixel Measures or Plane Position (Patient) Macros Present

A.8.5 Multi-frame True Color Secondary Capture Image IOD

A.8.5.1 Multi-frame True Color Image IOD Description

The Multi-frame True Color Secondary Capture (SC) Image Information Object Definition (IOD) specifies True Color images that are converted from a non-DICOM format to a modality independent DICOM format.

This IOD is typically used for screen captured or synthetic images where true color is used, but may also be appropriate for scanned color documents.

A.8.5.2 Multi-frame True Color SC Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.8.5.3 Multi-frame True Color SC Image IOD Module Table

Table A.8-5 specifies the Modules of the Multi-frame True Color SC Image IOD.

Table A.8-5. Multi-frame True Color SC Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if Pixel Measures or Plane Position (Patient) or Plane Orientation (Patient) Functional Group Macros Present
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	U
	SC Equipment	C.8.6.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	C - Required if Frame Increment Pointer (0028,0009) is Frame Time (0018,1063) or Frame Time Vector (0018,1065)
	Multi-frame	C.7.6.6	M
	Frame Pointers	C.7.6.9	U
	Device	C.7.6.12	U
	Multi-frame Functional Groups	C.7.6.16	U

IE	Module	Reference	Usage
	Multi-frame Dimension	C.7.6.17	U
	Specimen	C.7.6.22	U
	SC Image	C.8.6.2	U
	SC Multi-frame Image	C.8.6.3	M
	SC Multi-frame Vector	C.8.6.4	C - Required if Number of Frames is greater than 1
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.8.5.4 Multi-frame True Color SC Image IOD Content Constraints

The VOI LUT Module shall not be present.

In the Image Pixel Module, the following constraints apply:

- Samples per Pixel (0028,0002) shall be 3
- Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT for irreversible JPEG 2000 Transfer Syntaxes, YBR_RCT for reversible JPEG 2000 Transfer Syntaxes, YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264, HEVC/H.265 Transfer Syntaxes and YBR_FULL_422 for JPEG lossy compressed Transfer Syntaxes and YBR_FULL or RGB for RLE Transfer Syntaxes

  Note

  Future lossless and lossy Transfer Syntaxes may lead to the need for new definitions and choices for Photometric Interpretation.

- Bits Allocated (0028,0100) shall be 8
- Bits Stored (0028,0101) shall be 8
- High Bit (0028,0102) shall be 7
- Pixel Representation (0028,0103) shall be 0
- Planar Configuration (0028,0006) shall be 0 (color-by-pixel) if Photometric Interpretation (0028,0004) is RGB

The Overlay Plane Module shall not be present.

For images being referenced as texture maps that are not clinical images, a modality value of TEXTUREMAP may be used as the value of Modality (0008,0060).

A.8.5.5 Multi-frame True Color SC Image Functional Group Macros

Table A.8-5b specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Multi-frame True Color SC Image IOD.

Table A.8-5b. Multi-frame True Color SC Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Plane Position (Patient) or Plane Orientation (Patient) Macros Present

Functional Group Macro	Section	Usage
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Pixel Measures or Plane Orientation (Patient) Macros Present
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Pixel Measures or Plane Position (Patient) Macros Present

A.9 Standalone Overlay IOD

Retired. See PS3.3-2004.

A.10 Standalone Curve IOD

Retired. See PS3.3-2004.

A.11 Basic Study Descriptor IOD

Retired. See PS3.3-2004.

A.12 Standalone Modality LUT IOD

Retired. See PS3.3-2004.

A.13 Standalone VOI LUT IOD

Retired. See PS3.3-2004.

A.14 X-Ray Angiographic Image IOD

A.14.1 XA Image IOD Description

This Section defines the Information Object for single plane X-Ray Angiographic Imaging that includes those Attributes and Information Objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels.

The XA IOD share a significant amount of common information with the XRF IOD. The differences between the two IODs are that the XRF Image IOD includes a tomography Module; and the two IODs utilize different methods to specify positioner angles. The XRF Image IOD contains a single column angulation Data Element that uses an Equipment-Based Coordinate System, while XA Image IOD c-arm positioner angles are specified in a Patient-Based Coordinate System. RF applications that support a Patient-Based Coordinate System with cranial/caudal, LAO/RAO angles may utilize the XA IOD.

The XA IOD is also applicable to clinical areas other than angiography (e.g., Interventional Procedures, Myelography, Biopsy/Localization, and Neurology).

Note

1. For the purpose of X-Ray Angiography (XA), this IOD can be used to encode a single-frame image, or a Cine Run encoded in a single multi-frame image.

2. A typical Study might include all the images generated between the time a Patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single Study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a Series may be defined as comprising a set of images (single or multi-frame) associated with one such process within a Study.

3. This IOD can be used to encode a single plane acquisition, or one plane of a biplane acquisition.

A.14.2 XA Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.14.3 XA Image IOD Module Table

Table A.14-1 specifies the Modules of the XA Image IOD.

Table A.14-1. X-Ray Angiographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-frame Cine data
	Multi-frame	C.7.6.6	C - Required if pixel data is Multi-frame Cine data
	Frame Pointers	C.7.6.9	U
	Mask	C.7.6.10	C - Required if the Image may be subtracted
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Specimen	C.7.6.22	U
	X-Ray Image	C.8.7.1	M
	X-Ray Acquisition	C.8.7.2	M
	X-Ray Collimator	C.8.7.3	U
	X-Ray Table	C.8.7.4	C - Required if Image is created with table motion, may be present otherwise
	XA Positioner	C.8.7.5	M
	DX Detector	C.8.11.4	U
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	C - Required if Overlay data contains multiple frames.
	Modality LUT	C.11.1	C - Required if Pixel Intensity Relationship (0028,1040) is LOG U - Optional if Pixel Intensity Relationship (0028,1040) is DISP

IE	Module	Reference	Usage
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.15 X-Ray Angiographic Bi-plane Image Information Object Definition (Retired)

A.16 X-Ray Radiofluoroscopic Image IOD

A.16.1 XRF Image IOD Description

The focus for this X-Ray Radiofluoroscopic IOD is to address the requirements for image transfer found in general Radiofluoroscopic applications performed on a table with a column. For applications performed on X-Ray RF acquisition systems that support a Patient-Based Coordinate System with cranial/caudal, LAO/RAO angles, etc. the XA Image IOD may be used.

Note

An example of a case where the XA IOD may be preferred to the RF IOD are RF acquisition system equipped with an X-Ray source and an image Receptor positioned by what is generally called a c-arm (e.g., Interventional Procedures, Myelography, Biopsy, and Neurology).

This Section defines the Information Object for X-Ray Radiofluoroscopic Imaging that includes those Attributes and Information Objects necessary for the interchange of digital X-Ray RF Image data. The XRF IOD is applicable to X-Ray acquisition systems equipped with an image receptor whose plane is parallel to the table plane where the Patient is. This Table has in general the ability to be tilted. Furthermore the X-Ray source may be supported by a column that can be angulated to adjust the incidence of the X-Ray beam on the image receptor plan. An equipment based coordinated system is used to track these angles.

Note

1. For the purpose of X-Ray Radiofluoroscopy, this IOD can be used to encode a single-frame image, or a cine run encoded in a single multi-frame image.
2. A typical Study might include all the images generated between the time a Patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single Study, a Series may be defined as comprising a set of images (single or multi-frame) associated with one such process within a Study.

A.16.2 X-Ray Radiofluoroscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

Note

When a Study (or Study Component) contains a number of Multi-frame images that do not need to be grouped under different Series, a single Series may be used with a Series number containing an arbitrary value (e.g., 1).

A.16.3 X-Ray Radiofluoroscopic Image IOD Module Table

Table A.16-1 specifies the Modules of the X-Ray Radiofluoroscopic Image IOD.

Table A.16-1. X-Ray Radiofluoroscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this Image
	Cine	C.7.6.5	C - Required if pixel data is Multi-frame Cine Data
	Multi-frame	C.7.6.6	C - Required if pixel data is Multi-frame Cine Data
	Frame Pointers	C.7.6.9	U
	Mask	C.7.6.10	C - Required if the Image may be subtracted
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Specimen	C.7.6.22	U
	X-Ray Image	C.8.7.1	M
	X-Ray Acquisition	C.8.7.2	M
	X-Ray Collimator	C.8.7.3	U
	X-Ray Table	C.8.7.4	U
	XRF Positioner	C.8.7.6	U
	X-Ray Tomography Acquisition	C.8.7.7	C - Required if Scan Option (0018,0022) is TOMO
	DX Detector	C.8.11.4	U
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	C - Required if Overlay Data contains multiple frames
	Modality LUT	C.11.1	C - Required if Pixel Intensity Relationship (0028,1040) is LOG U - Optional if Pixel Intensity Relationship (0028,1040) is DISP
	VOI LUT	C.11.2	U
	SOP Common	C.12.1	M

IE	Module	Reference	Usage
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.17 RT Image IOD

A.17.1 RT Image IOD Description

The focus for this Radiotherapy Image IOD (RT Image IOD) is to address the requirements for image transfer found in general radiotherapy applications performed on conventional simulators, virtual simulators, and portal imaging devices. Such images have a conical imaging geometry and may either be acquired directly from the device, or digitized using a film digitizer. Numeric beam data parameters may also be recorded with the image, indicating the parameter values at the time the image was taken or created.

A.17.2 RT Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.17.3 RT Image IOD Module Table

Table A.17.3-1 specifies the Modules of the RT Image IOD.

Table A.17.3-1. RT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	C - Required if contrast media was used in this image.
	Cine	C.7.6.5	C - Required if multi-frame image is a cine image.
	Multi-frame	C.7.6.6	C - Required if pixel data is multi-frame data.
	Device	C.7.6.12	U
	RT Image	C.8.8.2	M

IE	Module	Reference	Usage
	Modality LUT	C.11.1	U
	VOI LUT	C.11.2	U
	Approval	C.8.8.16	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

1. The inclusion of the Multi-frame Module allows for the expression of time-dependent image series or multiple exposures of identical beam geometries (i.e., multiple exposure portal images). If a time-dependent series of images (such as port images or DRRs) is represented the Cine Module is used to indicate this. This would subsequently allow analysis of Patient movement during treatment. Multiple exposure images allow individual images of treatment ports and open field ports to be grouped into a single multi-frame image.

2. The Modality LUT Module has been included to allow the possibility of conversion between portal image pixel values and dose transmitted through the Patient. The VOI LUT Module has been included to allow the possibility of translation between stored pixel values (after the Modality LUT has been applied if specified) and display levels.

3. The Curve Module (Retired) and Audio Module (Retired) were previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

4. The General Equipment Module contains information describing the equipment used to acquire or generate the RT Image (such as a portal imager, conventional simulator or treatment planning system). However, the equipment Attributes in the RT Image Module describe the equipment on which the treatment has been or will be given, typically an electron accelerator.

5. For RT Images that contain no relevant pixel data, such as BEV images without DRR information, Pixel Data (7FE0,0010) should be filled with a sequence of zeros.

6. The Frame of Reference Module has been included to allow the indication of spatial association of two or more RT Image Instances (e.g., where the images have been acquired in the same Frame of Reference, or have been resampled to share the same Frame of Reference). If the Frame of Reference occurs within a SOP Instance within a given Series, then all SOP Instances within that Series will be spatially related. For example, two RT Images may share the same Frame of Reference if they are located on the same physical plane, as determined by the treatment machine Gantry Angle (300A,011E) and source to image plane distance specified by RT Image SID (3002,0026).

A.18 RT Dose IOD

A.18.1 RT Dose IOD Description

The focus for this Radiotherapy Dose IOD (RT Dose IOD) is to address the requirements for transfer of dose distributions calculated by radiotherapy treatment planning systems. These distributions may be represented as 2D or 3D grids, as isodose curves, or as named or unnamed dose points scattered throughout the volume. This IOD may also contain dose-volume histogram data, single or multi-frame overlays and application-defined lookup tables. This IOD does not provide for definition of doses in beam or other coordinate systems. The application is responsible for transforming data in other, Non-Patient-Based Coordinate Systems to the Patient-Based Coordinate System described in Section C.7.6.2.1.1.

A.18.2 RT Dose IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Dose IE below the Series IE.

A.18.3 RT Dose IOD Module Table

Table A.18.3-1 specifies the Modules of the RT Dose IOD.

Table A.18.3-1. RT Dose IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Dose	General Image	C.7.6.1	C - Required if dose data contains grid-based doses.
	Image Plane	C.7.6.2	C - Required if dose data contains grid-based doses.
	Image Pixel	C.7.6.3	C - Required if dose data contains grid-based doses.
	Multi-frame	C.7.6.6	C - Required if dose data contains grid-based doses and pixel data is multi-frame data.
	Overlay Plane	C.9.2	U
	Multi-frame Overlay	C.9.3	U
	Modality LUT	C.11.1	U
	RT Dose	C.8.8.3	M
	RT DVH	C.8.8.4	U
	Structure Set	C.8.8.5	C - Required if dose data contains dose points or isodose curves
	ROI Contour	C.8.8.6	C - Required if dose data contains dose points or isodose curves
	RT Dose ROI	C.8.8.7	C - Required if dose data contains dose points or isodose curves
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

1. Within the RT Dose IOD, the RT Dose Module supports 2D and 3D dose grids. The Structure Set Module, ROI Contour Module and RT Dose ROI Module together support isodose curves and points, and the RT DVH Module supports dose-volume histogram data. They are not mutually exclusive: all four representations may be included in a single Instance of the object or they may be included in any combination. Product Conformance Statements should clearly state which of these mechanisms is supported and under what conditions.

2. The RT Dose IOD has been defined as a composite IOD, separate from the RT Plan IOD. This has been done for the following reasons:

   - to allow for the multiplicity of possible dose calculations using beam models for the same basic plan,

   - to avoid undesirable transmission of large amounts of data with the treatment plan, and

- to accommodate the fact that CT Simulation and other "beam geometry" generating devices that use the RT Plan IOD do not have or require access to this data, either for transmission or storage.

3. The Audio Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.19 RT Structure Set IOD

A.19.1 RT Structure Set IOD Description

The focus for this Radiotherapy Structure Set IOD (RT Structure Set IOD) is to address the requirements for transfer of Patient structures and related data defined on CT scanners, virtual simulation workstations, treatment planning systems and similar devices.

A.19.2 RT Structure Set IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Structure Set IE below the Series IE.

A.19.3 RT Structure Set IOD Module Table

Table A.19.3-1 specifies the Modules of the RT Structure Set IOD.

Table A.19.3-1. RT Structure Set IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U - See note 2.
Structure Set	Structure Set	C.8.8.5	M
	ROI Contour	C.8.8.6	M
	RT ROI Observations	C.8.8.8	M
	Approval	C.8.8.16	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. The Audio Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

2. Previously the Frame of Reference Module was not included (see PS3.3-2014b). Historically, more than one Frame of Reference could be referenced within the Structure Set Module's Referenced Frame of Reference Sequence (3006,0010), in which case the Frame of Reference Module would not have been present.

A.19.4 RT Structure Set IOD Content Constraints

For Purpose of Reference Code Sequence (0040,A170) within Source Instance Sequence (0042,0013) in the General Reference Module DCID 7019 “Segmentation Non-Image Source Purposes of Reference” shall be used.

A.20 RT Plan IOD

A.20.1 RT Plan IOD Description

The focus for this Radiotherapy Plan IOD (RT Plan IOD) is to address the requirements for transfer of treatment plans generated by manual entry, a virtual simulation system, or a treatment planning system before or during a course of treatment. Such plans may contain fractionation information, and define external beams and/or brachytherapy application setups.

A.20.2 RT Plan IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Plan IE below the Series IE.

A.20.3 RT Plan IOD Module Table

Table A.20.3-1 specifies the Modules of the RT Plan IOD.

Table A.20.3-1. RT Plan IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Plan	RT General Plan	C.8.8.9	M
	RT Prescription	C.8.8.10	U
	RT Tolerance Tables	C.8.8.11	U
	RT Patient Setup	C.8.8.12	U
	RT Fraction Scheme	C.8.8.13	U
	RT Beams	C.8.8.14	C - Required if RT Fraction Scheme Module exists and Number of Beams (300A,0080) is greater than zero for one or more fraction groups. Shall not be present, if RT Brachy Application Setups Module is present. May be present otherwise.
	RT Brachy Application Setups	C.8.8.15	C - Required if RT Fraction Scheme Module exists and Number of Brachy Application Setups (300A,00A0) is greater than zero for one or more fraction groups. Shall not be present, if RT Beams Module is present. May be present otherwise.
	Approval	C.8.8.16	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. Retired. See PS3.3-2011.

2. The Audio Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.20.3.1 RT Fraction Scheme Module

The RT Fraction Scheme Module is structured to be used together with the RT Beams Module or RT Brachy Application Setups Module. If beams are referenced in the RT Fraction Scheme Module, all such beams shall be included in the RT Beams Module if it is present. Similarly, if brachy application setups are referenced in the RT Fraction Scheme Module, all such setups shall be included in the RT Brachy Application Setups Module if it is present. However, the RT Fraction Scheme Module can be used without the RT Beams Module or RT Brachy Application Setups Module if no beams or brachy application setups are referenced, and the RT Beams Module or RT Brachy Application Setups Module can also be used without the RT Fraction Scheme Module if no fraction scheme information is available.

A.20.3.2 RT Prescription Module

The RT Prescription Module provides for the inclusion of dose prescription information pertinent to the complete plan, which may comprise several fraction schemes, themselves consisting of many beams.

A.20.3.3 RT Tolerance Tables Module

The RT Tolerance Tables Module provides information concerning machine tolerances as they apply to the whole treatment plan. Tolerances are applied by reference to a tolerance table within the RT Tolerance Tables Module for beams contained within the RT Beams Module.

A.20.3.4 RT Patient Setup Module

The RT Patient Setup Module provides information concerning Patient setup parameters and fixation devices as they apply to the whole treatment plan. Patient setup information within the RT Patient Setup Module is referenced by beams contained within the RT Beams Module.

A.21 Positron Emission Tomography Image IOD

A.21.1 PET Image IOD Description

The Positron Emission Tomography (PET) Image Information Object Definition specifies an image that has been created by a Positron Tomograph imaging device, including dedicated PET cameras and Nuclear Medicine imaging devices operating in coincidence mode. This includes data created by external detection devices that create images of the distribution of administered radioactive materials, specifically positron emitters, in the body. Depending on the specific radiopharmaceuticals administered and the particular imaging procedure performed, problems involving changes in metabolism, function, or physiology can be investigated and various region pathologies can be studied. For these problems, quantitation of image data in absolute activity and physiological units is important. In addition, the PET Image IOD specifies attenuation (transmission) images used for correction and anatomical reference of emission images.

A.21.2 PET Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.21.3 PET Image IOD Module Table

Table A.21.3-1 specifies the Modules of the PET Image IOD.

Table A.21.3-1. PET Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

IE	Module	Reference	Usage
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	PET Series	C.8.9.1	M
	PET Isotope	C.8.9.2	M
	PET Multi-gated Acquisition	C.8.9.3	C - Required if Series Type (0054,1000) Value 1 is GATED.
	NM/PET Patient Orientation	C.8.4.6	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	PET Image	C.8.9.4	M
	Overlay Plane	C.9.2	U
	VOI LUT	C.11.2	U
	Acquisition Context	C.7.6.14	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.21.3.1 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 3470 “NM/PET Acquisition Context”, which includes description of the cardiovascular rest or stress state, and the blood glucose measurement.

The Acquisition Context information may be entered during acquisition, or obtained from the Modality Worklist using information supplied in the Protocol Context, using TID 15101 “NM/PET Protocol Context”.

A.22 Standalone PET Curve IOD

Retired. See PS3.3-2004.

A.23 Stored Print IOD

Retired. See PS3.3-2004.

A.24 Hardcopy Grayscale Image IOD

Retired. See PS3.3-2004.

A.25 Hardcopy Color Image IOD

Retired. See PS3.3-2004.

A.26 Digital X-Ray Image IOD

A.26.1 DX Image IOD Description

The Digital X-Ray (DX) Image Information Object Definition specifies an image that has been created by a digital projection radiography imaging device.

Note

1. This includes but is not limited to: chest radiography, linear and multi-directional tomography, orthopantomography and skeletal radiography. Acquisition of image data may include but is not limited to: CCD-based sensors, stimulable phosphor imaging plates, amorphous selenium, scintillation based amorphous silicon and secondary capture of film-based images.

2. Specific IODs are defined for intra-oral radiography and mammography that further specialize the DX IOD.

A DX image shall consist of the result of a single X-Ray exposure, in order to ensure that the anatomical and orientation Attributes are meaningful for the image, permitting safe annotation, appropriate image processing and appropriate dissemination.

Note

1. This requirement specifically deprecates the common film/screen and Computed Radiography practice of making multiple exposures on different areas of a cassette or plate by using lead occlusion between exposures. Such acquisitions could be separated and transformed into multiple DX images during an appropriate quality assurance step by an operator.

2. This requirement does not deprecate the acquisition of multiple paired structures during a single exposure, provided that they can be described by the relevant orientation Attributes. For example, an AP or PA projection of both hands side by side is typically obtained in a single exposure, and can be described by a Patient Orientation (0020,0020) of R\H or L\H since both hands are in the same traditional Anatomical Position. See Annex A “Explanation of Patient Orientation (Normative)” in PS3.17.

The DX Image IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for storage of images intended for presentation, and a SOP Class for storage of images intended for further processing before presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the DX Series Module, Presentation Intent Type (0008,0068).

A.26.2 DX Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.26.3 DX Image IOD Module Table

Table A.26-1 specifies the Modules of the DX Image IOD.

Table A.26-1. Digital X-Ray Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
	DX Series	C.8.11.1	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	U
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Specimen	C.7.6.22	U
	DX Anatomy Imaged	C.8.11.2	M
	DX Image	C.8.11.3	M
	DX Detector	C.8.11.4	M
	X-Ray Collimator	C.8.7.3	U
	DX Positioning	C.8.11.5	U
	X-Ray Tomography Acquisition	C.8.7.7	U
	X-Ray Acquisition Dose	C.8.7.8	U
	X-Ray Generation	C.8.7.9	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Overlay Plane	C.9.2	C - Required if graphic annotation is present - See Section A.26.4
	VOI LUT	C.11.2	C - Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION. Shall not be present otherwise. See Note 8.
	Image Histogram	C.11.5	U
	Acquisition Context	C.7.6.14	M - See Section A.26.5
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. The Overlay Plane requirement is determined by the presence of "graphic annotation". Graphic annotation includes user or machine drawn graphics or text (such as computer assisted diagnosis) to indicate regions of interest or descriptions. It specifically does not include Patient or image identification or technique information that is defined in other Attributes of the IOD.

2. The Device Module and Intervention Module are User optional, though it is desirable that, if present, they are stored by an SCP. It is recognized that in some cases the digital image acquisition system will not have a user interface or direct connection that allows acquisition of these parameters, even if device or therapy have been used.

3. The Common Frame of Reference Information Entity Modules, X-Ray Collimator Module, DX Positioning Module and X-Ray Tomography Acquisition Module are User optional, though it is desirable that, if present, they are stored by an SCP. It is recognized that in some cases the parameters of the mechanical devices used for collimation, positioning

and tomography may not be available to a digital image acquisition system that is not integrated with the X-Ray generation and positioning system.

4. The Image Histogram Module may contain a single or multiple statistical representations of the pixel data used to derive the VOI LUT Module, or intended to be used to derive or replace the VOI LUT Module. The Image Histogram Module may contain statistics of a subset of the stored image pixel data (such as from a cropped area or region of interest that is not the full field of view) that are useful for deriving a better VOI LUT than might be derived from the statistics obtained from the entire stored pixel data.

5. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

6. The VOI LUT Module Attributes and behavior are further specialized in the DX Image Module.

7. The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.26.4 Overlay Plane Module

If the Overlay Plane Module is present, any Overlays defined in that Module shall store the overlay data in Overlay Data (60xx,3000), and not any unused high bits in Pixel Data (7FE0,0010).

A.26.5 Acquisition Context Module

The Acquisition Context Module may be used to encode information about conditions present during acquisition that are not described by specific Attributes in other Modules of the IOD.

The Baseline TID shall be TID 3460 “Projection Radiography Acquisition Context”.

A.27 Digital Mammography X-Ray Image IOD

A.27.1 Digital Mammography X-Ray Image IOD Description

The Digital Mammography X-Ray Image Information Object Definition specifies an image that has been created by a digital mammography projection radiography imaging device.

Note

It meets all of the requirements of the DX IOD in Section A.26 in addition to those specified in this section.

The Digital Mammography Image IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for storage of images intended for presentation, and a SOP Class for storage of images intended for further processing before presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the DX Series Module, Presentation Intent Type (0008,0068).

A.27.2 Digital Mammography X-Ray Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.27.3 Digital Mammography X-Ray Image IOD Module Table

Table A.27-1 specifies the Modules of the Digital Mammography X-Ray Image IOD.

Table A.27-1. Digital Mammography X-Ray Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	DX Series	C.8.11.1	M
	Mammography Series	C.8.11.6	M
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if multiple images are obtained without releasing breast compression
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	U
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Specimen	C.7.6.22	U
	DX Anatomy Imaged	C.8.11.2	M
	DX Image	C.8.11.3	M
	DX Detector	C.8.11.4	M
	X-Ray Collimator	C.8.7.3	U
	DX Positioning	C.8.11.5	U
	X-Ray Tomography Acquisition	C.8.7.7	U
	X-Ray Acquisition Dose	C.8.7.8	U
	X-Ray Generation	C.8.7.9	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Mammography Image	C.8.11.7	M
	Overlay Plane	C.9.2	C - Required if graphic annotation is present - See Section A.27.3
	VOI LUT	C.11.2	C - Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION. Shall not be present otherwise.
	Image Histogram	C.11.5	U
	Acquisition Context	C.7.6.14	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

2. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.27.4 Overlay Plane Module

If the Overlay Plane Module is present, any Overlays defined in that Module shall store the overlay data in Overlay Data (60xx,3000), and not any unused high bits in Pixel Data (7FE0,0010).

A.28 Digital Intra-Oral X-Ray Image IOD

A.28.1 Digital Intra-Oral X-Ray Image IOD Description

The Digital Intra-Oral X-Ray Image Information Object Definition specifies an image that has been created by an intra-oral projection radiography imaging device.

Note

It meets all of the requirements of the DX IOD in Section A.26 in addition to those specified in this section.

The Digital Intra-Oral X-Ray Image IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for storage of images intended for presentation, and a SOP Class for storage of images intended for further processing before presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the DX Series Module, Presentation Intent Type (0008,0068).

A.28.2 Digital Intra-Oral X-Ray Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.28.3 Digital Intra-Oral X-Ray Image IOD Module Table

Table A.28-1 specifies the Modules of the Digital Intra-Oral X-Ray Image IOD.

Table A.28-1. Digital Intra-Oral X-Ray Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	DX Series	C.8.11.1	M
	Intra-Oral Series	C.8.11.8	M
Frame of Reference	Frame of Reference	C.7.4.1	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	U
	Display Shutter	C.7.6.11	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Specimen	C.7.6.22	U

IE	Module	Reference	Usage
	DX Anatomy Imaged	C.8.11.2	M
	DX Image	C.8.11.3	M
	DX Detector	C.8.11.4	M
	X-Ray Collimator	C.8.7.3	U
	DX Positioning	C.8.11.5	U
	X-Ray Tomography Acquisition	C.8.7.7	U
	X-Ray Acquisition Dose	C.8.7.8	U
	X-Ray Generation	C.8.7.9	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Intra-Oral Image	C.8.11.9	M
	Overlay Plane	C.9.2	C - Required if graphic annotation is present - See Section A.28.3
	VOI LUT	C.11.2	C - Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION. Shall not be present otherwise.
	Image Histogram	C.11.5	U
	Acquisition Context	C.7.6.14	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

1. The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.
2. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.28.4 Overlay Plane Module

If the Overlay Plane Module is present, any Overlays defined in that Module shall store the overlay data in Overlay Data (60xx,3000), and not any unused high bits in Pixel Data (7FE0,0010).

A.29 RT Beams Treatment Record IOD

A.29.1 RT Beams Treatment Record IOD Description

The focus for this Radiotherapy Beams Treatment Record IOD (RT Beams Treatment Record IOD) is to address the requirements for transfer of treatment session reports generated by a treatment verification system during a course of external beam treatment, with optional cumulative summary information. It may also be used for transfer of treatment information during delivery.

A.29.2 RT Beams Treatment Record IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Treatment Record IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.29.3 RT Beams Treatment Record IOD Module Table

Table A.29.3-1 specifies the Modules of the RT Beams Treatment Record IOD.

Table A.29.3-1. RT Beams Treatment Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Treatment Record	RT General Treatment Record	C.8.8.17	M
	RT Patient Setup	C.8.8.12	U
	RT Treatment Machine Record	C.8.8.18	M
	Measured Dose Reference Record	C.8.8.19	U
	Calculated Dose Reference Record	C.8.8.20	U
	RT Beams Session Record	C.8.8.21	M
	RT Treatment Summary Record	C.8.8.23	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.30 RT Brachy Treatment Record IOD

A.30.1 RT Brachy Treatment Record IOD Description

The focus for this Radiotherapy Brachy Treatment Record IOD (RT Brachy Treatment Record IOD) is to address the requirements for transfer of treatment session reports generated by a treatment verification system during a course of Brachytherapy treatment, with optional cumulative summary information. It may also be used for transfer of treatment information during delivery.

A.30.2 RT Brachy Treatment Record IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Treatment Record IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.30.3 RT Brachy Treatment Record IOD Module Table

Table A.30.3-1 specifies the Modules of the RT Brachy Treatment Record IOD.

Table A.30.3-1. RT Brachy Treatment Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Treatment Record	RT General Treatment Record	C.8.8.17	M
	RT Patient Setup	C.8.8.12	U
	RT Treatment Machine Record	C.8.8.18	M
	Measured Dose Reference Record	C.8.8.19	U
	Calculated Dose Reference Record	C.8.8.20	U
	RT Brachy Session Record	C.8.8.22	M
	RT Treatment Summary Record	C.8.8.23	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.31 RT Treatment Summary Record IOD

A.31.1 RT Treatment Summary Record IOD Description

The focus for this Radiotherapy Treatment Summary Record IOD (RT Treatment Summary Record IOD) is to address the requirements for transfer of cumulative summary information, normally generated at the completion of a course of treatment.

A.31.2 RT Treatment Summary Record IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Treatment Record IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.31.3 RT Treatment Summary Record IOD Module Table

Table A.31.3-1 specifies the Modules of the RT Treatment Summary Record IOD.

Table A.31.3-1. RT Treatment Summary Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Treatment Record	RT General Treatment Record	C.8.8.17	M
	RT Treatment Summary Record	C.8.8.23	M

IE	Module	Reference	Usage
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

Note

The Curve Module (Retired) was previously included in this IOD but has been retired. See PS3.3-2004.

A.32 Visible Light Image Information Object Definitions

The Visible Light (VL) Image Information Object Definition (IOD) specifies images that are acquired by means of a camera or other sensors that are sensitive to visible or near-visible light.

Examples of types of equipment that create Visible Light Images include:

a. Rigid and flexible endoscopy equipment

b. Operation microscopes / colposcopes

c. Ophthalmology equipment

d. Digital or Video Cameras

e. Analysis microscopes

Separate IODs have been defined for specialized applications. Some support only single-frame images, some support both single-frame and multi-frame video images.

A.32.1 VL Endoscopic Image IOD

A.32.1.1 VL Endoscopic Image IOD Description

The VL Endoscopic Image IOD specifies the Attributes of Single-frame VL Endoscopic Images.

A.32.1.2 VL Endoscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. An endoscopic procedure might include multiple Series of single-frame endoscopic images as well as one or more additional Series of related diagnostic images. The procedure might involve multiple Performed Procedure Steps, multiple endoscopes, and multiple anatomic regions and might be supervised, performed, and/or interpreted by one or more individuals.

2. Several distinct diagnostic or therapeutic processes might occur during an endoscopic procedure. For example: Endoscopic examination of duodenal mucosa, biopsy, lavage, or biliary stone removal.

3. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.

Table A.32.1-1. VL Endoscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

IE	Module	Reference	Usage
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	VL Image	C.8.12.1	M
	Overlay Plane	C.9.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.32.1.3 VL Endoscopic Image IOD Content Constraints

A.32.1.3.1 Modality

The value of Modality (0008,0060) shall be ES.

A.32.2 VL Microscopic Image IOD

A.32.2.1 VL Microscopic Image IOD Description

The VL Microscopic Image IOD specifies the Attributes of Single-frame VL Microscopic Images, including both imaging of specimens and direct microscopic imaging of the Patient (e.g., perioperative microscopy). Microscopic Images with Slide Coordinates shall not be encoded with this IOD.

A.32.2.2 VL Microscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.

2. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

Table A.32.1-2. VL Microscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

IE	Module	Reference	Usage
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if Imaging Subject is a specimen
	VL Image	C.8.12.1	M
	Optical Path	C.8.12.5	U
	Overlay Plane	C.9.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.32.2.3 VL Microscopic Image IOD Content Constraints

A.32.2.3.1 Modality

The value of Modality (0008,0060) shall be GM.

A.32.3 VL Slide-Coordinates Microscopic Image IOD

A.32.3.1 VL Slide-Coordinates Microscopic Image IOD Description

The VL Slide-Coordinates Microscopic Image IOD specifies the Attributes of VL single frame Slide-Coordinates Microscopic Images.

A.32.3.2 VL Slide-Coordinates Microscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

Note

1. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.

2. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

3. The Frame of Reference IE was previously (incorrectly) identified as not used in this IOD, although the Frame of Reference Module was specified as Mandatory. See PS3.3-2009.

Table A.32.1-3. VL Slide-Coordinates Microscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

IE	Module	Reference	Usage
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	M
	VL Image	C.8.12.1	M
	Slide Coordinates	C.8.12.2	M
	Optical Path	C.8.12.5	U
	Overlay Plane	C.9.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.32.3.3 VL Slide-coordinates Microscopic Image IOD Content Constraints

A.32.3.3.1 Modality

The value of Modality (0008,0060) shall be SM.

A.32.4 VL Photographic Image IOD

A.32.4.1 VL Photographic Image IOD Description

The VL Photographic Image IOD specifies the Attributes of VL Single-frame photographic Images.

A.32.4.2 VL Photographic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.

2. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

Table A.32.4-1. VL Photographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	VL Photographic Equipment	C.8.12.10	U
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if Imaging Subject is a specimen
	VL Image	C.8.12.1	M
	VL Photographic Acquisition	C.8.12.11	U
	VL Photographic Geolocation	C.8.12.12	U
	Overlay Plane	C.9.2	U
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.32.4.3 VL Photographic Image IOD Content Constraints

A.32.4.3.1 Modality

The value of Modality (0008,0060) shall be XC.

A.32.4.3.2 Anatomic Region Sequence

For dermatology applications:

- For Anatomic Region Sequence (0008,2218) BCID 4029 “Dermatology Anatomic Sites” may be used.
- For Anatomic Region Modifier Sequence (0008,2220) BCID 245 “Laterality with Median” may be used.

A.32.5 Video Endoscopic Image IOD

A.32.5.1 Video Endoscopic Image IOD Description

The Video Endoscopic Image IOD specifies the Attributes of Multi-frame Video Endoscopic Images.

A.32.5.2 Video Endoscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. The video may include audio channel(s) for acquiring Patient voice or physiological sounds, healthcare professionals' commentary, or environmental sounds.

2. The Frame Pointers Module has not been included because the selection of relevant sub-sequence(s) is usually made in a second workflow step and stored into separate Key Object Selection Documents.

3. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.

Table A.32.5-1. Video Endoscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if the Imaging Subject is a Specimen
	VL Image	C.8.12.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.32.5.3 Video Endoscopic Image IOD Content Constraints

A.32.5.3.1 Modality

The value of Modality (0008,0060) shall be ES.

Note

The use of a single value for Modality recognizes the fact that the same acquisition equipment is often used for different purposes (e.g., laparoscopy and colonoscopy). This means that Modality is not useful to distinguish one type of endoscopy from another when browsing a collection of Studies. Therefore, the use of Procedure Code Sequence (0008,1032) and Anatomic Region Sequence (0008,2218) in the Image Instances and in the query response is recommended, though gath-

ering sufficient information to populate these Attributes in an unscheduled workflow environment (i.e., in the absence of Modality Worklist) may require operator intervention.

A.32.5.3.2 Image Related Data Encoding

The Modality LUT Module, VOI LUT Module, Graphic Annotation Module and Overlay Plane Module shall not be present.

Note

The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.32.5.3.3 Anatomic Region Sequence

For Anatomic Region Sequence (0008,2218) DCID 4040 “Endoscopy Anatomic Regions” shall be used.

A.32.6 Video Microscopic Image IOD

A.32.6.1 Video Microscopic Image IOD Description

The Video Microscopic Image IOD specifies the Attributes of Video Microscopic Images, including both imaging of specimens and direct microscopic imaging of the Patient (e.g., perioperative microscopy). Microscopic Images with Slide Coordinates shall not be encoded with this IOD.

A.32.6.2 Video Microscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. The video may include audio channel for acquiring Patient voice or physiological sounds, healthcare professionals comment, or environment sounds.
2. The Frame Pointers Module has not been included because the selection of relevant sub-sequence(s) is usually made in a second step and stored into separate Key Object Selection Documents.
3. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.
4. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

Table A.32.6-1. Video Microscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U

IE	Module	Reference	Usage
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if the Imaging Subject is a Specimen
	VL Image	C.8.12.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.32.6.3 Video Microscopic Image IOD Content Constraints

A.32.6.3.1 Modality

The value of Modality (0008,0060) shall be GM.

A.32.6.3.2 Image Related Data Encoding

The Modality LUT Module, VOI LUT Module, Graphic Annotation Module and Overlay Plane Module shall not be present.

Note

The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.32.7 Video Photographic Image IOD

A.32.7.1 Video Photographic Image IOD Description

The Video Photographic Image IOD specifies the Attributes of VL Multi-frame photographic Images.

A.32.7.2 Video Photographic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

Note

1. The video may include audio channel for acquiring Patient voice or physiological sounds, healthcare professionals comment, or environment sounds.
2. The Frame Pointers Module has not been included because the selection of relevant sub-sequence(s) is usually made in a second step and stored into separate Key Object Selection Documents.
3. The Curve entity was previously include in the list of entities that are not used, but has been retired from DICOM. It is still not used in this IOD. See PS3.3-2004.
4. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

Table A.32.7-1. Video Photographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Synchronization	C.7.4.2	U	
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if the Imaging Subject is a Specimen
	VL Image	C.8.12.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.32.7.3 Video Photographic Image IOD Content Constraints

A.32.7.3.1 Modality

The value of Modality (0008,0060) shall be XC.

A.32.7.3.2 Image Related Data Encoding

The Modality LUT Module, VOI LUT Module, Graphic Annotation Module and Overlay Plane Module shall not be present.

Note

The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.32.8 VL Whole Slide Microscopy Image IOD

A.32.8.1 VL Whole Slide Microscopy Image IOD Description

The VL Whole Slide Microscopy Image IOD specifies the Attributes of a multi-frame visible light whole slide microscopy image encoded as a tiled decomposition. Each frame encodes a single tile within a three-dimensional imaged volume at a uniform resolution.

Note

An entire set of tiles for an acquisition may be encoded in the frames of a single SOP Instance, in multiple SOP Instances of a single concatenation, or in multiple SOP Instances in a Series (with or without concatenations). E.g., a single SOP Instance may contain an entire low resolution image as a single tile (single frame), or a single SOP Instance may contain an entire high resolution, multi-focal depth, multi-spectral acquisition (multiple frames).

A.32.8.2 VL Whole Slide Microscopy Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.32.8.3 VL Whole Slide Microscopy Image IOD Module Table

Table A.32.8-1 specifies the Modules of the VL Whole Slide Microscopy Image IOD.

Table A.32.8-1. VL Whole Slide Microscopy Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Whole Slide Microscopy Series	C.8.12.3	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Specimen	C.7.6.22	M
	Whole Slide Microscopy Image	C.8.12.4	M
	Optical Path	C.8.12.5	M
	Multi-Resolution Navigation	C.8.12.7	C - Required if Image Type (0008,0008) Value 3 is LOCALIZER
	Slide Label	C.8.12.8	C - Required if Image Type (0008,0008) Value 3 is LABEL; may be present otherwise
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.32.8.3.1 VL Whole Slide Microscopy Image IOD Content Constraints

A.32.8.3.1.1 Optical Path Module

The Code Sequences within the Optical Path Sequence (0048,0105) of the Optical Path Module (see Section C.8.12.5) are constrained as follows:

- For Illuminator Type Code Sequence (0048,0100) BCID 8125 “Microscopy Illuminator Type” may be used.
- For Illumination Color Code Sequence (0048,0108) BCID 8122 “Microscopy Illuminator and Sensor Color” may be used.
- For Illumination Type Code Sequence (0022,0016) BCID 8123 “Microscopy Illumination Method” may be used.
- For Lenses Code Sequence (0022,0019) BCID 8121 “Microscopy Lens Type” may be used.
- For Light Path Filter Type Stack Code Sequence (0022,0017) and for Image Path Filter Type Stack Code Sequence (0022,0018) BCID 8124 “Microscopy Filter” may be used.
- For Channel Description Code Sequence (0022,001A) BCID 8122 “Microscopy Illuminator and Sensor Color” may be used.

A.32.8.4 VL Whole Slide Microscopy Image Functional Group Macros

Table A.32.8-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the VL Whole Slide Microscopy Image IOD.

Table A.32.8-2. VL Whole Slide Microscopy Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M - Shall be used as a Shared Functional Group.
Frame Content	C.7.6.16.2.2	U - Shall not be used as a Shared Functional Group.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Real World Value Mapping	C.7.6.16.2.11	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Plane Position (Slide)	C.8.12.6.1	C - Required if Dimension Organization Type (0020,9311) is not TILED_FULL; may be present otherwise.
Optical Path Identification	C.8.12.6.2	C - Required if Dimension Organization Type (0020,9311) is not TILED_FULL; may be present otherwise.
Specimen Reference	C.8.12.6.3	U
Whole Slide Microscopy Image Frame Type	C.8.12.9	M - Shall be used as a Shared Functional Group.

Note

The Plane Position (Slide) and Optical Path Identification Macros are Type C, which allows the Per-Frame Functional Group Sequence (5200,9230) to be entirely omitted in those cases in which there are no other Per-Frame Functional Group Macros with content (i.e., the Frame Content Macro is empty or absent).

A.32.8.4.1 VL Whole Slide Microscopy Image Functional Group Macros Content Constraints

A.32.8.4.1.1 Referenced Image

For Purpose of Reference Code Sequence (0040,A170) in the Referenced Image Functional Group DCID 8120 “WSI Referenced Image Purposes of Reference” shall be used.

A.32.8.4.1.2 Plane Position (Slide)

Frames shall occupy plane positions in a regular tiling of the Total Image Matrix; the frames may extend beyond the edges of the Total Image Matrix. Therefore, the value of Column Position In Total Pixel Matrix (0048,021E) shall be an integer multiple of the value of Columns (0028,0011) plus a constant, and the value of Row Position In Total Pixel Matrix (0048,021F) shall be an integer multiple of the value of Rows (0028,0010) plus a (possibly different) constant.

Note

Pixels beyond the edge of the Total Image Matrix may be encoded with a fixed padding value. For images with MONOCHROME2 Photometric Interpretation, see Pixel Padding Value (0028,0120) in Section C.7.5.1.1.2.

The encoding of tiles may be sparse; i.e., some tiles may not be encoded in frames. There are no constraints on the ordering of frames within the pixel data; each frame specifies its position in the Plane Position (Slide) Functional Group.

Note

Different SOP Instances within a Series may have different tiling boundaries and sizes.

Frames associated with different optical paths may coincide in any spatial dimension.

A.32.9 Real-Time Video Endoscopic Image IOD

A.32.9.1 Real-Time Video Endoscopic Image IOD Description

The Real-Time Video Endoscopic Image IOD specifies the Attributes of Multi-frame Video Endoscopic Images transmitted in real-time.

A.32.9.2 Real-Time Video Endoscopic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE and Frame of Reference IE below the Series IE.

Table A.32.9-1. Real-Time Video Endoscopic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if multiple Instances are spatially related or if the Camera Position Functional Group Macro is present in the Current Frame Functional Groups Module
	Synchronization	C.7.4.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Real-Time Bulk Data Flow	C.7.6.26	M
	Acquisition Context	C.7.6.14	M

IE	Module	Reference	Usage
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if the Imaging Subject is a Specimen
	VL Image	C.8.12.1	M
	ICC Profile	C.11.15	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Real-Time Acquisition	C.7.6.28	M
	Current Frame Functional Groups	C.7.6.27	M

A.32.9.3 Real-Time Video Endoscopic Image IOD Content Constraints

The IOD shall not include audio. Captured patient voice or physiological sounds, healthcare professionals' commentary, or environmental sounds will be transported in a separate IOD.

A.32.9.3.1 Modality

The value of Modality (0008,0060) shall be ES.

Note

The use of a single value for Modality recognizes the fact that the same acquisition equipment is often used for different purposes (e.g., laparoscopy and colonoscopy). This means that Modality is not useful to distinguish one type of endoscopy from another when browsing a collection of studies. Therefore, the use of Procedure Code Sequence (0008,1032) and Anatomic Region Sequence (0008,2218) in the Image Instances and in the query response is recommended, though gathering sufficient information to populate these attributes in an unscheduled workflow environment (i.e.; in the absence of Modality Worklist) may require operator intervention.

A.32.9.3.2 Image Related Data Encoding

The Modality LUT Module, VOI LUT Module, Volumetric Graphic Annotation Module and Overlay Plane Module shall not be present.

A.32.9.3.3 Anatomic Region Sequence

For Anatomic Region Sequence (0008,2218) DCID 4040 “Endoscopy Anatomic Regions” shall be used.

A.32.9.3.4 Current Frame Functional Groups

The C.7.6.27 Current Frame Functional Groups Module shall be placed in the dynamic part of the RTP Payload.

Table A.32.9-2 specifies the Functional Group Macros included in the Current Frame Functional Groups Module for the Real-Time Video Endoscopic Image IOD.

Table A.32.9-2. Real-Time Video Endoscopic Image Functional Groups Macros

Functional Group Macro	Section	Usage
Time of Frame	C.7.6.16.2.29	M - shall not be used as a Shared Functional Group
Frame Content	C.7.6.16.2.2	M - shall not be used as a Shared Functional Group
Frame Usefulness	C.7.6.16.2.27	U - shall not be used as a Shared Functional Group
Camera Position	C.7.6.16.2.28	U

A.32.9.3.5 Time Distribution Protocol

The Time Distribution Protocol (0018,1802) of the Synchronization Module shall be set to "PTP".

A.32.10 Real-Time Video Photographic Image IOD

A.32.10.1 Real-Time Video Photographic Image IOD Description

The Real-Time Video Photographic Image IOD specifies Multi-frame photographic Images, transmitted in real-time.

A.32.10.2 Real-Time Video Photographic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

Note

The Frame Pointers Module is included to managed the temporal synchronization with the video signal the IOD is referring, and optionally the spatial reference if each frame information contains a spatial position.

Table A.32.10-1. Real-Time Video Photographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if multiple Instances are spatially related or if the Camera Position Functional Group Module is present in the Current Frame Functional Groups Module
	Synchronization	C.7.4.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Real-Time Bulk Data Flow	C.7.6.26	M
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	C - Required if the Imaging Subject is a Specimen
	VL Image	C.8.12.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Real-Time Acquisition	C.7.6.28	M
	Current Frame Functional Groups	C.7.6.27	M

A.32.10.3 Real-Time Video Photographic Image IOD Content Constraints

The IOD shall not include audio. Captured patient voice or physiological sounds, healthcare professionals' commentary, or environmental sounds will be transported in a separate IOD.

A.32.10.3.1 Modality

The value of Modality (0008,0060) shall be XC.

A.32.10.3.2 Image Related Data Encoding

The Modality LUT Module, VOI LUT Module, Volumetric Graphic Annotation Module and Overlay Plane Module shall not be present.

A.32.10.3.3 Current Frame Functional Groups

The C.7.6.27 Current Frame Functional Groups Module shall be placed in the dynamic part of the RTP Payload.

Table A.32.10-2 specifies the Functional Group Macros included in the Current Frame Functional Groups Module for the Real-Time Video Photographic Image IOD.

Table A.32.10-2. Real-Time Video Photographic Image Functional Group Macros

Functional Group Macro	Section	Usage
Time of Frame	C.7.6.16.2.29	M - shall not be used as a Shared Functional Group
Frame Content	C.7.6.16.2.2	M - shall not be used as a Shared Functional Group
Frame Usefulness	C.7.6.16.2.27	U - shall not be used as a Shared Functional Group
Camera Position	C.7.6.16.2.28	U

A.32.10.3.4 Time Distribution Protocol

The Time Distribution Protocol (0018,1802) of the Synchronization Module shall be set to "PTP".

A.33 Softcopy Presentation State Information Object Definitions

A.33.1 Grayscale Softcopy Presentation State IOD

A.33.1.1 Grayscale Softcopy Presentation State IOD Description

The Grayscale Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to present (display) images that are referenced from within the IOD.

It includes capabilities for specifying:

a. the output grayscale space in P-Values

b. grayscale contrast transformations including modality and VOI LUT

c. mask subtraction for multi-frame images

d. selection of the area of the image to display and whether to rotate or flip it

e. image and display relative annotations, including graphics, text and overlays

Note

This IOD does not support presentation control for a set of images for which the modality LUT varies on a frame-by-frame basis. Other Presentation State IODs (standard or private) may support such images.

A.33.1.2 Grayscale Softcopy Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.1.3 Grayscale Softcopy Presentation State IOD Module Table

Table A.33.1-1 specifies the Modules of the Grayscale Softcopy Presentation State IOD.

Table A.33.1-1. Grayscale Softcopy Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Relationship	C.11.11	M
	Presentation State Shutter	C.11.12	M
	Presentation State Mask	C.11.13	M
	Mask	C.7.6.10	C - Required if the referenced image(s) are multi-frame and are to be subtracted
	Display Shutter	C.7.6.11	C - Required if a Display Shutter is to be applied to referenced image(s) and the Bitmap Display Shutter Module is not present
	Bitmap Display Shutter	C.7.6.15	C - Required if a Display Shutter is to be applied to referenced image(s) and the Display Shutter Module is not present
	Overlay Plane	C.9.2	C - Required if Overlay is to be applied to referenced image(s) or the Bitmap Display Shutter Module is present.
	Overlay Activation	C.11.7	C - Required if referenced image contains overlay data that is to be displayed or Presentation State Instance contains Overlay data other than Bitmap Shutter
	Displayed Area	C.10.4	M
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied to referenced image(s)
	Spatial Transformation	C.10.6	C - Required if rotation or flipping are to be applied to referenced image(s)
	Graphic Layer	C.10.7	C - Required if Graphic Annotations or Overlays or Curves are to be applied to referenced image(s)
	Graphic Group	C.10.11	U
	Modality LUT	C.11.1	C - Required if a Modality LUT is to be applied to referenced image(s)

IE	Module	Reference	Usage
	Softcopy VOI LUT	C.11.8	C - Required if a VOI LUT is to be applied to referenced image(s)
	Softcopy Presentation LUT	C.11.6	M
	SOP Common	C.12.1	M

In the Grayscale Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module, the Presentation State Mask Module specializes some Attributes of the Mask Module, and the Presentation State Shutter Module specializes some Attributes of the Bitmap Display Shutter Module and Display Shutter Module.

Note

1. Subtraction between different images is not supported.
2. The Mask Module condition implies that it need not be supported by an SCP that supports presentation states only for single-frame image storage SOP Classes, or Instances of multi-frame image Storage SOP Classes that contain only one frame.
3. The Display Shutter may be used to darken image areas that surround important information and exclude extraneous bright areas that increase glare and ambient lighting impairing image interpretation. For example, unexposed areas in a CR image might be obscured using the Display Shutter, rather than permanently replacing image pixels in those areas.
4. This IOD does not support the storage of a multi-frame overlay in the IOD itself, but does support selective activation of multi-frame overlays within the referenced images via the Overlay Activation Module.

A.33.2 Color Softcopy Presentation State IOD

A.33.2.1 Color Softcopy Presentation State IOD Description

The Color Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to present (display) color images that are referenced from within the IOD.

It includes capabilities for specifying:

a. the output color space in PCS-Values

b. color transformations from device-dependent color to PCS-Values using an ICC profile

c. selection of the area of the image to display and whether to rotate or flip it

d. image and display relative annotations, including graphics, text and overlays

A.33.2.2 Color Softcopy Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.2.3 Color Softcopy Presentation State IOD Module Table

Table A.33.2-1 specifies the Modules of the Color Softcopy Presentation State IOD.

Table A.33.2-1. Color Softcopy Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Relationship	C.11.11	M
	Presentation State Shutter	C.11.12	M
	Display Shutter	C.7.6.11	C - Required if a Display Shutter is to be applied to referenced image(s) and the Bitmap Display Shutter Module is not present
	Bitmap Display Shutter	C.7.6.15	C - Required if a Display Shutter is to be applied to referenced image(s) and the Display Shutter Module is not present
	Overlay Plane	C.9.2	C - Required if Overlay is to be applied to referenced image(s) or the Bitmap Display Shutter Module is present.
	Overlay Activation	C.11.7	C - Required if referenced image contains overlay data that is to be displayed or Presentation State Instance contains Overlay data other than Bitmap Shutter
	Displayed Area	C.10.4	M
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied to referenced image(s)
	Spatial Transformation	C.10.6	C - Required if rotation, flipping or magnification are to be applied to referenced image(s)
	Graphic Layer	C.10.7	C - Required if Graphic Annotations or Overlays or Curves are to be applied to referenced image(s)
	Graphic Group	C.10.11	U
	ICC Profile	C.11.15	M
	SOP Common	C.12.1	M

In the Color Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module, and the Presentation State Relationship Module specializes some Attributes of the Bitmap Display Shutter Module and Display Shutter Module.

A.33.3 Pseudo-color Softcopy Presentation State IOD

A.33.3.1 Pseudo-color Softcopy Presentation State IOD Description

The Pseudo-Color Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to present (display) images that are referenced from within the IOD.

It includes capabilities for specifying:

a. the output color space in PCS-Values

b. grayscale contrast transformations including modality and VOI LUT

c. a color palette to map the transformed grayscale values into pseudo-color

d. mask subtraction for multi-frame images

e. selection of the area of the image to display and whether to rotate or flip it

f. image and display relative annotations, including graphics, text and overlays

Note

This IOD does not support presentation control for a set of images for which the modality LUT varies on a frame-by-frame basis. Other Presentation State IODs (standard or private) may support such images.

A.33.3.2 Pseudo-color Softcopy Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.3.3 Pseudo-color Softcopy Presentation State IOD Module Table

Table A.33.3-1 specifies the Modules of the Pseudo-color Softcopy Presentation State IOD.

Table A.33.3-1. Pseudo-Color Softcopy Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Relationship	C.11.11	M
	Presentation State Shutter	C.11.12	M
	Presentation State Mask	C.11.13	M
	Mask	C.7.6.10	C - Required if the referenced image(s) are multi-frame and are to be subtracted
	Display Shutter	C.7.6.11	C - Required if a Display Shutter is to be applied to referenced image(s) and the Bitmap Display Shutter Module is not present
	Bitmap Display Shutter	C.7.6.15	C - Required if a Display Shutter is to be applied to referenced image(s) and the Display Shutter Module is not present
	Overlay Plane	C.9.2	C - Required if Overlay is to be applied to referenced image(s) or the Bitmap Display Shutter Module is present.
	Overlay Activation	C.11.7	C - Required if referenced image contains overlay data that is to be displayed or Presentation State Instance contains Overlay data other than Bitmap Shutter
	Displayed Area	C.10.4	M

IE	Module	Reference	Usage
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied to referenced image(s)
	Spatial Transformation	C.10.6	C - Required if rotation or flipping are to be applied to referenced image(s)
	Graphic Layer	C.10.7	C - Required if Graphic Annotations or Overlays or Curves are to be applied to referenced image(s)
	Graphic Group	C.10.11	U
	Modality LUT	C.11.1	C - Required if a Modality LUT is to be applied to referenced image(s)
	Softcopy VOI LUT	C.11.8	C - Required if a VOI LUT is to be applied to referenced image(s)
	Palette Color Lookup Table	C.7.9	M
	ICC Profile	C.11.15	M
	SOP Common	C.12.1	M

In the Pseudo-Color Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module, the Presentation State Mask Module specializes some Attributes of the Mask Module, and the Presentation State Shutter Module specializes some Attributes of the Bitmap Display Shutter Module and Display Shutter Module.

The Softcopy Presentation LUT Module shall not be present in this IOD.

A.33.4 Blending Softcopy Presentation State IOD

A.33.4.1 Blending Softcopy Presentation State IOD Description

The Blending Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to blend two sets of images that are referenced from within the IOD for the purpose of presentation (display).

It includes capabilities for specifying:

a. the output color space in PCS-Values

b. grayscale contrast transformations including modality and VOI LUT for both the underlying and superimposed image sets

c. a color palette to map the transformed grayscale values of the superimposed image set into pseudo-color

d. selection of the area of the blended images to display and whether to rotate or flip it

e. image and display relative annotations, including graphics, text and overlays

Note

This IOD does not support presentation control for a set of images for which the modality LUT varies on a frame-by-frame basis. Other Presentation State IODs (standard or private) may support such images.

A.33.4.2 Blending Softcopy Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.4.3 Blending Softcopy Presentation State IOD Module Table

Table A.33.4-1 specifies the Modules of the Blending Softcopy Presentation State IOD.

Table A.33.4-1. Blending Softcopy Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Blending	C.11.14	M
	Displayed Area	C.10.4	M
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied
	Spatial Transformation	C.10.6	C - Required if rotation or flipping are to be applied
	Graphic Layer	C.10.7	C - Required if Graphic Annotation Module is present.
	Graphic Group	C.10.11	U
	Palette Color Lookup Table	C.7.9	M
	ICC Profile	C.11.15	M
	SOP Common	C.12.1	M

In the Blending Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module.

The Softcopy Presentation LUT Module shall not be present in this IOD.

The VOI LUT Module and Softcopy VOI LUT Module shall not be present in this IOD, since the Presentation State Blending Module subsumes their function.

The Palette Color Lookup Table Module describes the color mapping to be used for the superimposed image set.

The Displayed Area Module and Graphic Annotation Module specifically identify those images or frames to which they apply, and may include images or frames from the underlying or superimposed set.

The Spatial Transformation Module describes any necessary spatial transformation of the image to be rendered after the blending operation.

The Overlay Plane Module and Overlay Activation Module shall not be present, and any overlays present in the referenced images shall not be displayed.

The Display Shutter Module and Bitmap Display Shutter Module shall not be present, since the underlying image geometry may differ between the two sets of images.

The ICC Profile Module shall always be present. If the color space to be used is not calibrated (i.e., a device-specific ICC Input Profile is not available), then an ICC Input Profile specifying a well-known space (such as sRGB) may be specified.

A.33.5 Basic Structured Display IOD

A.33.5.1 Basic Structured Display IOD Description

The Basic Structured Display Information Object Definition (IOD) specifies an Instance of a single screen structured display that has been created for a Patient. It references specific image or other composite SOP Instances from one or more Studies for that Patient, or for other Patients for comparison, arranged in a specific presentation layout. Presentation of images within the structured display may be controlled by referenced Softcopy Presentation State Instances. The structured display may include text annotations.

A.33.5.2 Basic Structured Display IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.5.3 Basic Structured Display IOD Module Table

Table A.33.5.1-1 specifies the Modules of the Basic Structured Display IOD.

Table A.33.5.1-1. Basic Structured Display IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	U
Presentation State	Structured Display	C.11.16	M
	Structured Display Image Box	C.11.17	M
	Structured Display Annotation	C.11.18	U
	Common Instance Reference	C.12.2	M
	SOP Common	C.12.1	M

A.33.6 XA/XRF Grayscale Softcopy Presentation State IOD

A.33.6.1 XA/XRF Grayscale Softcopy Presentation State IOD Description

The XA/XRF Grayscale Softcopy Presentation State Information Object Definition (IOD) specifies information that may be used to present angiographic projection images that are referenced from within the IOD.

It includes capabilities from the Grayscale Softcopy Presentation State IOD for specifying:

a. the output grayscale space in P-Values

b. grayscale contrast transformations including VOI LUT

c. selection of the area of the image to display and whether to rotate or flip it

d. image and display relative annotations, including graphics, text and overlays

For the presentation of angiographic projection images the following capabilities are provided:

a. shutter specifications on a frame-by-frame basis

b. mask subtraction including regional pixel shift

c. presentation of sets of frames

A.33.6.2 XA/XRF Grayscale Softcopy Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.6.3 XA/XRF Grayscale Softcopy Presentation State IOD Module Table

Table A.33.6-1 specifies the Modules of the XA/XRF Grayscale Softcopy Presentation State IOD.

Table A.33.6-1. XA/XRF Grayscale Softcopy Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Presentation State	Presentation State Identification	C.11.10	M
	Presentation State Relationship	C.11.11	M
	Presentation State Shutter	C.11.12	M
	Bitmap Display Shutter	C.7.6.15	C - Required if a Display Shutter is to be applied to referenced image(s) and the XA/XRF Presentation State Shutter Module is not present
	Overlay Plane	C.9.2	C - Required if Overlay is to be applied to referenced image(s) or the Bitmap Display Shutter Module is present.
	Overlay Activation	C.11.7	C - Required if referenced image contains overlay data that is to be displayed or Presentation State Instance contains Overlay data other than Bitmap Shutter
	Displayed Area	C.10.4	M
	Graphic Annotation	C.10.5	C - Required if Graphic Annotations are to be applied to referenced image(s)
	Spatial Transformation	C.10.6	C - Required if rotation or flipping are to be applied to referenced image(s)
	Graphic Layer	C.10.7	C - Required if Graphic Annotations or Overlays or Curves are to be applied to referenced image(s)
	Softcopy VOI LUT	C.11.8	C - Required if a VOI LUT is to be applied to referenced image(s)

IE	Module	Reference	Usage
	XA/XRF Presentation State Mask	C.11.19	C - Required if the referenced image(s) are to be subtracted
	XA/XRF Presentation State Shutter	C.11.20	C - Required if a Display Shutter is to be applied to referenced image(s) and the Bitmap Display Shutter Module is not present
	XA/XRF Presentation State Presentation	C.11.21	C - Required if the referenced image(s) are to be displayed with a prescribed preference
	Softcopy Presentation LUT	C.11.6	M
	SOP Common	C.12.1	M

In the XA/XRF Grayscale Softcopy Presentation State IOD, the Presentation Series Module specializes some Attributes of the General Series Module, the XA/XRF Presentation State Mask Module specializes some Attributes of the Mask Module, and the XA/XRF Presentation State Shutter Module specializes some Attributes of the Bitmap Display Shutter Module and Display Shutter Module.

Note

1. Subtraction between different images is not supported.
2. The Display Shutter may be used to darken image areas that surround important information and exclude extraneous bright areas that increase glare and ambient lighting impairing image interpretation. For example, unexposed areas in a XA image might be obscured using the Display Shutter, rather than permanently replacing image pixels in those areas.
3. This IOD does not support the storage of a multi-frame overlay in the IOD itself, but does support selective activation of multi-frame overlays within the referenced images via the Overlay Activation Module.

A.33.7 Advanced Blending Presentation State IOD

A.33.7.1 Advanced Blending Presentation State IOD Description

The Advanced Blending Presentation State Information Object Definition (IOD) specifies information that may be used to blend two or more sets of images that are referenced from within the IOD for the purpose of presentation (display).

It includes capabilities for specifying:

a. output color space in PCS-Values

b. optional thresholds to restrict contributing areas of an input

c. definition of blending control values for the different inputs

d. selection of the area of the output images to display and whether to rotate or flip it

e. image and display relative annotations, including graphics, text and overlays

A.33.7.2 Advanced Blending Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.33.7.3 Advanced Blending Presentation State IOD Module Table

Table A.33.7-1. Advanced Blending Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

IE	Module	Reference	Usage
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Presentation Series	C.11.9	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Presentation State	Presentation State Identification	C.11.10	M
	Advanced Blending Presentation State	C.11.33	M
	Advanced Blending Presentation State Display	C.11.34	M
	Displayed Area	C.10.4	U
	Graphic Annotation	C.10.5	U
	Spatial Transformation	C.10.6	C - Required if rotation or flipping are to be applied
	Graphic Layer	C.10.7	C - Required if Graphic Annotation Module is present.
	Graphic Group	C.10.11	U
	ICC Profile	C.11.15	M
	Common Instance Reference	C.12.2	M
	SOP Common	C.12.1	M

A.34 Waveform Information Object Definitions

A.34.1 Waveform IOD Entity-Relationship Model

These IODs use the E-R Model in Section Section A.1.2, with only the Waveform IE below the Series IE.

A.34.2 Basic Voice Audio Waveform IOD

A.34.2.1 Basic Voice Audio Waveform IOD Description

The Basic Voice Audio Waveform IOD is the specification of a digitized sound that has been acquired or created by an audio modality or by an audio acquisition function within an imaging modality. A typical use is report dictation.

A.34.2.2 Basic Voice Audio Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.2.3 Basic Voice Audio Waveform IOD Module Table

Table A.34.2-1 specifies the Modules of the Basic Voice Audio Waveform IOD.

Table A.34.2-1. Basic Voice Audio Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

IE	Module	Reference	Usage
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	U
	SOP Common	C.12.1	M

A.34.2.4 Basic Voice Audio IOD Content Constraints

A.34.2.4.1 Modality

The value of Modality (0008,0060) shall be AU.

A.34.2.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be one.

A.34.2.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence (5400,0100) Item shall be 1 or 2.

A.34.2.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in the Waveform Sequence (5400,0100) Item shall be 8000.

A.34.2.4.5 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in the Waveform Sequence (5400,0100) Item shall be UB, MB, or AB.

A.34.3 12-Lead ECG IOD

A.34.3.1 12-Lead ECG IOD Description

The 12-Lead ECG IOD is the specification of digitized electrical signals from the patient cardiac conduction system collected on the body surface, which has been acquired by an ECG modality or by an ECG acquisition function within an imaging modality.

A.34.3.2 12-Lead ECG IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.3.3 12-Lead ECG IOD Module Table

Table A.34.3-1 specifies the Modules of the 12-Lead ECG IOD.

Table A.34.3-1. 12-Lead ECG IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.3.4 12-Lead ECG IOD Content Constraints

A.34.3.4.1 Modality

The value of Modality (0008,0060) shall be ECG.

A.34.3.4.2 Acquisition Context Module

For SOP Instances of ECG acquired in the cardiac catheterization lab, the Defined TID for Acquisition Context Sequence (0040,0555) is TID 3403 “Catheterization Acquisition Context”. For routine resting or stress ECG, the Defined TID for Acquisition Context Sequence (0040,0555) is TID 3401 “ECG Acquisition Context”.

A.34.3.4.3 Waveform Sequence

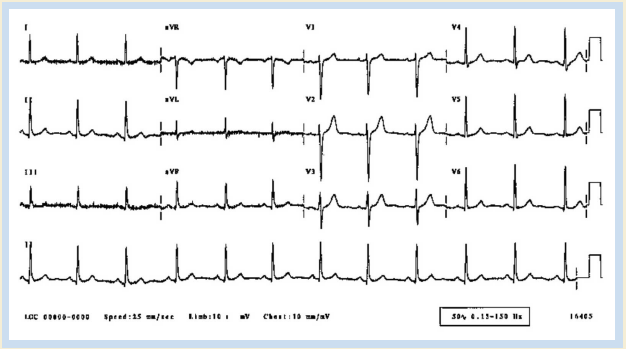
The number of Waveform Sequence (5400,0100) Items shall be between 1 and 5, inclusive.

A.34.3.4.4 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence (5400,0100) Item shall be between 1 and 13, inclusive. The total number of channels encoded across all Items shall not exceed 13.

Note

This specialization provides for up to five Waveform Sequence (5400,0100) Items (multiplex groups), with a total of 13 channels. This allows, for instance, encoding of four sets of three simultaneously recorded channels, the sets being acquired sequentially, plus one continuous channel for the duration of the other sets. This can be used to emulate the behavior of classical 12-lead ECG strip chart recorders with 4x3 presentation, plus a continuous lead II recording (see Figure A.34.3-1).



Multiplex Group	Leads	time offset	duration
Group 1	I, II, III	0.0 s	2.5 s
Group 2	aVR, aVL, aVF	2.5 s	2.5 s
Group 3	V1, V2, V3	5.0 s	2.5 s
Group 4	V4, V5, V6	7.5 s	2.5 s
Group 5	II	0.0 s	9.84 s

Figure A.34.3-1. 12-Lead ECG Example (Informative)

A.34.3.4.5 Number of Waveform Samples

The value of Number of Waveform Samples (003A,0010) in each Waveform Sequence (5400,0100) Item shall be less than or equal to 16384.

Note

This allows over 16 seconds per channel at the maximum sampling frequency; if longer recordings are required, the General ECG IOD may be used.

A.34.3.4.6 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be between 200 and 1000, inclusive.

A.34.3.4.7 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item BCID 3001 “ECG Leads” may be used.

A.34.3.4.8 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SS.

A.34.3.4.9 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 3335 “ECG Annotations” shall be used. This Context Group supports the annotation of suppressed pacemaker spikes in the ECG waveform.

A.34.4 General ECG IOD

A.34.4.1 General ECG IOD Description

The General ECG IOD is the specification of digitized electrical signals from the patient cardiac conduction system collected on the body surface, which has been acquired by an ECG modality or by an ECG acquisition function within an imaging modality.

A.34.4.2 General ECG IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.4.3 General ECG IOD Module Table

Table A.34.4-1 specifies the Modules of the General ECG IOD.

Table A.34.4-1. General ECG IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.4.4 General ECG IOD Content Constraints

A.34.4.4.1 Modality

The value of Modality (0008,0060) shall be ECG.

A.34.4.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be between 1 and 4, inclusive.

A.34.4.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence (5400,0100) Item shall be between 1 and 24, inclusive.

A.34.4.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be between 200 and 1000, inclusive.

A.34.4.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3001 “ECG Leads” shall be used.

Note

Terms from other Context Groups may also be used for extended specification of the Channel Source, as declared in the Conformance Statement for an application (see PS3.2).

A.34.4.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SS.

A.34.4.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 3335 “ECG Annotations” shall be used. This Context Group supports the annotation of suppressed pacemaker spikes in the ECG waveform.

A.34.5 Ambulatory ECG IOD

A.34.5.1 Ambulatory ECG IOD Description

The Ambulatory ECG IOD is the specification of digitized electrical signals from the patient cardiac conduction system collected on the body surface, which has been acquired by an ambulatory electrocardiography (Holter) device.

Note

The duration of acquisition represented in one SOP Instance is not specifically constrained, and is limited only by the maximum size of the Waveform Data Attribute.

A.34.5.2 Ambulatory ECG IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.5.3 Ambulatory ECG IOD Module Table

Table A.34.5-1 specifies the Modules of the Ambulatory ECG IOD.

Table A.34.5-1. Ambulatory ECG IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.5.4 Ambulatory ECG IOD Content Constraints

A.34.5.4.1 Modality

The value of Modality (0008,0060) shall be ECG.

A.34.5.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

A.34.5.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence (5400,0100) Item shall be between 1 and 12, inclusive.

A.34.5.4.5 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be between 50 and 1000, inclusive.

A.34.5.4.6 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3001 “ECG Leads” shall be used.

A.34.5.4.7 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SB or SS.

A.34.6 Hemodynamic Waveform IOD

A.34.6.1 Hemodynamic Waveform IOD Description

The Hemodynamic Waveform IOD is the specification of digitized pressure, electrical, and other signals from the patient circulatory system, which has been acquired by a hemodynamic modality.

Note

The duration of acquisition represented in one SOP Instance is not specifically constrained, and is limited only by the maximum size of the Waveform Data Attribute.

A.34.6.2 Hemodynamic Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.6.3 Hemodynamic Waveform IOD Module Table

Table A.34.6-1 specifies the Modules of the Hemodynamic Waveform IOD.

Table A.34.6-1. Hemodynamic Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - Required if Waveform Originality (003A,0004) is ORIGINAL; may be present otherwise
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.6.4 Hemodynamic IOD Content Constraints

A.34.6.4.1 Modality

The value of Modality (0008,0060) shall be HD.

A.34.6.4.2 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 3403 “Catheterization Acquisition Context”.

A.34.6.4.3 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be between 1 and 4, inclusive.

A.34.6.4.4 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence (5400,0100) Item shall be between 1 and 8, inclusive.

A.34.6.4.5 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be less than or equal to 400.

A.34.6.4.7 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3003 “Hemodynamic Waveform Sources”, DCID 3001 “ECG Leads” for surface ECG channels, or DCID 3090 “Time Synchronization Channel Types” for time synchronization channels shall be used. The Channel Source Code Value shall encode at minimum the metric (measured physical quality) and function (measurement or stimulus); unless otherwise specifically encoded, the default function shall be "measurement".

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003A,0200) Item shall be used to specify additional qualifiers of the semantics of the waveform source, including technique and anatomic location, if not encoded by the Channel Source Code Value. Technique, with terms from DCID 3241 “Hemodynamic Measurement Techniques”, shall be specified in Channel Source Modifiers Sequence (003A,0209) Items prior to the cardiac anatomic location(s), with terms from DCID 3010 “Cardiovascular Anatomic Locations”, DCID 3014 “Coronary Artery Segments”, and DCID 3019 “Cardiovascular Anatomic Location Modifiers”. If technique is pullback, the sequence of anatomic locations shall be specified in ordered Channel Source Modifiers Sequence (003A,0209) Items (e.g., initial, transitional, and final locations).

Note

Terms from other Context Groups may also be used for extended specification of the Channel Source, as declared in the Conformance Statement for an application (see PS3.2).

A.34.6.4.8 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SS.

A.34.6.4.9 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 3337 “Hemodynamic Annotations” shall be used.

A.34.7 Basic Cardiac Electrophysiology Waveform IOD

A.34.7.1 Basic Cardiac EP IOD Description

The Basic Cardiac Electrophysiology Waveform IOD is the specification of digitized electrical signals from the patient cardiac conduction system collected in the heart, which has been acquired by an EP modality.

Note

The duration of acquisition represented in one SOP Instance is not specifically constrained, and is limited only by the maximum size of the Waveform Data Attribute.

A.34.7.2 Basic Cardiac Electrophysiology Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.7.3 Basic Cardiac Electrophysiology Waveform IOD Module Table

Table A.34.7-1 specifies the Modules of the Basic Cardiac Electrophysiology Waveform IOD.

Table A.34.7-1. Basic Cardiac Electrophysiology Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - Required if Waveform Originality (003A,0004) value is ORIGINAL; may be present otherwise
Equipment	General Equipment	C.7.5.1	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.7.4 Basic Cardiac EP IOD Content Constraints

A.34.7.4.1 Modality

The value of Modality (0008,0060) shall be EPS.

A.34.7.4.2 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 3450 “Cardiac Electrophysiology Acquisition Context”.

A.34.7.4.3 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be between 1 and 4, inclusive.

A.34.7.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be less than or equal to 20000.

A.34.7.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003a,0200) Item DCID 3011 “Electrophysiology Anatomic Locations” shall be used. The Channel Source Code Value shall encode at minimum the anatomic location of the channel source.

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003a,0200) Item shall be used to specify additional qualifiers of the semantics of the waveform source, including metric (measured physical quality), function (measurement or stimulus), and technique from DCID 3240 “Electrophysiology Measurement Functions and Techniques”, and anatomic location qualifiers from DCID 3019 “Cardiovascular Anatomic Location Modifiers”, if not encoded by the Channel Source Code Value. If not explicitly encoded, the default metric and function shall be "voltage measurement". If a differential signal is used, that shall be indicated in a Modifier Item, and the positive pole and negative pole identified in the subsequent two modifiers.

Note

1. Terms from other Context Groups may also be used for extended specification of the Channel Source, as declared in the Conformance Statement for an application (see PS3.2).

2. A differential signal from the high right atrium, where electrode 1 on the catheter is the positive pole and electrode 3 the negative pole, could be specified by coded terms meaning:Channel Source: "High Right Atrium"Channel Source Modifiers: "Differential", "E1", "E3"(Implicit default modifier: "Voltage Measurement")

A.34.7.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SS.

A.34.7.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 3339 “Electrophysiology Annotations” shall be used.

A.34.8 Arterial Pulse Waveform IOD

A.34.8.1 Arterial Pulse Waveform IOD Description

The Arterial Pulse Waveform IOD is the specification of digitized electrical signals from the patient arterial system collected through pulse oximetry or other means by a Pulse modality or by a Pulse acquisition function within an imaging modality.

A.34.8.2 Arterial Pulse Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.8.3 Arterial Pulse Waveform IOD Module Table

Table A.34.8-1 specifies the Modules of the Arterial Pulse Waveform IOD.

Table A.34.8-1. Arterial Pulse Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.8.4 Arterial Pulse Waveform IOD Content Constraints

A.34.8.4.1 Modality

The value of Modality (0008,0060) shall be HD (hemodynamic waveform).

A.34.8.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

A.34.8.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence Item (5400,0100) shall be 1.

A.34.8.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be less than or equal to 600 Hz.

A.34.8.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3004 “Arterial Pulse Waveform” shall be used.

A.34.8.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SB or SS.

A.34.9 Respiratory Waveform IOD

A.34.9.1 Respiratory Waveform IOD Description

The Respiratory Waveform IOD is the specification of digitized electrical signals from the patient respiratory system, which has been acquired by a Respiratory modality or by a Respiratory acquisition function within an imaging modality.

A.34.9.2 Respiratory Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.9.3 Respiratory Waveform IOD Module Table

Table A.34.9-1 specifies the Modules of the Respiratory Waveform IOD.

Table A.34.9-1. Respiratory Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.9.4 Respiratory Waveform IOD Content Constraints

A.34.9.4.1 Modality

The value of Modality (0008,0060) shall be RESP.

A.34.9.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

A.34.9.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence (5400,0100) Item shall be 1.

A.34.9.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be less than or equal to100 Hz.

A.34.9.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3005 “Respiration Waveform” shall be used.

A.34.9.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SB or SS.

A.34.10 General Audio Waveform IOD

A.34.10.1 General Audio Waveform IOD Description

The General Audio Waveform IOD is the specification of one or two channel digitized audio signals.

A.34.10.2 General Audio Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.10.3 General Audio Waveform IOD Module Table

Table A.34.10-1 specifies the Modules of the General Audio Waveform IOD.

Table A.34.10-1. General Audio Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	C - Required if annotation is present.
	SOP Common	C.12.1	M

A.34.10.4 General Audio Waveform IOD Content Constraints

A.34.10.4.1 Modality

The value of Modality (0008,0060) shall be AU (audio).

A.34.10.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

A.34.10.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence (5400,0100) Item shall be1 or 2.

A.34.10.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence (5400,0100) Item shall be less than or equal to 44,100 Hz.

A.34.10.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3000 “Audio Channel Source” shall be used.

A.34.10.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (5400,0100) Item shall be SB or SS.

A.34.11 Real-Time Audio Waveform IOD

A.34.11.1 Real-Time Audio Waveform IOD Description

The Real-Time Audio Waveform IOD specifies one-channel or two-channel digitized audio signals, transmitted in real-time.

A.34.11.2 Real-Time Audio Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE and Frame of Reference IE below the Series IE.

A.34.11.3 Real-Time Audio Waveform IOD Module Table

Table A.34.11-1 specifies the Modules of the Real-Time Audio Waveform IOD.

Table A.34.11-1. Real-Time Audio Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Synchronization	C.7.4.2	M
Waveform	Waveform Identification	C.10.8	M
	Real-Time Bulk Data Flow	C.7.6.26	M
	Acquisition Context	C.7.6.14	M
	SOP Common	C.12.1	M
	Current Frame Functional Groups	C.7.6.27	M

A.34.11.4 Real-Time Audio Waveform IOD Content Constraints

A.34.11.4.1 Modality

The value of Modality (0008,0060) shall be AU (audio).

A.34.11.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

A.34.11.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in the Waveform Sequence Item shall be 1 or 2.

A.34.11.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item shall be 44.1 kHz, 48 kHz, or 96 kHz.

A.34.11.4.5 Channel Source

For Channel Source Sequence (003A,0208) in each Channel Definition Sequence (003A,0200) Item DCID 3000 “Audio Channel Source” shall be used.

A.34.11.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence Item shall be SB or SS.

A.34.11.4.7 Current Frame Functional Groups Module

The Current Frame Functional Groups Module ~~shallbe~~shall be placed in the dynamic part of the RTP Payload.

Table A.34.11-2 specifies the Functional Group Macros included in the Current Frame Functional Groups Module for the Real-Time Audio Waveform IOD.

Table A.34.11-2. Real-Time Audio Waveform Functional Group Macros

Functional Group Macro	Section	Usage
Time of Frame	C.7.6.16.2.29	M - shall not be used as a Shared Functional Group

A.34.11.4.8 Time Distribution Protocol

The Time Distribution Protocol (0018,1802) of the Synchronization Module shall be set to "PTP".

A.34.12 Routine Scalp Electroencephalogram IOD

A.34.12.1 Routine Scalp Electroencephalogram IOD Description

The Routine Scalp Electroencephalogram (EEG) IOD is the specification of digitized electrical signals from the patient's encephalon collected on the skull surface, which has been acquired by an EEG modality or by an EEG acquisition function within an imaging modality or a neurophysiology recording device.

Note

This type of object could cover these clinical scenarios:

- Routine EEG
- EEG-Video-Monitoring - scalp EEG

as these have similar physical properties and use the same electrode location scheme.

A.34.12.2 Routine Scalp Electroencephalogram IOD Entity-Relationship Model

The E-R Model in Section A.34.1 applies to the Routine Electroencephalogram IOD.

A.34.12.3 Routine Scalp Electroencephalogram IOD Module Table

Table A.34.12-1. Routine Scalp Electroencephalogram IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	M
	Waveform Annotation	C.10.10	U
	SOP Common	C.12.1	M

A.34.12.4 Routine Scalp Electroencephalogram IOD Constraints

A.34.12.4.1 Modality

The value of Modality (0008,0060) shall be EEG.

A.34.12.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items shall be 1.

Note

In case of recording interruptions, the recording will be encoded as separate instances.

A.34.12.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence Item shall be between 1 and 64, inclusive.

A.34.12.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item is not constrained.

A.34.12.4.5 Channel Source and Channel Source Modifiers

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3030 “EEG Leads”.

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003A,0200) Item shall be used to specify additional qualifiers of the semantics of the waveform source, including anatomic location, if not encoded by the Channel Source Code Value.

EEG recordings not using a common reference electrode shall contain the location of the reference electrode for the given channel in the Channel Source Modifiers Sequence (003A,0209) as follows:

- First Item: "Differential signal" (DCID 3240 “Electrophysiology Measurement Functions and Techniques”)
- Second Item: Location of the reference lead (DCID 3030 “EEG Leads”)

EEG recordings using a common reference electrode shall be coded in the same way, but use the same reference lead in every Channel Source Modifier.

Note

BCID 3030 “EEG Leads” is extensible. Terms from other Context Groups or elsewhere may be used in the Channel Source Sequence as well as in the Channel Source Modifier Sequence to identify channels not contained in CID 3030 “EEG Leads”. Such terms are expected to be described in the Conformance Statement.

A.34.12.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence Item shall be SS or SL.

A.34.12.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in Waveform Annotation Sequence (0040,B020) DCID 3035 “EEG Annotations – Neurophysiologic Enumerations (EEG)”, DCID 3038 “Pattern Events ”, and DCID 3040 “EEG Annotations - Neurological Monitoring Measurements” shall be used.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.34.13 Electromyogram IOD

A.34.13.1 Electromyogram IOD Description

The Electromyogram (EMG) IOD is the specification of digitized electrical signals evoked by the patient's muscle movements, which has been acquired by an EMG modality or by an EMG acquisition function within a neurophysiology recording device or a polysomnography modality.

A.34.13.2 Electromyogram IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.13.3 Electromyogram IOD Module Table

Table A.34.13-1. Electromyogram IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M

IE	Module	Reference	Usage
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present
	SOP Common	C.12.1	M

A.34.13.4 Electromyogram IOD Constraints

A.34.13.4.1 Modality

The value of Modality (0008,0060) shall be EMG.

A.34.13.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items is not constrained.

A.34.13.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence Item shall be between 1 and 64, inclusive.

A.34.13.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item is not constrained.

A.34.13.4.5 Channel Source and Channel Source Modifiers

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3031 “Lead locations near or in muscles” or CID 3032 “Lead locations near peripheral nerves”.

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003A,0200) Item shall be used to specify additional qualifiers of the semantics of the waveform source, including anatomic location, if not encoded by ~~theChannel~~the Channel Source Code Value.

EMG recordings not using a common reference electrode shall contain the location of the reference electrode for the given channel in the Channel Source Modifiers Sequence (003A,0209) as follows:

- First Item: "Differential signal" (DCID 3240 “Electrophysiology Measurement Functions and Techniques”)
- Second Item: Location of the reference lead (DCID 3031 “Lead locations near or in muscles”, BCID 3032 “Lead locations near peripheral nerves”)

EMG recordings using a common reference electrode shall be coded in the same way, but contain the same reference lead in every Channel Source Modifier.

Note

CID 3031 “Lead locations near or in muscles” and CID 3032 “Lead locations near peripheral nerves” are extensible. Terms from other Context Groups or elsewhere may be used in the Channel Source Sequence as well as in the Channel Source Modifier Sequence to identify channels not contained in these two Context Groups. Such terms are expected to be described in the Conformance Statement.

A.34.13.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (0054,0100) Item shall be ~~SSor~~SS or SL.

A.34.13.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in Waveform Annotation Sequence (0040,B020) DCID 3036 “EMG Annotations – Neurophysiological Enumerations (EMG)” and DCID 3039 “Device-related and Environment-related Events” shall be used.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.34.14 Electrooculogram IOD

A.34.14.1 Electrooculogram IOD Description

The Electrooculogram (EOG) IOD is the specification of digitized electrical signals evoked by the patient's eye movements collected on the face, which has been acquired by an EOG modality or by an EOG acquisition function within a neurophysiology recording device or a polysomnography modality.

A.34.14.2 Electrooculogram IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.14.3 Electrooculogram IOD Module Table

Table A.34.14-1. Electrooculogram IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present
	SOP Common	C.12.1	M

A.34.14.4 Electrooculogram IOD Constraints

A.34.14.4.1 Modality

The value of Modality (0008,0060) shall be EOG.

A.34.14.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items is not constrained.

A.34.14.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence Item shall be 2 or 4.

A.34.14.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item is not constrained.

A.34.14.4.5 Channel Source and Channel Source Modifiers

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3033 “EOG Leads”.

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003A,0200) Item shall be used to ~~specifyadditional~~specify additional qualifiers of the semantics of the waveform source, including anatomic location, if not encoded by the Channel Source Code Value.

EOG recordings not using a common reference electrode shall contain the location of the reference electrode for the given channel in the Channel Source Modifiers Sequence (003A,0209) as follows:

- First Item: "Differential signal" (DCID 3240 “Electrophysiology Measurement Functions and Techniques”)
- Second Item: Location of the reference lead (DCID 3033 “EOG Leads”)

EOG recordings using a common reference electrode shall be coded in the same way, but contain the same reference lead in every Channel Source Modifier.

Note

CID 3033 “EOG Leads” is extensible. Terms from other Context Groups or elsewhere may be used in the Channel Source Sequence as well as in the Channel Source Modifier Sequence to identify channels not contained in CID 3033 “EOG Leads”. Such terms are expected to be described in the Conformance Statement.

A.34.14.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence (0054,0100) Item shall be ~~SSor~~SS or SL.

A.34.14.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in Waveform Annotation Sequence (0040,B020) DCID 3037 “EOG Annotations – Neurophysiological Enumerations (EOG)” and DCID 3039 “Device-related and Environment-related Events” shall be used.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.34.15 Sleep Electroencephalogram IOD

A.34.15.1 Sleep Electroencephalogram IOD Description

The Sleep Electroencephalogram (EEG) IOD is the specification of digitized electrical signals from the patient's encephalon collected on the skull surface, which has been acquired by an EEG modality or by an EEG acquisition function within a polysomnography modality.

A.34.15.2 Sleep Electroencephalogram IOD Entity-Relationship Model

The E-R Model in Section A.34.1 applies to the Sleep Electroencephalogram IOD.

A.34.15.3 Sleep Electroencephalogram IOD Module Table

Table A.34.15-1. Sleep Electroencephalogram IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present
	SOP Common	C.12.1	M

A.34.15.4 Sleep Electroencephalogram IOD Constraints

A.34.15.4.1 Modality

The value of Modality (0008,0060) shall be EEG.

A.34.15.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items is not constrained

A.34.15.4.3 Number of Waveform Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence Item shall be between 1 and 64, inclusive.

A.34.15.4.4 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item is not constrained.

A.34.15.4.5 Channel Source and Channel Source Modifiers

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3030 “EEG Leads”.

The Channel Source Modifiers Sequence (003A,0209) in each Channel Definition Sequence (003A,0200) Item shall be used to specify additional qualifiers of the semantics of the waveform source, including technique and anatomic location, if not encoded by the Channel Source Code Value.

EEG recordings not using a common reference electrode shall contain the location of the reference electrode for the given channel in the Channel Source Modifiers Sequence (003A,0209) as follows:

- First Item: "Differential signal" (DCID 3240 “Electrophysiology Measurement Functions and Techniques”)

- Second Item: Location of the reference lead (DCID 3030 “EEG Leads”)

EEG recordings using a common reference electrode shall be coded in the same way, but contain the same reference lead in every Channel Source Modifier.

Note

CID 3030 “EEG Leads” is extensible. Terms from other Context Groups or elsewhere may be used in the Channel Source Sequence as well as in the Channel Source Modifier Sequence to identify channels not contained in CID 3030 “EEG Leads”. Such Terms are expected to be described in the Conformance Statement.

A.34.15.4.6 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence Item shall be ~~SSor~~SS or SL.

A.34.15.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in Waveform Annotation Sequence (0040,B020) DCID 3035 “EEG Annotations – Neurophysiologic Enumerations (EEG)”, DCID 3038 “Pattern Events ”, DCID 3039 “Device-related and Environment-related Events”, and DCID 3040 “EEG Annotations - Neurological Monitoring Measurements” shall be used.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.34.16 Multi-channel Respiratory Waveform IOD

A.34.16.1 Multi-channel Respiratory Waveform IOD Description

The Multi-channel Respiratory Waveform IOD is the specification of digitized electrical signals from the patient respiratory system, which has been acquired by a Respiratory modality or by a Respiratory acquisition function within a neurophysiology recording device or a polysomnography modality.

A.34.16.2 Multi-channel Respiratory Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.16.3 Multi-channel Respiratory Waveform IOD Module Table

Table A.34.16-1. Multi-channel Respiratory Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M

IE	Module	Reference	Usage
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present
	SOP Common	C.12.1	M

A.34.16.4 Multi-channel Respiratory Waveform IOD Constraints

A.34.16.4.1 Modality

The value of Modality (0008,0060) shall be RESP.

A.34.16.4.2 Waveform Sequence and Number of Waveform Channels

The number of Waveform Sequence (5400,0100) items is unconstrained.

Note

If the total number of Waveform Channels is one the Respiratory Waveform IOD could be used instead

A.34.16.4.3 Sampling Frequency

The value of Sampling Frequency (003A,001A) in each Waveform Sequence Item is not constrained.

A.34.16.4.4 Channel Source and Channel Source Modifiers

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3005 “Respiration Waveform”.

A.34.16.4.5 Waveform Sample Interpretation

The value of Waveform Sample Interpretation (5400,1006) in each Waveform Sequence Item shall be SS or SL.

A.34.16.4.6 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 3038 “Pattern Events ” and DCID 3039 “Device-related and Environment-related Events” shall be used.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.34.17 Body Position Waveform IOD

A.34.17.1 Body Position Waveform IOD Description

The Body Position Waveform IOD is the specification of digitized electrical signals acquired by ~~adevice~~a device or sensor on the body of the patient measuring the position of the ~~patient.Depending~~patient. Depending on the measurement method, either the digitized sensor data is saved directly or values derived from it.

A.34.17.2 Body Position Waveform IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Waveform IE below the Series IE.

A.34.17.3 Body Position Waveform IOD Module Table

Table A.34.17-1. Body Position Waveform IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Waveform	Waveform Identification	C.10.8	M
	Waveform	C.10.9	M
	Acquisition Context	C.7.6.14	U
	Waveform Annotation	C.10.10	C - Required if annotation is present
	SOP Common	C.12.1	M

A.34.17.4 Body Position Waveform IOD Constraints

A.34.17.4.1 Modality

The value of Modality (0008,0060) shall be POS.

A.34.17.4.2 Waveform Sequence

The number of Waveform Sequence (5400,0100) Items is unconstrained.

A.34.17.4.3 Number of Channels

The value of Number of Waveform Channels (003A,0005) in each Waveform Sequence depends on the measurement type; seeA.34.17.4.4 Channel Source

To encode the patient's position as fixed values a single channel shall be used.

To encode the patient's position as rotation and elevation, two channels shall be used. The first angle is the patient's angle of rotation around the longitudinal axis (head-feet axis). The second angle is the angle of elevation of the patient against horizontal, which could change if the patient sits up in bed, if the head of the bed is elevated, or if the patient stands up.

A.34.17.4.4 Channel Source

Channel Source Sequence (003A,0208) in each Channel Definition Sequence Item DCID 3034 “Body Position Channels”.

The Channel Source Code for a channel encoding the patient's position as fixed values is (130410, DCM, "Patient position").

The Channel Source Code for a channel encoding the patient's rotation around the body's longitudinal axis (head-feet axis) is (130411, DCM, "Patient rotation longitudinal").

The Channel Source Code for a channel encoding the elevation of the patient against horizontal is (130412, DCM, "Patient elevation").

A.34.17.4.5 Waveform Sample Interpretation

For channels encoding the patient's position as fixed values the value of Waveform Sample Interpretation (5400,1006) is UB.

For channels encoding the patient's position ~~asrotation~~as rotation angles the value of Waveform Sample Interpretation (5400,1006) is SS.

A.34.17.4.6 Waveform Data

For channels encoding the patient's position as fixed values Waveform Data (5400,1010) shall only contain defined values listed in Table A.34.17-2.

Table A.34.17-2. Defined Body Position Data Values

Value	Meaning
0x00	supine
0x01	left lateral decubitus
0x02	prone
0x03	right lateral decubitus
0x04	upright
0xff	undefined

Note

With 8-bit Waveform Data and a single channel there may be an odd number of samples; see PS3.5 for encoding rules.

For channels encoding the patient's rotation and elevation, angles are stored in Waveform data (5400,1010). Units of measure (Channel Sensitivity Units (003A,0211)) shall be degrees. Both angles having the value 0Â° is body position supine. Table A.34.17-3 shows the angle values of selected body positions.

Table A.34.17-3. Selected Body Position Angles

Position Value	Value in Channel I	Value in Channel 2
supine	0	0
lateral decubitus left	90	0
prone	180	0
lateral decubitus right	270	0
upright	0	90
feet up	0	-90

A.34.17.4.7 Waveform Annotation Module

For Concept Name Code Sequence (0040,A043) in the Waveform Annotation Sequence (0040,B020) DCID 19 “Patient Orientation” shall be used. Modifier Code Sequence (0040,A195) DCID 20 “Patient Orientation Modifier”.

Note

Annotations can be stored either in the Waveform Annotation Module of the waveform to which they apply, or in a separate Structured Report object. The Waveform Annotation Module is only intended for annotations made at the time of acquisition.

A.35 Structured Report Document Information Object Definitions

A.35.1 Basic Text SR IOD

A.35.1.1 Basic Text SR IOD Description

The Basic Text Structured Report (SR) IOD is intended for the representation of reports with minimal usage of coded entries (typically used in Document Title and headings) and a hierarchical tree of headings under which may appear text and subheadings. Reference to SOP Instances (e.g., images or waveforms or other SR Documents) is restricted to appear at the level of the leaves of this primarily textual tree. This structure simplifies the encoding of conventional textual reports as SR Documents, as well as their rendering.

A.35.1.2 Basic Text SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.1.3 Basic Text SR IOD Module Table

Table A.35.1-1 specifies the Modules of the Basic Text SR IOD.

Table A.35.1-1. Basic Text SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.1.3.1 Basic Text SR IOD Content Constraints

A.35.1.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
DATETIME
DATE
TIME
UIDREF
PNAME

COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.1.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.1-2 specifies the relationship constraints of this IOD.

Table A.35.1-2. Relationship Content Constraints for Basic Text SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME, COMPOSITE[1], IMAGE[1], WAVEFORM[1], CONTAINER
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME, COMPOSITE[1]
CONTAINER, IMAGE[1], WAVEFORM[1], COMPOSITE[1]	HAS ACQ CONTEXT	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1]
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME
TEXT	INFERRED FROM	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1]

Note

1. Which SOP Classes the IMAGE, WAVEFORM or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).
2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.2 Enhanced SR IOD

A.35.2.1 Enhanced SR IOD Description

The Enhanced Structured Report (SR) IOD is a superset of the Basic Text SR IOD. It is also intended for the representation of reports with minimal usage of coded entries (typically Document Title and headings) and a hierarchical tree of headings under which may appear text and subheadings. In addition, it supports the use of numeric measurements with coded measurement names and units. Reference to SOP Instances (e.g., images or waveforms or SR Documents) is restricted to appear at the level of the leaves of this primarily textual tree. It enhances references to SOP Instances with spatial regions of interest (points, lines, circle, ellipse, etc.) and temporal regions of interest.

A.35.2.2 Enhanced SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.2.3 Enhanced SR IOD Module Table

Table A.35.2-1 specifies the Modules of the Enhanced SR IOD.

Table A.35.2-1. Enhanced SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.2.3.1 Enhanced SR IOD Content Constraints

A.35.2.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
TIME
UIDREF
PNAME
SCOORD
TCOORD
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.2.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.2-2 specifies the relationship constraints of this IOD.

Table A.35.2-2. Relationship Content Constraints for Enhanced SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, SCOORD, TCOORD, COMPOSITE[1], IMAGE[1], WAVEFORM[1], CONTAINER
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, COMPOSITE[1]
CONTAINER, IMAGE[1], WAVEFORM[1], COMPOSITE[1], NUM	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, TCOORD
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, TCOORD
SCOORD	SELECTED FROM	IMAGE[1]
TCOORD	SELECTED FROM	SCOORD, IMAGE[1], WAVEFORM[1]

Note

1. Which SOP Classes the IMAGE, WAVEFORM or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.3 Comprehensive SR IOD

A.35.3.1 Comprehensive SR IOD Description

The Comprehensive SR IOD is a superset of the Basic Text SR IOD and the Enhanced SR IOD, which specifies a class of documents, the content of which may include textual and a variety of coded information, numeric measurement values, references to the SOP Instances and spatial or temporal regions of interest within such SOP Instances. Relationships by-reference are enabled between Content Items.

A.35.3.2 Comprehensive SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.3.3 Comprehensive SR IOD Module Table

Table A.35.3-1 specifies the Modules of the Comprehensive SR IOD.

Table A.35.3-1. Comprehensive SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.3.3.1 Comprehensive SR IOD Content Constraints

A.35.3.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
TIME
UIDREF
PNAME
SCOORD
TCOORD
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.3.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD may be conveyed either by-value or by-reference. Table A.35.3-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.3-2. Relationship Content Constraints for Comprehensive SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, SCOORD, TCOORD, COMPOSITE[1], IMAGE[1], WAVEFORM[1], CONTAINER (see below).
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, COMPOSITE[1]
CONTAINER, IMAGE[1], WAVEFORM[1], COMPOSITE[1], NUM	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, TCOORD, CONTAINER
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, TCOORD, CONTAINER
SCOORD	SELECTED FROM	IMAGE[1]
TCOORD	SELECTED FROM	SCOORD, IMAGE[1], WAVEFORM[1]

Note

1. Which SOP Classes the IMAGE, WAVEFORM or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

The HAS CONCEPT MOD and CONTAINS relationships shall not be conveyed by-reference.

Relationships by-reference to ancestor Content Items are forbidden in this IOD to prevent loops.

A.35.4 Key Object Selection Document IOD

A.35.4.1 Key Object Selection Document IOD Description

The Key Object Selection Document IOD is intended for flagging one or more significant images, waveforms, or other composite SOP Instances.

A.35.4.2 Key Object Selection Document IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.4.3 Key Object Selection Document IOD Module Table

Table A.35.4-1 specifies the Modules of the Key Object Selection Document IOD.

Table A.35.4-1. Key Object Selection Document IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	Key Object Document Series	C.17.6.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Document	Key Object Document	C.17.6.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.4.3.1 Key Object Selection Document IOD Content Constraints

A.35.4.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
UIDREF
PNAME
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.4.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.4-2 specifies the relationship constraints of this IOD.

Table A.35.4-2. Relationship Content Constraints for Key Object Selection Document IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, IMAGE, WAVEFORM, COMPOSITE
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, UIDREF, PNAME
CONTAINER	HAS CONCEPT MOD	CODE

A.35.4.3.1.3 Template Constraints

The document shall be constructed from TID 2010 “Key Object Selection” invoked at the root node.

A.35.5 Mammography CAD SR IOD

A.35.5.1 Mammography CAD SR IOD Description

The Mammography CAD SR IOD is used to convey the detection and analysis results of a mammography CAD device. The content may include textual and a variety of coded information, numeric measurement values, references to the SOP Instances, and spatial regions of interest within such SOP Instances. Relationships by-reference are enabled between Content Items.

A.35.5.2 Mammography CAD SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.5.3 Mammography CAD SR IOD Module Table

Table A.35.5-1 specifies the Modules of the Mammography CAD SR IOD.

Table A.35.5-1. Mammography CAD SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.5.3.1 Mammography CAD SR IOD Content Constraints

A.35.5.3.1.1 Template Constraints

- The document shall be constructed from TID 4000 “Mammography CAD Document Root” invoked at the root node.
- When a Content Item sub-tree from a prior document is duplicated by-value, its observation context shall be defined by TID 1001 “Observation Context” and its subordinate templates.

Note

All Template and Context Group definitions are located in Annex A “Structured Reporting Templates (Normative)” in PS3.16 and Annex B “DCMR Context Groups (Normative)” in PS3.16, respectively.

A.35.5.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATE
TIME
PNAME
SCOORD
COMPOSITE
IMAGE
CONTAINER

A.35.5.3.1.3 Relationship Constraints

The Mammography CAD SR IOD makes extensive use of by-reference INFERRED FROM, by-reference HAS PROPERTIES and by-reference SELECTED FROM relationships. Other relationships by-reference are forbidden. Table A.35.5-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.5-2. Relationship Content Constraints for Mammography CAD SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CODE, NUM, SCOORD, IMAGE[1], CONTAINER, TEXT, DATE.
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATE, TIME, PNAME, UIDREF, COMPOSITE[1].
IMAGE	HAS ACQ CONTEXT	TEXT, CODE, DATE, TIME, NUM.
CONTAINER, CODE, NUM, COMPOSITE	HAS CONCEPT MOD	TEXT, CODE[2].
TEXT, CODE, NUM	HAS PROPERTIES	CONTAINER, TEXT, CODE, NUM, DATE, IMAGE[1], SCOORD, UIDREF.
CODE, NUM	INFERRED FROM	CODE, NUM, SCOORD, CONTAINER, TEXT, IMAGE.
SCOORD	SELECTED FROM	IMAGE[1].

Note

1. Which SOP Classes the IMAGE or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.6 Chest CAD SR IOD

A.35.6.1 Chest CAD SR IOD Description

The Chest CAD SR IOD is used to convey the detection and analysis results of a chest CAD device. The content may include textual and a variety of coded information, numeric measurement values, references to the SOP Instances, and spatial regions of interest within such SOP Instances. Relationships by-reference are enabled between Content Items.

A.35.6.2 Chest CAD SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.6.3 Chest CAD SR IOD Module Table

Table A.35.6-1 specifies the Modules of the Chest CAD SR IOD.

Table A.35.6-1. Chest CAD SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.35.6.3.1 Chest CAD SR IOD Content Constraints

A.35.6.3.1.1 Template Constraints

- The document shall be constructed from TID 4100 “Chest CAD Document Root” invoked at the root node.
- When a Content Item sub-tree from a prior document is duplicated by-value, its observation context shall be defined by TID 1001 “Observation Context” and its subordinate templates.

Note

All Template and Context Group definitions are located in Annex A “Structured Reporting Templates (Normative)” in PS3.16 and Annex B “DCMR Context Groups (Normative)” in PS3.16, respectively.

A.35.6.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATE
TIME
UIDREF

PNAME
SCOORD
TCOORD
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.6.3.1.3 Relationship Constraints

The Chest CAD SR IOD makes use of by-reference INFERRED FROM, by-reference SELECTED FROM, and by-reference HAS PROPERTIES relationships. Other relationships by-reference are forbidden. Table A.35.6-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.6-2. Relationship Content Constraints for Chest CAD SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CODE, NUM, IMAGE[1], CONTAINER
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATE, TIME, PNAME, UIDREF, COMPOSITE[1].
IMAGE, WAVEFORM	HAS ACQ CONTEXT	TEXT, CODE, DATE, TIME, NUM.
CONTAINER, CODE, COMPOSITE, NUM	HAS CONCEPT MOD	TEXT, CODE[2].
TEXT, CODE, NUM	HAS PROPERTIES	CONTAINER, TEXT, CODE, NUM, DATE, IMAGE[1], WAVEFORM[1], SCOORD, TCOORD, UIDREF.
CODE, NUM	INFERRED FROM	CODE, NUM, IMAGE[1], WAVEFORM[1], SCOORD, TCOORD, CONTAINER, TEXT.
SCOORD	SELECTED FROM	IMAGE[1].
TCOORD	SELECTED FROM	SCOORD, IMAGE[1], WAVEFORM[1].

Note

1. Which SOP Classes the IMAGE or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).
2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.7 Procedure Log IOD

A.35.7.1 Procedure Log IOD Description

The Procedure Log IOD is intended for the representation of reports or logs of time-stamped events occurring during an extended diagnostic or interventional procedure, typical of the cardiac catheterization lab.

A.35.7.2 Procedure Log IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

Note

Unlike some other SR IODs, the Frame of Reference IE is critical to the synchronized time stamping of events in the Procedure Log IOD and to multi-modality coordination.

A.35.7.3 Procedure Log IOD Module Table

Table A.35.7-1 specifies the Modules of the Procedure Log IOD.

Table A.35.7-1. Procedure Log IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.7.3.1 Procedure Log IOD Content Constraints

A.35.7.3.1.1 Template

The document may be constructed from BTID 3001 “Procedure Log” invoked at the root node.

Note

This template defines a container (the root) with subsidiary Content Items, each of which represents a single procedure log entry. There is a defined recording observer (the person responsible for recording the log, generally a technician or nurse). The log entries follow a canonical model of a coded log entry type (the concept name of the Content Item), the value associated with the concept name as one of the SR Value Types, and optionally a subsidiary free text comment and/or an identifier of the author or device source of the log entry (which may be other than the recording observer).

A.35.7.3.1.2 Observation DateTime

Each Item in Content Sequence (0040,A730) of the SR Document Content Module that is a target of a "CONTAINS" relationship from the root node, i.e., the first level Log Content Items, shall include Observation DateTime (0040,A032) as a Type 1 Attribute. This Attribute shall represent the DateTime at which the event recorded in the Content Item occurred, not the time at which the Item was recorded.

The first level Procedure Log Content Items in the Content Sequence shall be strictly ordered by monotonically increasing Observation DateTime (0040,A032) values.

Observation DateTime (0040,A032) shall be specified to a precision of one second or finer.

A.35.7.3.1.3 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE

TIME
UIDREF
PNAME
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.7.3.1.4 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

1. Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.
2. CONTAINERs are not permitted as a target of any relationship.

Table A.35.7-2 specifies the relationship constraints of this IOD.

Table A.35.7-2. Relationship Content Constraints for Procedure Log IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, PNAME, COMPOSITE, IMAGE, WAVEFORM
any type	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME
CONTAINER, IMAGE, WAVEFORM, COMPOSITE	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME
any type	HAS CONCEPT MOD	TEXT, CODE
any type (except CONTAINER)	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	IMAGE, WAVEFORM, COMPOSITE

A.35.8 X-Ray Radiation Dose SR IOD

A.35.8.1 X-Ray Radiation Dose SR IOD Description

The X-Ray Radiation Dose SR IOD is used to convey the exposure characteristics and dose from X-Rays generated by imaging devices.

Note

Therapeutic dose is reported in the RT Dose IOD.

A.35.8.2 X-Ray Radiation Dose SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.8.3 X-Ray Radiation Dose SR IOD Module Table

Table A.35.8-1 specifies the Modules of the X-Ray Radiation Dose SR IOD.

Table A.35.8-1. X-Ray Radiation Dose SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - shall be present if system time is synchronized to an external reference. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.8.3.1 X-Ray Radiation Dose SR IOD Content Constraints

A.35.8.3.1.1 Template

The document may be constructed from BTID 10001 “Projection X-Ray Radiation Dose” or BTID 10011 “CT Radiation Dose” invoked at the root node.

Note

This IOD maybe used with other Templates defined for Dose Reporting. Such other Templates maybe specialized for specific modalities or future dose measurement techniques.

A.35.8.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
UIDREF
PNAME
COMPOSITE
IMAGE
CONTAINER

A.35.8.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed by-value. Table A.35.8-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.8-2. Relationship Content Constraints for X-Ray Radiation Dose SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, IMAGE, COMPOSITE, CONTAINER
CONTAINER	HAS OBS CONTEXT	DATETIME, CODE, TEXT, UIDREF, PNAME
TEXT, CODE, NUM	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, COMPOSITE
CONTAINER, IMAGE, COMPOSITE	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, IMAGE, COMPOSITE, CONTAINER
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, UIDREF, IMAGE, COMPOSITE, CONTAINER

Note

The SOP Classes to which an IMAGE or COMPOSITE Value Type may refer are documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

A.35.8.3.1.4 Completion Flag

The Completion Flag (0040,A491) of an X-Ray Radiation Dose SR shall have the value "COMPLETE".

Note

An RDSR must contain all relevant information from its Scope of Accumulation. The value "PARTIAL" is not be used, as it would mean that the RDSR does not contain all the irradiation events within the Scope of Accumulation.

A.35.9 Spectacle Prescription Report IOD

A.35.9.1 Spectacle Prescription Report IOD Description

The Spectacle Prescription Report IOD is used to represent the spectacle prescription for a Patient.

A.35.9.2 Spectacle Prescription Report IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.9.3 Spectacle Prescription Report IOD Module Table

Table A.35.9-1 specifies the Modules of the Spectacle Prescription Report IOD.

Table A.35.9-1. Spectacle Prescription Report IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.9.3.1 Spectacle Prescription Report IOD Content Constraints

A.35.9.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
CONTAINER

A.35.9.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.9-2 specifies the relationship constraints of this IOD.

Table A.35.9-2. Relationship Content Constraints for Spectacle Prescription Report IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CONTAINER, CODE, NUM, TEXT

A.35.9.3.1.3 Template Constraints

The document shall be constructed from TID 2020 “Spectacle Prescription Report” invoked at the root node.

A.35.10 Colon CAD SR IOD

A.35.10.1 Colon CAD SR IOD Description

The Colon CAD SR IOD is used to convey the detection and analysis results of a colon CAD device. The content may include textual and a variety of coded information, numeric measurement values, references to the SOP Instances, and spatial regions of interest within such SOP Instances. Relationships by-reference are enabled between Content Items.

A.35.10.2 Colon CAD SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.10.3 Colon CAD SR IOD Module Table

Table A.35.10-1 specifies the Modules of the Colon CAD SR IOD.

Table A.35.10-1. Colon CAD SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.10.3.1 Colon CAD SR IOD Content Constraints

A.35.10.3.1.1 Template Constraints

The document shall be constructed from TID 4120 “Colon CAD Document Root” invoked at the root node.

Note

All Template and Context Group definitions are located in Annex A “Structured Reporting Templates (Normative)” in PS3.16 and Annex B “DCMR Context Groups (Normative)” in PS3.16, respectively.

A.35.10.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATE
TIME
UIDREF
PNAME
SCOORD
SCOORD3D
TCOORD
COMPOSITE
IMAGE
CONTAINER

A.35.10.3.1.3 Relationship Constraints

The Colon CAD SR IOD makes use of by-reference INFERRED FROM and by-reference HAS ACQ CONTEXT relationships. Other relationships by-reference are forbidden. Table A.35.10-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.10-2. Relationship Content Constraints for Colon CAD SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CODE, NUM, IMAGE[1], CONTAINER, UIDREF, DATE, TIME.
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATE, TIME, PNAME, UIDREF, COMPOSITE[1].
IMAGE	HAS ACQ CONTEXT	TEXT, CODE, DATE, TIME, NUM, CONTAINER
CONTAINER, CODE, COMPOSITE, NUM	HAS CONCEPT MOD	TEXT, CODE[2].
TEXT, CODE, NUM	HAS PROPERTIES	CONTAINER, TEXT, CODE, NUM, DATE, IMAGE[1], SCOORD, SCOORD3D, UIDREF.
CODE, NUM	INFERRED FROM	CODE, NUM, IMAGE[1], SCOORD, SCOORD3D, CONTAINER, TEXT.
SCOORD	SELECTED FROM	IMAGE[1].
TCOORD	SELECTED FROM	SCOORD, SCOORD3D, IMAGE[1], WAVEFORM[1].

Note

1. Which SOP Classes the IMAGE or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).
2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.11 Macular Grid Thickness and Volume Report IOD

A.35.11.1 Macular Grid Thickness and Volume Report IOD Description

The Macular Grid Thickness and Volume Report IOD is used to represent the macular grid thickness and volume values derived from ophthalmic images.

A.35.11.2 Macular Grid Thickness and Volume Report IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.11.3 Macular Grid Thickness and Volume Report IOD Module Table

Table A.35.11-1 specifies the Modules of the Macular Grid Thickness and Volume Report IOD.

Table A.35.11-1. Macular Grid Thickness and Volume Report IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

IE	Module	Reference	Usage
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.11.3.1 Macular Grid Thickness and Volume Report IOD Content Constraints

A.35.11.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATE
UIDREF
PNAME
IMAGE
CONTAINER

A.35.11.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.11-2 specifies the relationship constraints of this IOD.

Table A.35.11-2. Relationship Content Constraints for Macular Grid Thickness and Volume Report IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	HAS OBS CONTEXT	CODE, PNAME, TEXT, UIDREF, DATE, NUM
CONTAINER	CONTAINS	CONTAINER, NUM, TEXT, CODE
any type	HAS CONCEPT MOD	CODE
NUM	HAS OBS CONTEXT	TEXT
NUM	INFERRED FROM	IMAGE

A.35.11.3.1.3 Template Constraints

The document shall be constructed from TID 2100 “Macular Grid Thickness and Volume Report” invoked at the root node.

A.35.12 Implantation Plan SR Document IOD

A.35.12.1 Implantation Plan SR Document IOD Description

The Implantation Plan SR Document IOD contains the results of a planning process for an individual Patient, wherein specific implant templates are selected and positioned using images of the Patient. The Implantation Plan SR Document references the implant templates, the images, and the registration SOP Instances that are used in the planning.

A.35.12.2 Implantation Plan SR Document IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.35.12.3 Implantation Plan SR Document IOD Module Table

Table A.35.12-1 specifies the Modules of the Implantation Plan SR Document IOD.

Table A.35.12-1. Implantation Plan SR Document IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.12.3.1 Implantation Plan SR Document IOD Content Constraints

A.35.12.3.1.1 Template Constraints

The document shall be constructed from TID 7000 “Implantation Plan” invoked at the root node.

Note

All Template and Context Group definitions are located in Annex A “Structured Reporting Templates (Normative)” in PS3.16 and Annex B “DCMR Context Groups (Normative)” in PS3.16, respectively.

A.35.12.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATE
UIDREF

PNAME
COMPOSITE
IMAGE
CONTAINER

A.35.12.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD may be conveyed by-value. Table A.35.12-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.12-2. Relationship Content Constraints for Implantation Plan SR Document IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, UIDREF, COMPOSITE[1], IMAGE[1], CONTAINER
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATE, UIDREF, PNAME, COMPOSITE[1]
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM, IMAGE, UIDREF, COMPOSITE	HAS PROPERTIES	TEXT, CODE, NUM, UIDREF, IMAGE[1], COMPOSITE[1]

Note

1. Which SOP Classes the IMAGE or COMPOSITE Value Type may refer to is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).
2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example, to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.13 Comprehensive 3D SR IOD

A.35.13.1 Comprehensive 3D SR IOD Description

The Comprehensive 3D SR IOD is a superset of the Comprehensive SR IOD, which specifies a class of documents, the content of which may include textual and a variety of coded information, numeric measurement values, references to the SOP Instances and 2D or 3D spatial or temporal regions of interest within such SOP Instances. Relationships by-reference are enabled between Content Items.

A.35.13.2 Comprehensive 3D SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.13.3 Comprehensive 3D SR IOD Module Table

Table A.35.13-1 specifies the Modules of the Comprehensive 3D SR IOD.

Table A.35.13-1. Comprehensive 3D SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U

IE	Module	Reference	Usage
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.13.3.1 Comprehensive 3D SR IOD Content Constraints

A.35.13.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
TIME
UIDREF
PNAME
SCOORD
SCOORD3D
TCOORD
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.13.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD may be conveyed either by-value or by-reference. Table A.35.13-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.13-2. Relationship Content Constraints for Comprehensive 3D SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, SCOORD, SCOORD3D, TCOORD, COMPOSITE[1], IMAGE[1], WAVEFORM[1], CONTAINER (see below).
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, COMPOSITE[1]
CONTAINER, IMAGE[1], WAVEFORM[1], COMPOSITE[1], NUM	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, SCOORD3D, TCOORD, CONTAINER

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, TIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, DATE, TIME, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], SCOORD, SCOORD3D, TCOORD, CONTAINER
SCOORD	SELECTED FROM	IMAGE[1]
TCOORD	SELECTED FROM	SCOORD, SCOORD3D, IMAGE[1], WAVEFORM[1]

Note

1. Which SOP Classes the IMAGE, WAVEFORM or COMPOSITE Value Type may refer to, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).
2. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.
3. SCOORD3D has no children, since its coordinates are patient rather than image-relative.

The HAS CONCEPT MOD and CONTAINS relationships shall not be conveyed by-reference.

Relationships by-reference to ancestor Content Items are forbidden in this IOD to prevent loops.

A.35.14 Radiopharmaceutical Radiation Dose SR IOD

A.35.14.1 Radiopharmaceutical Radiation Dose SR IOD Description

The Radiopharmaceutical Radiation Dose SR IOD is used to convey the exposure characteristics and dose from the administration of radiopharmaceuticals.

A.35.14.2 Radiopharmaceutical Radiation Dose SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.14.3 Radiopharmaceutical Radiation Dose SR IOD Module Table

Table A.35.14-1 specifies the Modules of the Radiopharmaceutical Radiation Dose SR IOD.

Table A.35.14-1. Radiopharmaceutical Radiation Dose SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - shall be present if system time is synchronized to an external reference. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.14.3.1 Radiopharmaceutical Radiation Dose SR IOD Content Constraints

A.35.14.3.1.1 Template

The document may be constructed from BTID 10021 “Radiopharmaceutical Radiation Dose” invoked at the root node.

A.35.14.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
UIDREF
PNAME
CONTAINER

A.35.14.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed by-value. Table A.35.14-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.14-2. Relationship Content Constraints for Radiopharmaceutical Radiation Dose SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
TEXT, CODE, NUM	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME
CONTAINER	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE
TEXT, CODE, NUM, PNAME	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, UIDREF, CONTAINER

A.35.15 Extensible SR IOD

A.35.15.1 Extensible SR IOD Description

The Extensible SR IOD specifies support for all SR Content Item and relationship types currently defined and that may be added in the future.

It is designed specifically to support the possibility of future extensions, and the corresponding SOP Class defined in PS3.4 has specific behavior defined for a recipient in the presence of unrecognized or unsupported extensions.

A.35.15.2 Extensible SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.15.3 Extensible SR IOD Module Table

Table A.35.15-1 specifies the Modules of the Extensible SR IOD.

Table A.35.15-1. Extensible SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.15.3.1 Extensible SR IOD Content Constraints

A.35.15.3.1.1 Value Type

Value Type (0040,A040) in the Content Sequence (0040,A730) of the SR Document Content Module is constrained to any of the Enumerated Values defined in Section C.17.3.

A.35.15.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD may be conveyed either by-value or by-reference. Table A.35.15-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.15-2. Relationship Content Constraints for Extensible SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	any type.
any type	any type other than CONTAINS	any type.

Note

The lack of explicit constraints between value types and relationship types is necessary to support extensibility in unanticipated ways (e.g., to support new coordinate value types that may be selected from new composite object value types), but that does not mean that all possible combinations will make sense or be usable (e.g., HAS OBS CONTEXT with source and target value types of IMAGE).

Relationships by-reference to ancestor Content Items are forbidden in this IOD to prevent loops.

A.35.16 Acquisition Context SR IOD

A.35.16.1 Acquisition Context SR IOD Description

The Acquisition Context SR IOD is used to represent the description of the conditions present during data acquisition of other data that is stored separately (such as images).

A.35.16.2 Acquisition Context SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.16.3 Acquisition Context SR IOD Module Table

Table A.35.16-1 specifies the Modules of the Acquisition Context SR IOD.

Table A.35.16-1. Acquisition Context SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - Required if time synchronization was applied
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.16.3.1 Acquisition Context SR IOD Content Constraints

A.35.16.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
TIME
UIDREF
PNAME
SCOORD3D
CONTAINER

A.35.16.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.16-2 specifies the relationship constraints of this IOD.

Table A.35.16-2. Relationship Content Constraints for Acquisition Context SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	CODE, CONTAINER, DATETIME, NUM, PNAME, TEXT, TIME, UIDREF
CONTAINER	HAS OBS CONTEXT	CODE, DATE, DATETIME, NUM, PNAME, TEXT, TIME, UIDREF
CODE	HAS OBS CONTEXT	CODE
any type	HAS CONCEPT MOD	CODE, TEXT[1]
CODE	HAS PROPERTIES	CODE, DATETIME, NUM, SCOORD3D, TEXT

Note

1. The HAS CONCEPT MOD relationship is used to modify the meaning of the Concept Name of a Source Content Item, for example to provide a more descriptive explanation, a different language translation, or to define a post-coordinated concept.

A.35.16.3.1.3 Template Constraints

The document may be constructed from BTID 8101 “Preclinical Small Animal Image Acquisition Context” invoked at the root node.

Note

This IOD maybe used with other Templates defined for Acquisition Context.

A.35.17 Simplified Adult Echo SR IOD

A.35.17.1 Simplified Adult Echo SR IOD Description

The Simplified Adult Echo SR IOD is used to convey measurements collected in association with an adult echocardiography procedure.

A.35.17.2 Simplified Adult Echo SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.17.3 Simplified Adult Echo SR IOD Module Table

Table A.35.17-1 specifies the Modules of the Simplified Adult Echo SR IOD.

Table A.35.17-1. Simplified Adult Echo SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

IE	Module	Reference	Usage
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - Required if time synchronization was applied
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	Timezone	C.12.5	M
	SOP Common	C.12.1	M

A.35.17.3.1 Simplified Adult Echo SR IOD Content Constraints

A.35.17.3.1.1 Template

The document shall be constructed from TID 5300 “Simplified Echo Procedure Report” invoked at the root node.

A.35.17.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
UIDREF
PNAME
CONTAINER
IMAGE
SCOORD
WAVEFORM
TCOORD

A.35.17.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.17-2 specifies the relationship constraints of this IOD.

Table A.35.17-2. Relationship Content Constraints for Simplified Adult Echo SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
TEXT, CODE, NUM	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
CONTAINER	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	CODE, TEXT
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, UIDREF, CONTAINER, IMAGE, SCOORD, WAVEFORM, TCOORD
SCOORD	SELECTED FROM	IMAGE
TCOORD	SELECTED FROM	WAVEFORM

A.35.18 Patient Radiation Dose SR IOD

A.35.18.1 Patient Radiation Dose SR IOD Description

The Patient Radiation Dose Structured Report IOD is used to convey the information used in the calculations for estimating the radiation dose to an individual Patient. The complexity of the calculations and the precision of the resulting dose estimate will vary depending on the need.

This IOD is not intended for determining patient dose from therapeutic use of radiation in oncology settings. The therapeutic dose in oncology settings is reported by the RT Dose IOD.

A.35.18.2 Patient Radiation Dose SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. Table A.35.18-1 specifies the Modules of the Patient Radiation Dose SR IOD.

A.35.18.3 Patient Radiation Dose SR IOD Module Table

Table A.35.18-1. Patient Radiation Dose Structured Report IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	C - shall be present if system time is synchronized to an external reference. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.18.3.1 Patient Radiation Dose SR IOD Content Constraints

A.35.18.3.1.1 Template

The document shall be constructed from BTID 10030 “Patient Radiation Dose” invoked at the root node.

A.35.18.3.1.2 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
UIDREF
PNAME
COMPOSITE
IMAGE
CONTAINER

A.35.18.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed by-value. Table A.35.18-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.18-2. Relationship Content Constraints for Patient Radiation Dose SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, IMAGE, COMPOSITE, CONTAINER
CONTAINER	HAS OBS CONTEXT	DATETIME, CODE, TEXT, UIDREF, PNAME
TEXT, CODE, NUM, COMPOSITE	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, COMPOSITE
CONTAINER, IMAGE, COMPOSITE	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE
TEXT, CODE, NUM, COMPOSITE	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, UIDREF, PNAME, IMAGE, COMPOSITE, CONTAINER
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, UIDREF, IMAGE, COMPOSITE, CONTAINER

Note

The SOP Classes to which an IMAGE or COMPOSITE Value Type may refer are documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

A.35.19 Planned Imaging Agent Administration SR IOD

A.35.19.1 Planned Imaging Agent Administration SR IOD Description

The Planned Imaging Agent Administration SR IOD is the plan for administering imaging agent material to a specific patient during an imaging study.

A.35.19.2 Planned Imaging Agent Administration SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE. The Frame Reference IE is not a component of this IOD.

A.35.19.3 Planned Imaging Agent Administration SR IOD Module Table

Table A.35.19-1. Planned Imaging Agent Administration SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.19.3.1 Planned Imaging Agent Administration SR IOD Content Constraints

A.35.19.3.1.1 Template

The document shall be constructed from TID 11001 “Planned Imaging Agent Administration” invoked at the root node.

A.35.19.3.1.2 Value Type

Value Type (0040,A040) in the Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
UIDREF
PNAME
CONTAINER

A.35.19.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed by-value. Table A.35.19-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.19-2. Relationship Content Constraints for Planned Imaging Agent Administration SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, CONTAINER
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME
CONTAINER, NUM	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE[1]
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, CONTAINER
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, CONTAINER

Note

1. The HAS CONCEPT MOD relationship is used to modify the meaning of the concept name of a parent node (or Source Content Item), with a modifier or qualifier in a child (target node) to provide a more descriptive explanation, a different coded language translation, or to define a post-coordinated concept.

A.35.20 Performed Imaging Agent Administration SR IOD

A.35.20.1 Performed Imaging Agent Administration SR IOD Description

The Performed Imaging Agent Administration SR IOD describes the imaging agent delivery whether manual methods or automated power-injector devices were used. It includes a reference to the Planned Imaging Agent Administration Procedure SR SOP Instance if based on a plan.

A.35.20.2 Performed Imaging Agent Administration SR IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.20.3 Performed Imaging Agent Administration SR IOD Module Table

Table A.35.20-1. Performed Imaging Agent Administration SR IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	SR Document Series	C.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
	Enhanced General Equipment	C.7.5.2	M
Document	SR Document General	C.17.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.20.3.1 Performed Imaging Agent Administration SR IOD Content Constraints

A.35.20.3.1.1 Template

The document shall be constructed from TID 11020 “Performed Imaging Agent Administration” invoked at the root node.

A.35.20.3.1.2 Value Type

Value Type (0040,A040) in the Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
NUM
DATETIME
DATE
UIDREF
PNAME
COMPOSITE
IMAGE
WAVEFORM
CONTAINER

A.35.20.3.1.3 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed by-value. Table A.35.20-2 specifies the relationship constraints of this IOD. See Table C.17.3-8 for Relationship Type definitions.

Table A.35.20-2. Relationship Content Constraints for Performed Imaging Agent Administration SR IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, COMPOSITE[1], IMAGE[1], WAVEFORM[1], CONTAINER
TEXT, CODE, NUM, CONTAINER	HAS OBS CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, COMPOSITE[1]
CONTAINER, IMAGE[1], WAVEFORM[1], COMPOSITE[1], NUM	HAS ACQ CONTEXT	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, CONTAINER
any type	HAS CONCEPT MOD	TEXT, CODE[2]
TEXT, CODE, NUM	HAS PROPERTIES	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], CONTAINER
PNAME	HAS PROPERTIES	TEXT, CODE, DATETIME, DATE, UIDREF, PNAME
TEXT, CODE, NUM	INFERRED FROM	TEXT, CODE, NUM, DATETIME, DATE, UIDREF, PNAME, IMAGE[1], WAVEFORM[1], COMPOSITE[1], CONTAINER

Note

1. The SOP Classes to which an IMAGE or WAVEFORM or COMPOSITE Value Type may refer, is documented in the Conformance Statement for an application (see PS3.2 and PS3.4).

2. The HAS CONCEPT MOD relationship is used to modify the meaning of the concept name of a parent node (or Source Content Item), with a modifier or qualifier in a child (target node) to provide a more descriptive explanation, a different coded language translation, or to define a post-coordinated concept.

A.35.21 Rendition Selection Document IOD

A.35.21.1 Rendition Selection Document IOD Description

The Rendition Selection Document IOD associates a group of time-synchronized Flows produced for a simultaneous presentation, transported using DICOM-RTV.

A.35.21.2 Rendition Selection Document IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the SR Document IE below the Series IE.

A.35.21.3 Rendition Selection Document IOD Module Table

Table A.35.21-1 specifies the Modules of the Rendition Selection Document IOD.

Table A.35.21-1. Rendition Selection Document IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	Key Object Document Series	C.17.6.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame Of Reference	Synchronization	C.7.4.2	M
Document	Key Object Document	C.17.6.2	M
	SR Document Content	C.17.3	M
	SOP Common	C.12.1	M

A.35.21.3.1 Rendition Selection Document IOD Content Constraints

A.35.21.3.1.1 Value Type

Value Type (0040,A040) in Content Sequence (0040,A730) of the SR Document Content Module is constrained to the following Enumerated Values (see Table C.17.3-7 for Value Type definitions):

Enumerated Values:

TEXT
CODE
UIDREF
PNAME
COMPOSITE

IMAGE
WAVEFORM
CONTAINER

The IMAGE and WAVEFORM Content Items shall only include references to SOP Instance UIDs of DICOM-RTV Metadata Flows.

A.35.21.3.1.2 Relationship Constraints

Relationships between Content Items in the content of this IOD shall be conveyed in the by-value mode. See Table C.17.3-8 for Relationship Type definitions.

Note

Relationships by-reference are forbidden. Therefore, Referenced Content Item Identifier (0040,DB73) is not present in any of the Content Items within the SR Document Content Module.

Table A.35.21-2 specifies the relationship constraints of this IOD.

Table A.35.21-2. Relationship Content Constraints for Rendition Selection Document IOD

Source Value Type	Relationship Type (Enumerated Values)	Target Value Type
CONTAINER	CONTAINS	TEXT, IMAGE, WAVEFORM, COMPOSITE
CONTAINER	HAS OBS CONTEXT	TEXT, CODE, UIDREF, PNAME
CONTAINER	HAS CONCEPT MOD	CODE

A.35.21.3.1.3 Template Constraints

The document shall be constructed from TID 2010 “Key Object Selection” invoked at the root node.

A.36 Enhanced MR Information Object Definitions

A.36.1 Relationship Between Enhanced MR IODs

Figure A.36-1 illustrates the relationships between the Enhanced MR IODs described in Section A.36.

Source Image Sequence (0008,2112), Referenced Image Sequence (0008,1140) and Referenced Raw Data Sequence (0008,9121) provide references between SOP Instances.

Note

Many Attributes have names and descriptions that include the terms "pixel" and "image". Although MR spectroscopy is not pixel based, some of these "pixel" and "image" Attributes encode concepts that are still relevant for this technique. Where such Attributes appear in the MR Spectroscopy IOD, it may be helpful to consider the term "pixel" to be equivalent to a spectroscopy "voxel", and the term "image" to be equivalent to "MR Spectroscopy SOP Instance".

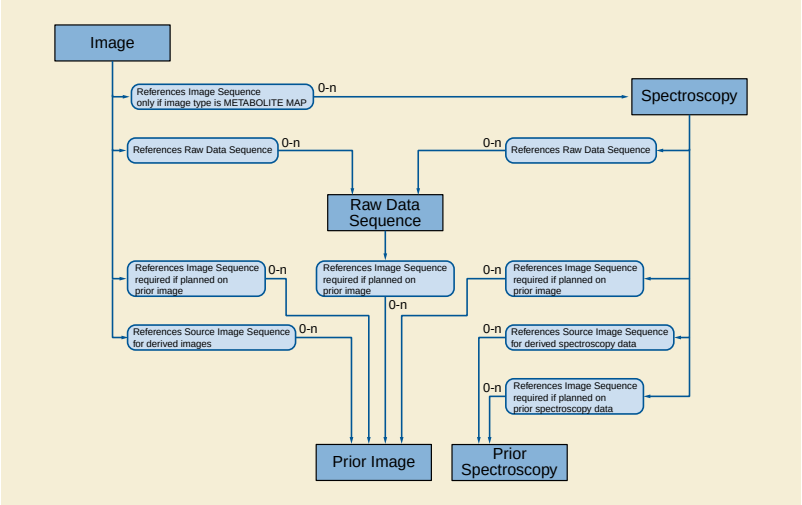


Figure A.36-1. Relationships between Enhanced MR IODs

A.36.2 Enhanced MR Image IOD

A.36.2.1 Enhanced MR Image IOD Description

The Enhanced Magnetic Resonance (MR) Image Information Object Definition (IOD) specifies an image, which has been created by a magnetic resonance device.

A.36.2.2 Enhanced MR Image Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.36.2.3 Enhanced MR Image IOD Module Table

Table A.36-1 specifies the Modules of the Enhanced MR Image IOD.

Table A.36-1. Enhanced MR Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	MR Series	C.8.13.6	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M

IE	Module	Reference	Usage
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media were applied.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Bulk Motion Synchronization	C.7.6.18.3	C - Required if bulk motion synchronization was applied.
	Supplemental Palette Color Lookup Table	C.7.6.19	C - Required if Pixel Presentation (0008,9205) in the Enhanced MR Image Module equals COLOR or MIXED.
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	Enhanced MR Image	C.8.13.1	M
	MR Pulse Sequence	C.8.13.4	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.36.2.3.1 Enhanced MR Image IOD Content Constraints

The General Image Module, Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced MR Image.

Note

1. In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

   No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

   Grayscale Softcopy Presentation State Storage Instances that are generated during acquisition may be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the MR Image and Spectroscopy Instance Macro invoked from the Enhanced MR Image Module. See Section C.8.13.2.

2. The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

3. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

The Photometric Interpretation (0028,0004) defined in Section C.8.13.1 Enhanced MR Image Module, shall be MONOCHROME2.

A.36.2.4 Enhanced MR Image Functional Group Macros

Table A.36-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced MR Image IOD.

Table A.36-2. Enhanced MR Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if the image or frame has been planned on another image or frame. May be present otherwise
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Frame Anatomy	C.7.6.16.2.8	M
Pixel Value Transformation	C.7.6.16.2.9	C - Required if Photometric Interpretation (0028,0004) is MONOCHROME2.
Frame VOI LUT	C.7.6.16.2.10	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Real World Value Mapping	C.7.6.16.2.11	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if Contrast/Bolus Agent Sequence (0018,0012) is used.
Respiratory Synchronization	C.7.6.16.2.17	C - Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Image Frame Type	C.8.13.5.1	M
MR Timing and Related Parameters	C.8.13.5.2	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR FOV/Geometry	C.8.13.5.3	C - Required if Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Echo	C.8.13.5.4	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Modifier	C.8.13.5.5	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Imaging Modifier	C.8.13.5.6	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Receive Coil	C.8.13.5.7	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Transmit Coil	C.8.13.5.8	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Functional Group Macro	Section	Usage
MR Diffusion	C.8.13.5.9	C - Required if Acquisition Contrast (0008,9209) in any MR Image Frame Type Functional Group in the SOP Instance equals DIFFUSION and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Averages	C.8.13.5.10	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Spatial Saturation	C.8.13.5.11	C - Required if Spatial Pre-saturation (0018,9027) equals SLAB for any frame in the SOP Instance and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Metabolite Map	C.8.13.5.12	C - Required if Image Type (0008,0008) Value 3 equals METABOLITE_MAP. May be present otherwise.
MR Velocity Encoding	C.8.13.5.13	C - Required if Phase Contrast (0018,9014) equals YES and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Arterial Spin Labeling	C.8.13.5.14	C - Required if Image Type (0008,0008) Value 3 is ASL. May be present otherwise.
Functional MR	C.8.13.5.15	U
Temporal Position	C.7.6.16.2.23	U

A.36.3 MR Spectroscopy IOD

A.36.3.1 MR Spectroscopy IOD Description

The Magnetic Resonance (MR) Spectroscopy Information Object Definition (IOD) specifies spectroscopic data, which has been created by a magnetic resonance device.

A.36.3.2 MR Spectroscopy Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Spectroscopy IE below the Series IE.

A.36.3.3 MR Spectroscopy IOD Module Table

Table A.36-3 specifies the Modules of the MR Spectroscopy IOD.

Table A.36-3. MR Spectroscopy IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	MR Series	C.8.13.6	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M

IE	Module	Reference	Usage
	Enhanced General Equipment	C.7.5.2	M
MR Spectroscopy	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media were applied.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Bulk Motion Synchronization	C.7.6.18.3	C - Required if bulk motion synchronization was applied.
	Acquisition Context	C.7.6.14	M
	Specimen	C.7.6.22	U
	MR Spectroscopy	C.8.14.1	M
	MR Spectroscopy Pulse Sequence	C.8.14.2	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
	MR Spectroscopy Data	C.8.14.4	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.36.3.4 MR Spectroscopy Functional Group Macros

Table A.36-4 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the MR Spectroscopy IOD.

Table A.36-4. MR Spectroscopy Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if the image or frame has been planned on another image or frame. May be present otherwise
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Frame Anatomy	C.7.6.16.2.8	M

Functional Group Macro	Section	Usage
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if Contrast/Bolus Agent Sequence (0018,0012) is used.
Respiratory Synchronization	C.7.6.16.2.17	C - Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Spectroscopy Frame Type	C.8.14.3.1	M
MR Timing and Related Parameters	C.8.13.5.2	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Spectroscopy FOV/Geometry	C.8.14.3.2	C - Required if Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Echo	C.8.13.5.4	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Modifier	C.8.13.5.5	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Receive Coil	C.8.13.5.7	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Transmit Coil	C.8.13.5.8	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Diffusion	C.8.13.5.9	C - Required if Acquisition Contrast (0008,9209) in any MR Image Frame Type Functional Group in the SOP Instance equals DIFFUSION and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Averages	C.8.13.5.10	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Spatial Saturation	C.8.13.5.11	C - Required if Spatial Pre-saturation (0018,9027) equals SLAB for any frame in the SOP Instance and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Velocity Encoding	C.8.13.5.13	C - Required if Phase Contrast (0018,9014) equals YES and Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Temporal Position	C.7.6.16.2.23	U

A.36.4 Enhanced MR Color Image IOD

A.36.4.1 Enhanced MR Color Image IOD Description

The Enhanced Magnetic Resonance (MR) Color Image Information Object Definition (IOD) specifies an image, which has been created by a magnetic resonance device.

A.36.4.2 Enhanced MR Color Image Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.36.4.3 Enhanced MR Color Image IOD Module Table

Table A.36-5 specifies the Modules of the Enhanced MR Color Image IOD.

Table A.36-5. Enhanced MR Color Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	MR Series	C.8.13.6	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media were applied.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Bulk Motion Synchronization	C.7.6.18.3	C - Required if bulk motion synchronization was applied.
	Acquisition Context	C.7.6.14	M
	Specimen	C.7.6.22	C - Required if Imaging Subject is a specimen
	Device	C.7.6.12	U
	Enhanced MR Image	C.8.13.1	M
	MR Pulse Sequence	C.8.13.4	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
	ICC Profile	C.11.15	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.36.4.3.1 Enhanced MR Color Image IOD Content Constraints

The General Image Module, Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced MR Color Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Color Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

Color Softcopy Presentation State Storage Instances that are generated during acquisition may be referenced from the Image SOP Instance by using the Referenced Presentation State Sequence in the MR Image and Spectroscopy Instance Macro invoked from the Enhanced MR Image Module. See Section C.8.13.2.

Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT for irreversible JPEG2000 Transfer Syntaxes, YBR_RCT for reversible JPEG2000 Transfer Syntaxes, YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264, HEVC/H.265 Transfer Syntaxes and YBR_FULL_422 for JPEG lossy compressed Transfer Syntaxes and YBR_FULL or RGB for RLE Transfer Syntaxes.

Note

Future lossless and lossy Transfer Syntaxes may lead to the need for new definitions and choices for Photometric Interpretation.

Pixel Presentation (0008,9205) shall be TRUE_COLOR.

A.36.4.4 Enhanced MR Color Image Functional Group Macros

Table A.36-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced MR Color Image IOD.

A.37 Raw Data IOD

A.37.1 Raw Data IOD Description

The Raw Data Information Object Definition (IOD) specifies raw data.

A.37.2 Raw Data Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Raw Data IE below the Series IE.

A.37.3 Raw Data IOD Module Table

Table A.37-1 specifies the Modules of the Raw Data IOD.

Table A.37-1. Raw Data IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
Raw Data	Acquisition Context	C.7.6.14	M
	Specimen	C.7.6.22	U
	Raw Data	C.19.1	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.38 Enhanced Computed Tomography Image IOD

A.38.1 Enhanced CT Image IOD

A.38.1.1 Enhanced CT Image IOD Description

The Enhanced Computed Tomography (CT) Image Information Object Definition (IOD) specifies an image that has been created by a computed tomography imaging device.

A.38.1.2 Enhanced CT Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.38.1.3 Enhanced CT Image IOD Module Table

Table A.38-1 specifies the Modules of the Enhanced CT Image IOD.

Table A.38-1. Enhanced CT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	CT Series	C.8.15.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M

IE	Module	Reference	Usage
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Supplemental Palette Color Lookup Table	C.7.6.19	C - Required if Pixel Presentation (0008,9205) in the Enhanced CT Image Module equals COLOR or MIXED.
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	Enhanced CT Image	C.8.15.2	M
	Enhanced Multi-energy CT Acquisition	C.8.15.4	C - Required if Multi-energy CT Acquisition (0018,9361) is YES.
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.38.1.3.1 Enhanced CT Image IOD Content Constraints

The General Image Module, Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced CT Image.

Note

1. In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

   No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

   Grayscale Softcopy Presentation State Storage Instances that are generated during acquisition may be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the Enhanced CT Image Module. See Section C.8.15.2.

2. The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

3. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

4. The Enhanced Contrast/Bolus Module will be present even if images are processed to remove contrast information from the pixels, e.g. Virtual Non-Contrast images.

A.38.1.4 Enhanced CT Image Functional Group Macros

Table A.38-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced CT Image IOD.

Table A.38-2. Enhanced CT Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if the image or frame has been planned on another image or frame, may be present otherwise.
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Frame Anatomy	C.7.6.16.2.8	M
Frame VOI LUT	C.7.6.16.2.10	U
Real World Value Mapping	C.7.6.16.2.11	C - Required if Multi-energy CT Acquisition (0018,9361) is YES. May be present otherwise.
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if Contrast/Bolus Agent Sequence (0018,0012) is used.
Respiratory Synchronization	C.7.6.16.2.17	C - Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Irradiation Event Identification	C.7.6.16.2.18	M
CT Image Frame Type	C.8.15.3.1	M
CT Acquisition Type	C.8.15.3.2	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Acquisition Details	C.8.15.3.3	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Table Dynamics	C.8.15.3.4	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Position	C.8.15.3.5	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise
CT Geometry	C.8.15.3.6	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Reconstruction	C.8.15.3.7	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE, may be present otherwise.
CT Exposure	C.8.15.3.8	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT X-Ray Details	C.8.15.3.9	C - Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED, may be present otherwise.
CT Pixel Value Transformation	C.8.15.3.10	M
CT Additional X-Ray Source	C.8.15.3.11	C - Required if the image is reconstructed from a system with multiple X-Ray sources.
Multi-energy CT Processing	C.8.15.3.13	C - Required if the image pixel data contains the results of Multi-energy material processing.
Multi-energy CT Characteristics	C.8.15.3.12	U

Functional Group Macro	Section	Usage
Temporal Position	C.7.6.16.2.23	U

For Measurement Units Code Sequence (0040,08EA) in Real World Value Mapping Sequence (0040,9096) DCID 301 “Multi-energy Material Units” shall be used.

A.39 Spatial Registration Information Object Definitions

A.39.1 Spatial Registration IOD

A.39.1.1 Spatial Registration IOD Description

The Registration IOD specifies the spatial relationship between Frames of Reference.

A.39.1.2 Spatial Registration IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Registration IE below the Series IE.

A.39.1.3 Spatial Registration IOD Module Table

Table A.39.1-1 specifies the Modules of the Spatial Registration IOD.

Table A.39.1-1. Spatial Registration IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Spatial Registration Series	C.20.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Spatial Registration	Spatial Registration	C.20.2	M
	Common Instance Reference	C.12.2	M
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.39.2 Deformable Spatial Registration IOD

A.39.2.1 Deformable Spatial Registration IOD Description

The Deformable Spatial Registration Information Object Definition (IOD) describes spatial relationships between images in one or more frames of reference via deformation grids and transformation matrices. The deformations and transformations describe to an application how to sample data from one or more *Source* RCS into the *Registered* RCS.

The *Registered* RCS is the Frame of Reference specified within an Instance of this IOD. The IOD may specify that only a subset of the entire *Source* RCS Frame of Reference is affected by the transformation, by specifying specific frames of image SOP Instances that use the *Source* Frame of Reference.

The deformation is described as a grid of offset vectors. Each grid element contains 3 values representing offset distances in the X, Y, and Z directions at the center position of the deformation grid element. The relationship between the data being deformed and the deformation grid is purely spatial. Therefore the resolution of the grid is independent of the data being deformed.

A.39.2.2 Deformable Spatial Registration IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Registration IE below the Series IE.

A.39.2.3 Deformable Spatial Registration IOD Module Table

Table A.39.2-1 specifies the Modules of the Deformable Spatial Registration IOD.

Table A.39.2-1. Deformable Spatial Registration IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Spatial Registration Series	C.20.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Spatial Registration	Deformable Spatial Registration	C.20.3	M
	Common Instance Reference	C.12.2	M
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

A.40 Spatial Fiducials IOD

A.40.1 Spatial Fiducials IOD Description

The Fiducials IOD specifies the spatial relationship between the Composite Fiducial Instance, to one or more images.

A.40.2 Spatial Fiducials IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Spatial Fiducials IE below the Series IE.

A.40.3 Spatial Fiducials IOD Module Table

Table A.40-1 specifies the Modules of the Spatial Fiducials IOD.

Table A.40-1. Spatial Fiducials IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Spatial Fiducials Series	C.21.1	M
Equipment	General Equipment	C.7.5.1	M
Spatial Fiducials	Spatial Fiducials	C.21.2	M
	Common Instance Reference	C.12.2	M
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.41 Ophthalmic Photography 8 Bit Image IOD

This Section defines an Information Object to be used with several types of ophthalmic photographic imaging devices including fundus cameras, slit lamp cameras, scanning laser devices, stereoscopic cameras, video equipment and digital photographic equipment, with 8 bit resolution per pixel in each image plane.

A.41.1 Ophthalmic Photography 8 Bit Image IOD Description

The Ophthalmic Photography 8 Bit Image IOD specifies a single-frame or a multi-frame image acquired on a digital photographic DICOM modality. This IOD can be used to encode single ophthalmic images and cine sequences.

A.41.2 Ophthalmic Photography 8 Bit Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

Note

The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.41.3 Ophthalmic Photography 8 Bit Image IOD Modules

Table A.41-1. Ophthalmic Photography 8 Bit Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M

IE	Module	Reference	Usage
	Ophthalmic Photography Series	C.8.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast was administered, see Section A.41.4.2
	Cine	C.7.6.5	C - Required if there is a sequential temporal relationship between all frames
	Multi-frame	C.7.6.6	M
	Device	C.7.6.12	U
	Acquisition Context	C.7.6.14	U
	Ophthalmic Photography Image	C.8.17.2	M
	Ocular Region Imaged	C.8.17.5	M
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M
	Ophthalmic Photographic Parameters	C.8.17.3	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.41.4 Ophthalmic Photography 8 Bit Image IOD Content Constraints

The following constraints on Series and Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.41.4.1 Bits Allocated, Bits Stored, and High Bit

For Ophthalmic Photography 8 bit images, the Enumerated Value of Bits Allocated (0028,0100) (Image Pixel Module, Section C.7.6.3) shall be 8; the Enumerated Value of Bits Stored (0028,0101) shall be 8; and the Enumerated Value of High Bit (0028,0102) shall be 7.

A.41.4.2 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012) DCID 4200 “Ophthalmic Imaging Agent” shall be used.

A.42 Ophthalmic Photography 16 Bit Image IOD

This Section defines an Information Object to be used with several types of ophthalmic photographic imaging devices including fundus cameras, slit lamp cameras, scanning laser devices, stereoscopic cameras, video equipment and digital photographic equipment, with16 bit resolution per pixel in each image plane.

A.42.1 Ophthalmic Photography 16 Bit Image IOD Description

The Ophthalmic Photography 16 Bit Image IOD specifies a single-frame or a multi-frame image acquired on a digital photographic DICOM modality. This IOD can be used to encode single ophthalmic images and other combinations including cine sequences.

A.42.2 Ophthalmic Photography 16 Bit Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

Note

The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.42.3 Ophthalmic Photography 16 Bit Image IOD Modules

Table A.42-1. Ophthalmic Photography 16 Bit Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Photography Series	C.8.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast was administered; See Section A.42.4.2
	Cine	C.7.6.5	C - Required if there is a sequential temporal relationship between all frames
	Multi-frame	C.7.6.6	M
	Device	C.7.6.12	U
	Acquisition Context	C.7.6.14	U
	Ophthalmic Photography Image	C.8.17.2	M
	Ocular Region Imaged	C.8.17.5	M
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M

IE	Module	Reference	Usage
	Ophthalmic Photographic Parameters	C.8.17.3	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.42.4 Ophthalmic Photography 16 Bit Image IOD Content Constraints

The following constraints on Series and Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.42.4.1 Bits Allocated, Bits Stored, and High Bit

For Ophthalmic Photography 16 bit images, the Enumerated Value of Bits Allocated (0028,0100) (Image Pixel Module, Section C.7.6.3) shall be 16; the Enumerated Value of Bits Stored (0028,0101) shall be 16; and the Enumerated Value of High Bit (0028,0102) shall be 15.

A.42.4.2 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012) DCID 4200 “Ophthalmic Imaging Agent” shall be used.

A.43 Stereometric Relationship IOD

A.43.1 Stereometric Relationship IOD Description

This Section defines an Information Object to be used for linking together images belonging to stereoscopic pairs. A Series IE will typically contain a single Stereometric Relationship IE that references one or more sets of stereoscopic images. Stereoscopic pairs for ophthalmic photographic imaging may include single images, multi-frame images, or cine images.

A.43.2 Stereometric Relationship IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Stereometric Relationship IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.43.3 Stereometric Relationship IOD Modules

Table A.43-1. Stereometric Relationship IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Stereometric Series	C.8.18.1	M

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
Stereometric Relationship	Stereometric Relationship	C.8.18.2	M
	Common Instance Reference	C.12.2	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.44 Hanging Protocol IOD

A.44.1 Hanging Protocol IOD Description

A Hanging Protocol entity specifies the viewing preferences of a specific user or group, for a specific type of Study (Modality, Anatomy, Laterality combination, and optionally Procedure, and/or Reason), that may be exchanged between connecting devices that claim conformance to the DICOM Standard. The Hanging Protocol contains information about the Hanging Protocol, the creator, the type of Study it addresses, the type of image sets to display, the intended display environment, and the intended layout for the screen(s).

A.44.2 Hanging Protocol IOD Entity-Relationship Model

A Hanging Protocol is not related to other Information Entities of the DICOM real-world model, as it is not associated with a specific Patient. The E-R model for the Hanging Protocol IOD is shown in Figure A.44.2-1.

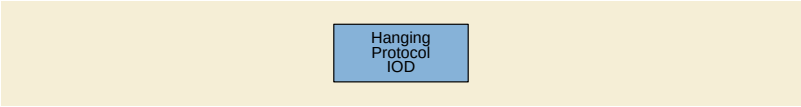


Figure A.44.2-1. Hanging Protocol IOD E-R Model

A.44.3 Hanging Protocol IOD Module Table

Table A.44.3-1 lists the Modules that make up the Hanging Protocol IOD.

Table A.44.3-1. Hanging Protocol IOD Modules

IE	Module	Reference	Usage
Hanging Protocol	SOP Common	C.12.1	M
	Hanging Protocol Definition	C.23.1	M
	Hanging Protocol Environment	C.23.2	M
	Hanging Protocol Display	C.23.3	M

A.45 Encapsulated Document IOD

A.45.1 Encapsulated PDF IOD

A.45.1.1 Encapsulated PDF IOD Description

The Encapsulated PDF Information Object Definition (IOD) describes a PDF document that has been encapsulated within a DICOM Information Object.

A.45.1.2 Encapsulated PDF Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Encapsulated Document IE below the Series IE.

A.45.1.3 Encapsulated PDF IOD Module Table

Table A.45.1-1 specifies the Encapsulated PDF IOD Modules.

Table A.45.1-1. Encapsulated PDF IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	SC Equipment	C.8.6.1	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.45.1.4 Encapsulated PDF IOD Content Constraints

A.45.1.4.1 MIME Type of Encapsulated Document

Enumerated Values:

application/pdf

A.45.2 Encapsulated CDA IOD

A.45.2.1 Encapsulated CDA IOD Description

The Encapsulated CDA Information Object Definition (IOD) describes an HL7 Clinical Document Architecture (CDA) document that has been encapsulated within a DICOM Information Object.

A.45.2.2 Encapsulated CDA Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Encapsulated Document IE below the Series IE.

A.45.2.3 Encapsulated CDA IOD Module Table

Table A.45.2-1 specifies the Encapsulated CDA IOD Modules.

Table A.45.2-1. Encapsulated CDA IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	SC Equipment	C.8.6.1	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	SOP Common	C.12.1	M

A.45.2.4 Encapsulated CDA IOD Content Constraints

Encapsulated Document (0042,0011) Attribute shall contain an HL7 CDA document of Release 2 or later. Any non-XML multimedia content shall be encoded in-line.

Enumerated Values for MIME Type of Encapsulated Document (0042,0012):

text/XML

A.46 Real World Value Mapping IOD

A.46.1 Real World Value Mapping IOD Description

The Real World Value Mapping Information Object Definition specifies a mapping of the stored pixel values of referenced images into some Real World value in defined units. This allows the capture of retrospectively determined mappings, e.g., for values that cannot be determined at the time of image acquisition and encoding.

Note

A particular use case is mapping of PET pixel values to counts, concentration, or standardized uptake values (SUVs) normalized by one of several factors.

A.46.2 Real World Value Mapping IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Real World Value Mapping IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.46.3 Real World Value Mapping IOD Modules

Table A.46-1. Real World Value Mapping IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Real World Value Mapping Series	C.25.1	M
Equipment	General Equipment	C.7.5.1	M
Real World Value Mapping	Real World Value Mapping	C.25.2	M
	Common Instance Reference	C.12.2	M

IE	Module	Reference	Usage
	SOP Common	C.12.1	M

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.47 Enhanced XA Image IOD

A.47.1 Enhanced XA Image IOD Description

This Section defines the enhanced Information Object for single plane X-Ray Angiographic Imaging that includes those Attributes and Information Objects necessary for the interchange of digital X-Ray Angiographic data. This includes images of the heart and all blood vessels.

The enhanced XA IOD is also applicable to clinical areas other than angiography (e.g., Interventional Procedures, Myelography, Biopsy/Localization, and Neurology).

Note

1. For the purpose of X-Ray Angiography (XA), this enhanced IOD can be used to encode a single-frame image, or a Cine Run, or a single multi-frame image with non-time related dimensions.

2. A typical Study might include all the images generated between the time a Patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single Study (e.g., pre-intervention CA, left ventriculography, and post-intervention CA), a Series may be defined as comprising a set of images (single or multi-frame) associated with one such process within a Study.

3. This enhanced IOD can be used to encode a single plane acquisition, or one plane of a biplane acquisition.

A.47.2 Enhanced XA Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.47.3 Enhanced XA Image IOD Module Table

Table A.47-1 specifies the Modules of the Enhanced XA Image IOD.

Table A.47-1. Enhanced XA Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	XA/XRF Series	C.8.19.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if C-arm Positioner Tabletop Relationship (0018,9474) equals YES. May be present otherwise.
	Synchronization	C.7.4.2	C - Required if C-arm Positioner Tabletop Relationship (0018,9474) equals YES. May be present otherwise.

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied and the system is able to register contrast usage.
	Mask	C.7.6.10	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Specimen	C.7.6.22	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Enhanced XA/XRF Image	C.8.19.2	M
	XA/XRF Acquisition	C.8.19.3	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
	X-Ray Image Intensifier	C.8.19.4	C - Required if X-Ray Receptor Type (0018,9420) is present and equals IMG_INTENSIFIER.
	X-Ray Detector	C.8.19.5	C - Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.
	XA/XRF Multi-frame Presentation	C.8.19.7	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.47.3.1 Enhanced XA Image IOD Content Constraints

A.47.3.1.1 Modality Attribute

Modality (0008,0060) shall have the value XA.

A.47.3.1.2 Overlay Plane, Curve, VOI LUT and Specimen Identification Modules

The Overlay Plane Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced XA Image.

Note

1. The VOI LUT function is provided by a Frame VOI LUT Functional Group.
2. The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

3. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.47.3.1.3 Positioner Type

Positioner Type (0018,1508) shall have the value CARM if the XA/XRF Acquisition Module is present.

A.47.4 Enhanced XA Image Functional Group Macros

Table A.47-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced XA Image IOD.

Table A.47-2. Enhanced XA Image Functional Group Macros

Functional Group Macro	Section	Usage
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	M
Frame VOI LUT	C.7.6.16.2.10	M
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
Pixel Intensity Relationship LUT	C.7.6.16.2.13	C - Required if Pixel Intensity Relationship (0028,1040) equals LOG. May be present otherwise.
Frame Pixel Shift	C.7.6.16.2.14	U
Patient Orientation in Frame	C.7.6.16.2.15	C - Required if C-arm Positioner Tabletop Relationship (0018,9474) is present and equals YES. May be present otherwise.
Frame Display Shutter	C.7.6.16.2.16	U
Respiratory Synchronization	C.7.6.16.2.17	U
Irradiation Event Identification	C.7.6.16.2.18	M
X-Ray Frame Characteristics	C.8.19.6.1	U
X-Ray Field of View	C.8.19.6.2	C - Required if Isocenter Reference System Sequence (0018,9462) is present. May be present otherwise.
X-Ray Exposure Control Sensing Regions	C.8.19.6.3	U
X-Ray Frame Pixel Data Properties	C.8.19.6.4	M
X-Ray Frame Detector Parameters	C.8.19.6.5	C - Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.
X-Ray Calibration Device Usage	C.8.19.6.6	U
X-Ray Object Thickness	C.8.19.6.7	U
X-Ray Frame Acquisition	C.8.19.6.8	U
X-Ray Projection Pixel Calibration	C.8.19.6.9	C - Required if C-arm Positioner Tabletop Relationship (0018,9474) is present and equals YES.
X-Ray Positioner	C.8.19.6.10	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL and C-arm Positioner Tabletop Relationship (0018,9474) is present and equals YES. May be present otherwise.

Functional Group Macro	Section	Usage
X-Ray Table Position	C.8.19.6.11	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL and C-arm Positioner Tabletop Relationship (0018,9474) is present and equals YES. May be present otherwise.
X-Ray Collimator	C.8.19.6.12	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
X-Ray Isocenter Reference System	C.8.19.6.13	U - May not be used if C-arm Positioner Tabletop Relationship (0018,9474) is not present or equals NO.
X-Ray Geometry	C.8.19.6.14	C - Required if Projection Pixel Calibration Sequence (0018,9401) is present. May be present otherwise.

A.47.4.1 Enhanced XA Image Functional Group Macros Content Constraints

A.47.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4042 “XA/XRF Anatomy Imaged” shall be used.

A.48 Enhanced XRF Image IOD

A.48.1 Enhanced XRF Image IOD Description

The focus for this Enhanced XRF IOD is to address the requirements for image transfer found in general Radiofluoroscopic applications performed on a table with a column. For applications performed on X-Ray RF acquisition systems that support a Patient-Based Coordinate System with cranial/caudal, LAO/RAO angles, etc. the enhanced XA Image IOD may be used.

Note

1. An example of a case where the enhanced XA IOD may be preferred to the enhanced RF IOD are RF acquisition system equipped with an X-Ray source and an image Receptor positioned by what is generally called a C-arm (e.g., Interventional Procedures, Myelography, Biopsy, and Neurology).
2. For the purpose of X-Ray Radiofluoroscopy, this IOD can be used to encode a single-frame image, or a cine run, or a single multi-frame image with non-time related dimensions.
3. A typical Study might include all the images generated between the time a Patient gets on and gets off the procedure table. As several separable diagnostic or therapeutic processes may occur during a single Study, a Series may be defined as comprising a set of images (single or multi-frame) associated with one such process within a Study.

A.48.2 Enhanced XRF Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.48.3 Enhanced XRF Image IOD Module Table

Table A.48-1 specifies the Modules of the Enhanced XRF Image IOD.

Table A.48-1. Enhanced XRF Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U

IE	Module	Reference	Usage
Series	General Series	C.7.3.1	M
	XA/XRF Series	C.8.19.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	U
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied and the system is able to register contrast usage.
	Mask	C.7.6.10	U
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Specimen	C.7.6.22	U
	X-Ray Tomography Acquisition	C.8.7.7	U
	X-Ray Filtration	C.8.7.10	U
	X-Ray Grid	C.8.7.11	U
	Enhanced XA/XRF Image	C.8.19.2	M
	XA/XRF Acquisition	C.8.19.3	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
	X-Ray Image Intensifier	C.8.19.4	C - Required if X-Ray Receptor Type (0018,9420) is present and equals IMG_INTENSIFIER.
	X-Ray Detector	C.8.19.5	C - Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.
	XA/XRF Multi-frame Presentation	C.8.19.7	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.48.3.1 Enhanced XRF Image IOD Content Constraints

A.48.3.1.1 Modality Attribute

Modality (0008,0060) shall have the value RF.

A.48.3.1.2 Overlay Plane, Curve, VOI LUT and Specimen Identification Modules

The Overlay Plane Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced XRF Image.

Note

1. The VOI LUT function is provided by a Frame VOI LUT Functional Group.
2. The Curve Module (Retired) was previously include in the list of Modules that shall not be present, but has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.
3. The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.48.3.1.3 Positioner Type

Positioner Type (0018,1508) shall have the value COLUMN if the XA/XRF Acquisition Module is present.

A.48.4 Enhanced XRF Image Functional Group Macros

Table A.48-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced XRF Image IOD.

Table A.48-2. Enhanced XRF Image Functional Group Macros

Functional Group Macro	Section	Usage
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	M
Frame VOI LUT	C.7.6.16.2.10	M
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
Pixel Intensity Relationship LUT	C.7.6.16.2.13	C - Required if Pixel Intensity Relationship (0028,1040) equals LOG. May be present otherwise.
Frame Pixel Shift	C.7.6.16.2.14	U
Patient Orientation in Frame	C.7.6.16.2.15	U
Frame Display Shutter	C.7.6.16.2.16	U
Respiratory Synchronization	C.7.6.16.2.17	U
Irradiation Event Identification	C.7.6.16.2.18	M
X-Ray Frame Characteristics	C.8.19.6.1	U
X-Ray Field of View	C.8.19.6.2	U
X-Ray Exposure Control Sensing Regions	C.8.19.6.3	U
X-Ray Frame Pixel Data Properties	C.8.19.6.4	M
X-Ray Frame Detector Parameters	C.8.19.6.5	C - Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.
X-Ray Calibration Device Usage	C.8.19.6.6	U

Functional Group Macro	Section	Usage
X-Ray Object Thickness	C.8.19.6.7	U
X-Ray Frame Acquisition	C.8.19.6.8	U
X-Ray Positioner	C.8.19.6.10	U
X-Ray Table Position	C.8.19.6.11	U
X-Ray Collimator	C.8.19.6.12	U
X-Ray Geometry	C.8.19.6.14	U

A.48.4.1 Enhanced XRF Image Functional Group Macros Content Constraints

A.48.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4042 “XA/XRF Anatomy Imaged” shall be used.

A.49 RT Ion Plan IOD

A.49.1 RT Ion Plan IOD Description

The focus for this Radiotherapy Ion Plan IOD (RT Ion Plan IOD) is to address the requirements for transfer of treatment plans generated by manual entry, a virtual simulation system, or a treatment planning system before or during a course of Ion therapy treatment. Such plans may contain fractionation information, and define Ion beams.

A.49.2 RT Ion Plan IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Plan IE below the Series IE.

A.49.3 RT Ion Plan IOD Modules

Table A.49-1 identifies and defines the Modules that comprise this IOD. Modules listed are either mandatory or optional as specified in PS3.4. Mandatory Modules contain Attributes that are included in all SOP Instances employing this IOD.

Table A.49-1. RT Ion Plan IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
Plan	RT General Plan	C.8.8.9	M
	RT Prescription	C.8.8.10	U
	RT Ion Tolerance Tables	C.8.8.24	U
	RT Patient Setup	C.8.8.12	U
	RT Fraction Scheme	C.8.8.13	U

IE	Module	Reference	Usage
	RT Ion Beams	C.8.8.25	C - Required if RT Fraction Scheme Module is included and Number of Beams (300A,0080) is greater than zero for one or more fraction groups
	Approval	C.8.8.16	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.50 RT Ion Beams Treatment Record IOD

A.50.1 RT Ion Beams Treatment Record IOD Description

The Radiotherapy Ion Beams Treatment Record IOD (RT Ion Beams Treatment Record IOD) addresses the requirements for transfer of treatment session reports generated by a treatment verification system during a course of Ion beam treatment, with optional cumulative summary information. It may also be used for transfer of treatment information during delivery.

A.50.2 RT Ion Beams Treatment Record IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Treatment Record IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.50.3 RT Ion Beams Treatment Record IOD Modules

Table A.50-1 identifies and defines the Modules that comprise this IOD. Modules listed are either mandatory or optional as specified in PS3.4. Mandatory Modules contain Attributes that are included in all SOP Instances employing this IOD.

Table A.50-1. RT Ion Beams Treatment Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Clinical Trial Study	C.7.2.3	U
	Patient Study	C.7.2.2	U
Series	RT Series	C.8.8.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Treatment Record	RT General Treatment Record	C.8.8.17	M
	RT Patient Setup	C.8.8.12	U
	RT Treatment Machine Record	C.8.8.18	M
	Measured Dose Reference Record	C.8.8.19	U
	Calculated Dose Reference Record	C.8.8.20	U
	RT Ion Beams Session Record	C.8.8.26	M
	RT Treatment Summary Record	C.8.8.23	U
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

IE	Module	Reference	Usage
	Common Instance Reference	C.12.2	U

A.51 Segmentation IOD

A.51.1 Segmentation IOD Description

The Segmentation Information Object Definition (IOD) specifies a multi-frame image representing a classification of pixels in one or more referenced images. Segmentations are either binary or fractional. If the referenced images have a defined Frame of Reference, the Segmentation Instance shall have the same Frame of Reference and is not required to have the same spatial sampling or extent as the referenced images. If the referenced image does not have a defined Frame of Reference, the Segmentation Instance shall have the same spatial sampling and extent as the referenced image.

The Segmentation IOD does not include the full set of acquisition parameters of the referenced images, e.g., cardiac phase. An application rendering or processing the segmentation may need to access the referenced images for such information.

A.51.2 Segmentation IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.51.3 Segmentation IOD Module Table

Table A.51-1 specifies the Modules of the Segmentation IOD.

Table A.51-1. Segmentation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Segmentation Series	C.8.20.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present. May be present otherwise.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Segmentation Image	C.8.20.2	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Specimen	C.7.6.22	U
	Common Instance Reference	C.12.2	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is present.

IE	Module	Reference	Usage
	SOP Common	C.12.1	M
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

Note

The Specimen Identification Module was previously included in this IOD but has been retired, and its functionality replaced by the Specimen Module. See PS3.3-2008.

A.51.4 Segmentation IOD Content Constraints

The VOI LUT Module shall not be present.

The Modality LUT Module shall not be present.

The Overlay Plane Module shall not be present.

Pixel Padding Value (0028,0120) shall not be present.

For Purpose of Reference Code Sequence (0040,A170) within Source Instance Sequence (0042,0013) in the General Reference Module DCID 7019 “Segmentation Non-Image Source Purposes of Reference” shall be used.

A.51.5 Segmentation Functional Groups

Table A.51-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Segmentation IOD.

Table A.51-2. Segmentation Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present and the Frame of Reference is defined in the patient-relative Reference Coordinate System. May be present otherwise if the Frame of Reference is defined in the patient-relative Reference Coordinate System. See Section A.51.5.1
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present and the Frame of Reference is defined in the patient-relative Reference Coordinate System. May be present otherwise if the Frame of Reference is defined in the patient-relative Reference Coordinate System. See Section A.51.5.1
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present. May be present otherwise. See Section A.51.5.1
Plane Position (Slide)	C.8.12.6.1	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present and the Frame of Reference is defined in the Slide Coordinate System and Dimension Organization Type (0020,9311) is not TILED_FULL. May be present otherwise if the Frame of Reference is defined in the Slide Coordinate System. See Section A.51.5.1.
Derivation Image	C.7.6.16.2.6	C - Required if Pixel Measures (C.7.6.16.2.1) or either Plane Position (Patient) (C.7.6.16.2.3) or Plane Orientation (Patient) (C.7.6.16.2.4) (if the Frame of Reference is defined in the patient-relative Reference Coordinate System), or Plane Position (Slide) (C.8.12.6.1) (if the Frame of Reference is defined in the Slide Coordinate System) Functional Groups are not present. May be present otherwise. See Section A.51.5.1
Frame Content	C.7.6.16.2.2	M
Segmentation	C.8.20.3.1	M

A.51.5.1 Segmentation Functional Groups Description

When a Frame of Reference UID is present the segment shall be specified within that coordinate system, using the Pixel Measures and either the Plane Position (Patient) and Plane Orientation (Patient), or the Plane Position (Slide) Functional Groups. Since this defines the spatial relationship of the segment, the size of the segmentation frames need not be the same size, or resolution, as the image data used to generate the segment data. The Derivation Image Functional Group may also be present, to specify on which images the segmentation was actually performed (since there may be others in the same Frame of Reference that are spatially co-located, but were not used to perform the segmentation).

If the Frame of Reference UID is not present, each pixel of the segmentation shall correspond to a pixel in a referenced image, using the Derivation Image Functional Group. Hence, the rows and columns of each referenced image will match the segmentation image. If both the Frame of Reference UID and the Derivation Image Functional Group are present, the segmentation and referenced image pixels need not correspond.

The value of Purpose of Reference Code Sequence (0040,A170) in the Derivation Image Functional Group Macro shall be (121322, DCM, "Source Image for Image Processing Operation"). The value of Derivation Code Sequence (0008,9215) shall be (113076, DCM, "Segmentation").

Note

Non-image source Instances used during segmentation, such as real world value maps, can be described in the top level Data Set in the Source Instance Sequence (0042,0013) of the General Reference Module and are implied to have been used for the derivation of all frames. I.e., there is no mechanism for selectively specifying on a per-frame basis which non-Image Instances were used. Real World Value Map Instances already contain a means of selectively applying different scale factors to different frames.

A.52 Ophthalmic Tomography Image IOD

This Section defines an Information Object to be used with optical ophthalmic tomographic imaging devices, including optical coherence scanners and confocal scanning laser ophthalmoscopes, but excluding ophthalmic ultrasound devices.

A.52.1 Ophthalmic Tomography Image IOD Description

The Ophthalmic Tomography Image IOD specifies a single-frame or a multi-frame image acquired on an Ophthalmic Tomography modality. This IOD can be used to encode both single and multi-frame ophthalmic images.

A.52.2 Ophthalmic Tomography Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.52.3 Ophthalmic Tomography Image IOD Modules

Table A.52.3-1. Ophthalmic Tomography Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Ophthalmic Tomography Series	C.8.17.6	M

IE	Module	Reference	Usage
Frame of Reference	Frame of Reference	C.7.4.1	C - Required if Ophthalmic Photography Reference Image available or if Ophthalmic Volumetric Properties Flag (0022,1622) is YES. May be present otherwise.
	Synchronization	C.7.4.2	C - Required if Ophthalmic Photography Reference Image available
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast was administered
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Acquisition Context	C.7.6.14	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was used
	Ophthalmic Tomography Image	C.8.17.7	M
	Ophthalmic Tomography Acquisition Parameters	C.8.17.8	M
	Ophthalmic Tomography Parameters	C.8.17.9	M
	Ocular Region Imaged	C.8.17.5	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.52.4 Ophthalmic Tomography Image IOD Content Constraints

The following constraints on Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.52.4.1 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012), the Defined Context Group is 4200.

A.52.4.2 Overlay Plane Module and VOI LUT Module

The Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Ophthalmic Tomography Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance may be used.

Pseudo-color presentation information may be applied through the use of separate Pseudo-color Softcopy Presentation State SOP Instances.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself and implementers are discouraged from using private extensions to circumvent this restriction.

A.52.4.3 Ophthalmic Tomography Image Functional Group Macros

Table A.52.4.3-1 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Ophthalmic Tomography Image IOD.

Table A.52.4.3-1. Ophthalmic Tomography Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	C - Required if no Ophthalmic Photography Reference Image is available or if Ophthalmic Volumetric Properties Flag (0022,1622) is YES; May be present otherwise
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if no Ophthalmic Photography Reference Image is available or if Ophthalmic Volumetric Properties Flag (0022,1622) is YES; May be present otherwise
Referenced Image	C.7.6.16.2.5	C - Required if Ophthalmic Photography Reference Image is available.
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Frame Anatomy	C.7.6.16.2.8	M
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE. May be present otherwise.
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if Contrast/Bolus Agent Sequence (0018,0012) is used. May not be used as a Shared Functional Group
Ophthalmic Frame Location	C.8.17.10.1	U

A.53 X-Ray 3D Angiographic Image IOD

A.53.1 X-Ray 3D Angiographic Image IOD Description

This Section defines the Information Object for multi-dimensional reconstructed cone beam X-Ray Angiographic Images and includes those Attributes and Information Objects necessary for the interchange of Multi-dimensional X-Ray volumes.

Examples of X-Ray 3D Angiographic Images are: 3D reconstruction of static vascular structures (e.g., in Neuro-Radiology), ECG triggered cardiac volumes at different phases in the cardiac cycle, coronary artery tree reconstructions.

A.53.2 X-Ray 3D Angiographic Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.53.3 X-Ray 3D Angiographic Image IOD Module Table

Table A.53-1. X-Ray 3D Angiographic Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M

IE	Module	Reference	Usage
	Clinical Trial Series	C.7.3.2	U
	Enhanced Series	C.7.3.3	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied.
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Patient Orientation	C.7.6.20	U
	Image - Equipment Coordinate Relationship	C.7.6.21	U
	Specimen	C.7.6.22	U
	X-Ray 3D Image	C.8.21.1	M
	X-Ray 3D Angiographic Image Contributing Sources	C.8.21.2.1	U
	X-Ray 3D Angiographic Acquisition	C.8.21.3.2	U
	X-Ray 3D Reconstruction	C.8.21.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.53.3.1 X-Ray 3D Angiographic Image IOD Content Constraints

A.53.3.1.1 Modality Attribute

Modality (0008,0060) shall have the value XA.

A.53.3.1.2 Restrictions for Standard Extended SOP Classes

The Overlay Plane Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the X-Ray 3D Angiographic Image.

Note

1. The VOI LUT function is provided by a Frame VOI LUT Functional Group.
2. The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.53.3.1.3 Image - Equipment Coordinate Relationship Module

For X-Ray 3D Angiographic Images created from SOP Instances of the Enhanced XA SOP Class (1.2.840.10008.5.1.4.1.1.12.1.1) the isocenter coordinate system is used to describe the positioning of the table and positioner (see Section C.8.19.6.13), and shall use only the Defined Term ISOCENTER for Equipment Coordinate System Identification (0028,9537).

A.53.4 X-Ray 3D Angiographic Image Functional Group Macros

Table A.53-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the X-Ray 3D Angiographic Image IOD.

Table A.53-2. X-Ray 3D Angiographic Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if Image Type (0008,0008) Value 1 equals DERIVED.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	M
Pixel Value Transformation	C.7.6.16.2.9	U
Frame VOI LUT	C.7.6.16.2.10	M
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
Respiratory Synchronization	C.7.6.16.2.17	U
X-Ray 3D Frame Type	C.8.21.5.1	M

A.53.4.1 X-Ray 3D Angiographic Image Functional Group Macros Content Constraints

A.53.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4042 “XA/XRF Anatomy Imaged” shall be used.

A.54 X-Ray 3D Craniofacial Image IOD

A.54.1 X-Ray 3D Craniofacial Image IOD Description

This Section defines the Information Object for multi-dimensional reconstructed cone beam X-Ray Craniofacial Images and includes those Attributes and Information Objects necessary for the interchange of Multi-dimensional X-Ray volumes.

Examples of X-Ray 3D Craniofacial Images are: 3D reconstruction of craniofacial structures for surgical placement of implants, dimensional analysis for orthodontic therapy and evaluation of craniofacial pathology.

A.54.2 X-Ray 3D Craniofacial Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.54.3 X-Ray 3D Craniofacial Image IOD Module Table

Table A.54-1 specifies the Modules of the X-Ray 3D Craniofacial Image IOD.

Table A.54-1. X-Ray 3D Craniofacial Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced Series	C.7.3.3	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied.
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Patient Orientation	C.7.6.20	U
	Image - Equipment Coordinate Relationship	C.7.6.21	U
	Specimen	C.7.6.22	U
	X-Ray 3D Image	C.8.21.1	M
	X-Ray 3D Craniofacial Image Contributing Sources	C.8.21.2.2	U
	X-Ray 3D Craniofacial Acquisition	C.8.21.3.3	U
	X-Ray 3D Reconstruction	C.8.21.4	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.54.3.1 X-Ray 3D Craniofacial Image IOD Content Constraints

A.54.3.1.1 Modality Attribute

Modality (0008,0060) shall have the value DX.

A.54.3.1.2 Restrictions for Standard Extended SOP Classes

The Overlay Plane Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the X-Ray 3D Craniofacial Image.

Note

1. The VOI LUT function is provided by a Frame VOI LUT Functional Group.
2. The Curve Module (Retired) was previously included in the Image IE for this IOD but has been retired. See PS3.3-2004.

A.54.4 X-Ray 3D Craniofacial Image Functional Group Macros

Table A.54-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the X-Ray 3D Craniofacial Image IOD.

Table A.54-2. X-Ray 3D Craniofacial Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M- May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if Image Type (0008,0008) Value 1 equals DERIVED.
Frame Anatomy	C.7.6.16.2.8	M
Pixel Value Transformation	C.7.6.16.2.9	U
Frame VOI LUT	C.7.6.16.2.10	M
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
X-Ray 3D Frame Type	C.8.21.5.1	M

A.54.4.1 X-Ray 3D Craniofacial Image Functional Group Macros Content Constraints

A.54.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4028 “Craniofacial Anatomic Regions” or DCID 4016 “Anatomic Region for Intra-oral Radiography” shall be used.

In the case of CID 4016 “Anatomic Region for Intra-oral Radiography”, for Anatomic Region Modifier Sequence (0008,2220), if present, DCID 4017 “Anatomic Region Modifier for Intra-oral Radiography” shall be used, and for Primary Anatomic Structure Sequence (0008,2228), if present, DCID 4026 “Primary Anatomic Structure for Intra-oral and Craniofacial Radiography - Teeth” shall be used.

A.55 Breast Tomosynthesis Image IOD

A.55.1 Breast Tomosynthesis Image IOD Description

This Section defines the Information Object for multi-dimensional reconstructed breast tomosynthesis X-Ray Images that includes those Attributes and Information Objects necessary for the interchange of multi-dimensional breast tomosynthesis X-Ray volumes.

Note

This IOD is not intended for interchange of source projection X-Ray images.

A.55.2 Breast Tomosynthesis Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.55.3 Breast Tomosynthesis Image IOD Module Table

Table A.55-1 specifies the Modules of the Breast Tomosynthesis Image IOD.

Table A.55-1. Breast Tomosynthesis Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced Mammography Series	C.8.11.10	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied.
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Image - Equipment Coordinate Relationship	C.7.6.21	U
	Specimen	C.7.6.22	U
	X-Ray 3D Image	C.8.21.1	M
	Breast Tomosynthesis Contributing Sources	C.8.21.2.3	U
	Breast Tomosynthesis Acquisition	C.8.21.3.4	U
	X-Ray 3D Reconstruction	C.8.21.4	U
	Breast View	C.8.21.6	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.55.3.1 Breast Tomosynthesis Image IOD Content Constraints

A.55.3.1.1 Restrictions for Standard Extended SOP Classes

The Overlay Plane Module, Modality LUT Module, VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Breast Tomosynthesis Image.

Note

The VOI LUT function is provided by a Frame VOI LUT Functional Group.

A.55.3.1.2 Image - Equipment Coordinate Relationship Module

For Breast Tomosynthesis Image SOP Instances created from SOP Instances of the Breast Projection X-Ray Image SOP Classes (1.2.840.10008.5.1.4.1.1.13.1.4 or 1.2.840.10008.5.1.4.1.1.13.1.5) the isocenter coordinate system shall be used to describe the positioning of the X-Ray Source, Detector and Breast Support (see Section C.8.31.6), and shall use only the value ISOCENTER for Equipment Coordinate System Identification (0028,9537).

A.55.4 Breast Tomosynthesis Image Functional Group Macros

Table A.55-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Breast Tomosynthesis Image IOD.

Table A.55-2. Breast Tomosynthesis Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if Image Type (0008,0008) Value 1 equals DERIVED.
Frame Anatomy	C.7.6.16.2.8	M
Identity Pixel Value Transformation	C.7.6.16.2.9b	M
Frame VOI LUT With LUT	C.7.6.16.2.10b	M
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
X-Ray 3D Frame Type	C.8.21.5.1	M - May not be used as a Shared Functional Group.
Breast Biopsy Target	C.8.21.5.2	U – May not be used as a Shared Functional Group.

A.55.4.1 Breast Tomosynthesis Image Functional Group Macros Content Constraints

A.55.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4013 “Anatomic Region for Mammography” shall be used.

A.56 Enhanced PET Image IOD

A.56.1 Enhanced PET Image IOD Description

The Enhanced Positron Emission Tomography (PET) Image Information Object Definition (IOD) specifies an image that has been created by a positron emission tomography coincidence imaging device.

A.56.2 Enhanced PET Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.56.3 Enhanced PET Image IOD Module Table

Table A.56-1 specifies the Modules of the Enhanced PET Image IOD.

Table A.56-1. Enhanced PET Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Enhanced PET Series	C.8.22.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Specimen	C.7.6.22	U
	Enhanced PET Isotope	C.8.22.4	M
	Enhanced PET Acquisition	C.8.22.2	M
	Enhanced PET Image	C.8.22.3	M
	Enhanced PET Corrections	C.8.22.6	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

IE	Module	Reference	Usage
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.56.3.1 Enhanced PET Image IOD Content Constraints

Modality (0008,0060) shall have the value PT.

The General Image Module, Overlay Plane Module, VOI LUT Module, Supplemental Palette Color Lookup Table Module, and the Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Enhanced PET Image.

Note

1. In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage, Color Softcopy Presentation State Storage, or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

2. No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

3. The Blending Softcopy Presentation State and Spatial Registration SOP Classes can be used to relate this SOP Instance to related image, registration, or fiducial SOP Instances.

4. If contrast was administered during a CT acquisition used for attenuation correction, this information can be obtained from the CT SOP Instances and is not encoded in the PET SOP Instances.

A.56.4 Enhanced PET Image Functional Group Macros

Table A.56-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced PET Image IOD.

Table A.56-2. Enhanced PET Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if the image or frame has been planned on another image or frame, may be present otherwise.
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Frame Anatomy	C.7.6.16.2.8	M
Pixel Value Transformation	C.7.6.16.2.9	M
Frame VOI LUT	C.7.6.16.2.10	M
Real World Value Mapping	C.7.6.16.2.11	M
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE. May be present otherwise.
Respiratory Synchronization	C.7.6.16.2.17	C - Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE. May be present otherwise.
Radiopharmaceutical Usage	C.7.6.16.2.19	M

Functional Group Macro	Section	Usage
Patient Physiological State	C.7.6.16.2.20	C - Required for cardiac rest and stress images.
PET Frame Type	C.8.22.5.1	M
PET Frame Acquisition	C.8.22.5.2	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
PET Detector Motion Details	C.8.22.5.3	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL and Type of Detector Motion (0054,0202) is not equal to STATIONARY.
PET Position	C.8.22.5.4	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
PET Frame Correction Factors	C.8.22.5.5	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
PET Reconstruction	C.8.22.5.6	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise.
PET Table Dynamics	C.8.22.5.7	C - Required if Image Type (0008,0008) Value 1 equals ORIGINAL and Table Motion (0018,1134) is equal to DYNAMIC.

For Measurement Units Code Sequence in the Real World Value Mapping Macro DCID 84 “PET Units” shall be used.

A.56.5 Acquisition Context Module

For Acquisition Context Sequence (0040,0555) DTID 3471 “PET Covariates Acquisition Context”, which includes the blood glucose measurement, shall be used. In contrast to the PET Image IOD, the description of the cardiovascular rest or stress state is encoded in the Enhanced PET Image IOD using the Patient Physiological State Functional Group Macro, rather than the Acquisition Context.

The Acquisition Context information may be entered during acquisition, or obtained from the Modality Worklist using information supplied in the Protocol Context, BTID 15101 “NM/PET Protocol Context”.

A.57 Surface Segmentation IOD

A.57.1 Surface Segmentation IOD Description

The Surface Segmentation Information Object Definition (IOD) specifies a polygonal representation of a three dimensional surface. A Surface Segmentation SOP Instance may reference an externally defined coordinate system via the Frame of Reference UID (0020,0052) or establish its own coordinate system.

The Surface Segmentation IOD does not include the full set of acquisition parameters of the referenced images, e.g., cardiac phase. An application rendering or processing the segmentation may need to access the referenced images for such information.

One Segmented Surface Instance can contain one or more surfaces. Each surface within a Segmented Surface IE is represented as a single object.

A.57.2 Surface Segmentation IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Surface IE below the Series IE.

A.57.3 Surface Segmentation IOD Module Table

Table A.57-1 specifies the Modules of the Surface Segmentation IOD.

Table A.57-1. Surface Segmentation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

IE	Module	Reference	Usage
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Segmentation Series	C.8.20.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Surface	Surface Segmentation	C.8.23.1	M
	Surface Mesh	C.27.1	M
	Common Instance Reference	C.12.2	C - Required if the surface has been derived from another SOP Instance
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

A.57.4 Surface Segmentation IOD Content Constraints

For Purpose of Reference Code Sequence (0040,A170) within Source Instance Sequence (0042,0013) in the General Reference Module DCID 7019 “Segmentation Non-Image Source Purposes of Reference” shall be used.

A.58 Color Palette IOD

A.58.1 Color Palette IOD Description

A Color Palette entity specifies a color palette suitable for application to a grayscale image or parametric map.

A.58.2 Color Palette IOD Entity-Relationship Model

A Color Palette is not related to other Information Entities of the DICOM real-world model, as it is not associated with a specific Patient. The E-R model for the Color Palette IOD is shown in Figure A.58.2-1.

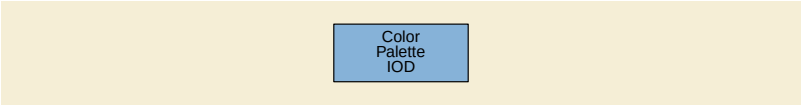


Figure A.58.2-1. Color Palette IOD E-R Model

A.58.3 Color Palette IOD Module Table

Table A.58.3-1 lists the Modules that make up the Color Palette IOD.

Table A.58.3-1. Color Palette IOD Modules

IE	Module	Reference	Usage
Color Palette	SOP Common	C.12.1	M
	Color Palette Definition	C.28.1	M

IE	Module	Reference	Usage
	Palette Color Lookup Table	C.7.9	M
	ICC Profile	C.11.15	M

Note

The number of bits for each entry in the Lookup Table Data is constrained in the Palette Color Lookup Table Module to be 8 in this IOD.

A.59 Enhanced US Volume IOD

A.59.1 Enhanced US Volume IOD Description

Image objects of different types may be created from a 3D Ultrasound image acquisition, illustrated in Figure A.59-1. It can be seen that there are two different types of data related to 3D image acquisition: 3D volume data and several kinds of 2D image derived from the volume data.

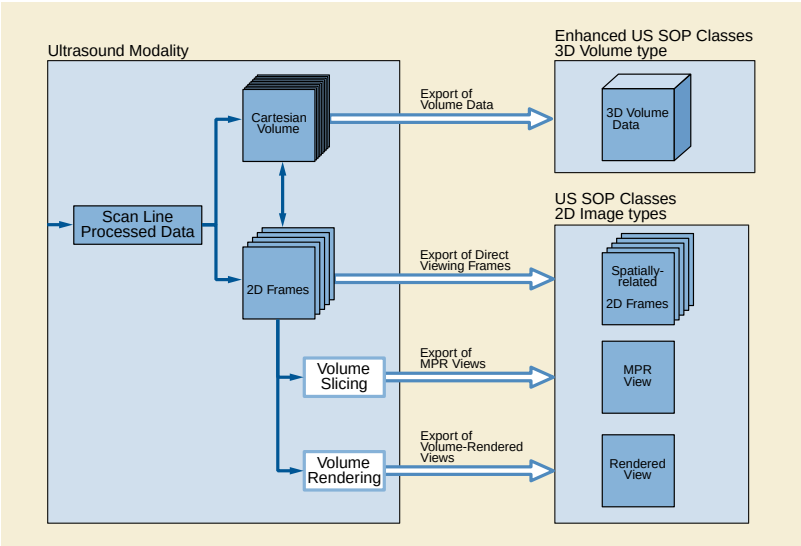


Figure A.59-1. Types of 3D Ultrasound Source and Derived Images (Informative)

The 3D volume data (the diagonally shaded box in Figure A.59-1) contains a Cartesian volume or two or more temporally related Cartesian volumes. 3D volume data is exchanged using the Enhanced US Volume SOP Class, and are suitable for subsequent Multi-Planar Reconstruction and rendering operations. Within each Enhanced US Volume Instance, each Cartesian volume consists of a set of parallel planes, and each plane consists of one or more frames each of a single data type. All Cartesian volumes have the same spacing between adjacent planes.

Most acquisition devices construct the Cartesian volume by resampling data from a different acquisition geometry. The method of generation of the Cartesian volume, its relationship to spatially-related 2D frames (whether the volume was created from spatially-related frames, or spatially-related frames extracted from the Cartesian volume), and the algorithms used for Multi-Planar Reconstruction and rendering operations are outside the scope of this Standard.

The 2D image types represent collections of frames that are derived from the volume data, namely 3D rendered views (projections), separate Multi-Planar Reconstructed (MPR) views, or collections of spatially-related source frames, either parallel or oblique (the cross-hatched boxes in Figure A.59-1). The Ultrasound Image and Ultrasound Multi-frame Image IODs are used to represent these derived images. See Section A.6 for the Ultrasound Image IOD description or Section A.7 for the Ultrasound Multi-frame Image IOD description.

Note

See Annex PP “3D Ultrasound Volumes (Informative)” in PS3.17 for an informative discussion on the use of these objects for the exchange of 3D ultrasound volume data.

A.59.2 Enhanced US Volume IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.59.3 Enhanced US Volume IOD Module Table

Table A.59-1 specifies the Modules of the Enhanced US Volume IOD.

Table A.59-1. Enhanced US Volume IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Enhanced US Series	C.8.24.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Ultrasound Frame of Reference	C.8.24.2	M
	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied. See Section A.59.3.1.2 for baseline context group ID.
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was applied.
	Respiratory Synchronization	C.7.6.18.2	C - Required if respiratory synchronization was applied.
	Device	C.7.6.12	U
	Acquisition Context	C.7.6.14	M
	Specimen	C.7.6.22	U
	Enhanced Palette Color Lookup Table	C.7.6.23	U
	Enhanced US Image	C.8.24.3	M
	IVUS Image	C.8.24.4	C - Required if Modality = IVUS
	Excluded Intervals	C.8.24.5	U

IE	Module	Reference	Usage
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.59.3.1 Enhanced US Volume IOD Content Constraints

A.59.3.1.1 Associated Physiological Waveforms

The Acquisition Time Synchronized (0018,1800) Attribute shall have a value of 'Y' if associated physiological waveforms are linked to the Enhanced US Volume. As described in the Synchronization Module, the same value of Synchronization Frame of Reference UID (0020,0200) is shared between the Waveform and Enhanced US Instances to indicate a common temporal Frame of Reference for Acquisition DateTime (0008,002A) values in the waveform and Enhanced US Instances. Further, Frame Reference DateTime (0018,9151) may be used in optimizing alignment between the displayed image and displayed physiological waveforms.

In the case of gated acquisition in which information from multiple events (such as ECG beats) are used to create sub-volumes that are "spliced" or "interleaved" together to form the volume data, the Excluded Intervals Module describes the timing of each of the constituent sub-volumes for correlation with the physio waveform.

Note

It is recommended that the Waveform Annotation Module in the General ECG Waveform IOD be used to indicate the times of the R-wave events within the acquisition duration. This allows the viewing application to be able to mark those R-R intervals that contributed to the acquisition of the Enhanced US Volume.

A.59.3.1.2 Contrast

For Contrast/Bolus Agent Sequence (0018,0012) in the Enhanced Contrast/Bolus Module BCID 12030 “Ultrasound Contrast/Bolus Agents” may be used.

A.59.4 Enhanced US Volume Functional Group Macros

Table A.59-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Enhanced US Volume IOD.

Table A.59-2. Enhanced US Volume Functional Group Macros

Functional Group Macro	Section	Usage
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Pixel Measures	C.7.6.16.2.1	M
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Ultrasound Acquisition Geometry (0020,9307) has a value of PATIENT. May be present otherwise. See Section A.59.4.1.2.
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Ultrasound Acquisition Geometry (0020,9307) has a value of PATIENT. May be present otherwise. See Section A.59.4.1.2.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization is used
Frame VOI LUT	C.7.6.16.2.10	M

Functional Group Macro	Section	Usage
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
Patient Orientation in Frame	C.7.6.16.2.15	U
Frame Display Shutter	C.7.6.16.2.16	U
Respiratory Synchronization	C.7.6.16.2.17	C - Required if Respiratory Synchronization is used
Plane Position (Volume)	C.7.6.16.2.21	M - May not be used as a Shared Functional Group. See Section A.59.4.1.2.
Plane Orientation (Volume)	C.7.6.16.2.22	M - May not be used as a Per-Frame Functional Group. See Section A.59.4.1.2.
Temporal Position	C.7.6.16.2.23	C - Required if frames are temporally related and not temporally referenced to a Cardiac or Respiratory event
Image Data Type	C.7.6.16.2.24	M
US Image Description	C.8.24.6.1	M - May not be used as a Per-Frame Functional Group

A.59.4.1 Enhanced US Volume Functional Group Macros Content Constraints

A.59.4.1.1 US Image Description Macro

The value of Volumetric Properties (0008,9206) shall be VOLUME. The value of Volume Based Calculation Technique (0008,9207) shall be NONE.

A.59.4.1.2 Plane Position (Volume) and Plane Orientation (Volume) Macros

Image Position (Volume) (0020,9301) first value (X) shall be zero and second value (Y) shall be zero. Image Orientation (Volume) (0020,9302) values shall be 1\0\0\0\1\0. This ensures that the origins of each frame lies on the Volume Frame of Reference Z_V axis, the rows of each frame are parallel to the Volume Frame of Reference X_V axis, and the columns of each frame are parallel to the Volume Frame of Reference Y_V axis.

Adjacent planes in the volume shall be equally spaced in the Z direction.

Note

1. More than one frame may be encoded for the same plane, for example, with a different temporal or cardiac cycle position.
2. Frames with the same value of Image Position (Volume) (0020,9301) will also have the same second value of Dimension Index Value (the spatial position Dimension); See Section C.8.24.3.3.
3. When Ultrasound Acquisition Geometry (0020,9307) has a value of PATIENT, the Plane Position (Patient) and Plane Orientation (Patient) Functional Group Macros will be present. They may contain Attributes with identical values to the corresponding Attributes in the Plane Position (Volume) and Plane Orientation (Volume) Functional Group Macros if the frames are transverse and the origin of the Patient-Based Coordinate System and the volume coincide (i.e., to remain compliant with the first paragraph of this section, which constrains the origin and orientation of the Volume Frame of Reference.

A.60 Ophthalmic Refractive Measurements Information Object Definitions

The following IODs specify Module use for storage of the measurements from ophthalmic refractive instruments. These instruments address the power of a lens or of a Patient's eye to bend light. There are many ophthalmic refractive instruments used to create this type of information. Some examples include Lensometers, Keratometers, Autorefractors, etc. An Ophthalmic Measurements SOP Instance is related to a single Series within a single Study.

A.60.1 Lensometry Measurements IOD

A.60.1.1 Lensometry Measurements IOD Description

The Lensometry Measurements IOD is used to capture the refractive measurements by a lensometer of spectacles.

A.60.1.2 Lensometry Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.1.3 Lensometry Measurements IOD Module Table

Table A.60.1-1 specifies the Modules of the Lensometry Measurements IOD.

Table A.60.1-1. Lensometry Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Lensometry Measurements Series	C.8.25.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.25.7	M
	Lensometry Measurements	C.8.25.8	M
	SOP Common	C.12.1	M

A.60.2 Autorefraction Measurements IOD

A.60.2.1 Autorefraction Measurements IOD Description

The Autorefraction Measurements IOD is used to encode the results of a modality (autorefractor) that automatically determines, without Patient input, what a Patient's refractive correction should be.

A.60.2.2 Autorefraction Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.2.3 Autorefraction Measurements IOD Module Table

Table A.60.2-1 specifies the Modules of the Autorefraction Measurements IOD.

Table A.60.2-1. Autorefraction Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

IE	Module	Reference	Usage
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Autorefraction Measurements Series	C.8.25.2	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.25.7	M
	Autorefraction Measurements	C.8.25.9	M
	SOP Common	C.12.1	M

A.60.3 Keratometry Measurements IOD

A.60.3.1 Keratometry Measurements IOD Description

The Keratometry Measurements IOD is used to encode the measurements of a modality (keratometer) that measures the curvature, and thus the refractive power, of a Patient's cornea.

A.60.3.2 Keratometry Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.3.3 Keratometry Measurements IOD Module Table

Table A.60.3-1 specifies the Modules of the Keratometry Measurements IOD.

Table A.60.3-1. Keratometry Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Keratometry Measurements Series	C.8.25.3	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.25.7	M
	Keratometry Measurements	C.8.25.10	M
	SOP Common	C.12.1	M

A.60.4 Subjective Refraction Measurements IOD

A.60.4.1 Subjective Refraction Measurements IOD Description

The Subjective Refraction Measurements IOD is used for encoding the measurements that subjectively determine the refractive correction of the eye that results in best corrected visual acuity.

A.60.4.2 Subjective Refraction Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.4.3 Subjective Refraction Measurements IOD Module Table

Table A.60.4-1 specifies the Modules of the Subjective Refraction Measurements IOD.

Table A.60.4-1. Subjective Refraction Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Subjective Refraction Measurements Series	C.8.25.4	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.25.7	M
	Subjective Refraction Measurements	C.8.25.11	M
	SOP Common	C.12.1	M

A.60.5 Visual Acuity Measurements IOD

A.60.5.1 Visual Acuity Measurements IOD Description

The Visual Acuity Measurements IOD is used to capture a Patient's visual acuity relative to that of a reference standard Patient under given viewing conditions (distance, lighting, etc.).

A.60.5.2 Visual Acuity Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.5.3 Visual Acuity Measurements IOD Module Table

Table A.60.5-1 specifies the Modules of the Visual Acuity Measurements IOD.

Table A.60.5-1. Visual Acuity Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

IE	Module	Reference	Usage
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Visual Acuity Measurements Series	C.8.25.5	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	General Ophthalmic Refractive Measurements	C.8.25.7	M
	Visual Acuity Measurements	C.8.25.12	M
	SOP Common	C.12.1	M

A.60.6 Ophthalmic Axial Measurements IOD

A.60.6.1 Ophthalmic Axial Measurements IOD Description

The Ophthalmic Axial Measurements IOD is used to encode axial measurements of the eye made by an axial measurements device.

A.60.6.2 Ophthalmic Axial Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.6.3 Ophthalmic Axial Measurements IOD Module Table

Table A.60.6-1 specifies the Modules of the Ophthalmic Axial Measurements IOD.

Table A.60.6-1. Ophthalmic Axial Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Axial Measurements Series	C.8.25.13	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	Ophthalmic Axial Measurements	C.8.25.14	M
	General Ophthalmic Refractive Measurements	C.8.25.7	M
	SOP Common	C.12.1	M

A.60.7 Intraocular Lens Calculations IOD

A.60.7.1 Intraocular Lens Calculations IOD Description

The Intraocular Lens Calculations IOD is used to encode calculations performed by ophthalmic axial measurements devices or by standalone software. Data input to these calculations comes both from the devices and from other sources.

A.60.7.2 Intraocular Lens Calculations IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.60.7.3 Intraocular Lens Calculations IOD Module Table

Table A.60.7-1 specifies the Modules of the Intraocular Lens Calculations IOD.

Table A.60.7-1. Intraocular Lens Calculations IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Intraocular Lens Calculations Series	C.8.25.15	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	Intraocular Lens Calculations	C.8.25.16	M
	General Ophthalmic Refractive Measurements	C.8.25.7	M
	SOP Common	C.12.1	M

A.61 Generic Implant Template IOD

A.61.1 Generic Implant Template IOD Description

The Generic Implant Template Information Object Definition (IOD) specifies the description of a 2D- and/or 3D-template representing a rigid and passive implant. The specific properties of flexible implants, such as silicone implants, and active implants such as cardiac pacemakers are not reflected. The IOD contains mechanisms for implant assembly, i.e., the rigid connection of two or more implants and implant registration, i.e., the placement of an implant in relation to anatomical landmarks.

The Generic Implant Template is a kind of Implant Template (see Section 7.10).

A.61.2 Generic Implant Template IOD Entity-Relationship Model

The E-R Model in Figure A.61-1 depicts those entities of the DICOM Information Model that are used in the following IODs.

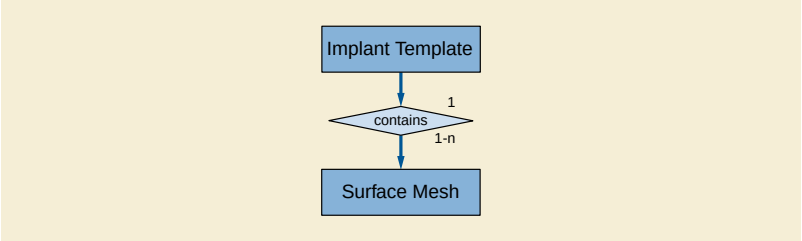


Figure A.61-1. Generic Implant Template IOD Information Model

Note

Implant templates are not referenced to a Patient, a Study or a Series.

A.61.3 Generic Implant Module IOD Module Table

Implant Templates can contain 2D drawings as well as 3D models describing one implant. At least one of the two must be present in one Instance; both may be present in the same Instance.

Table A.61-1. Generic Implant Template IOD Modules

IE	Module	Reference	Usage
Implant Template	Generic Implant Template Description	C.29.1.1	M
	Generic Implant Template 2D Drawings	C.29.1.2	U
	Generic Implant Template 3D Models	C.29.1.3	U
	Generic Implant Template Mating Features	C.29.1.4	U
	Generic Implant Template Planning Landmarks	C.29.1.5	U
	SOP Common	C.12.1	M
Surface Mesh	Surface Mesh	C.27.1	C - Required if Generic Implant Template 3D Models Module is present.

A.62 Implant Assembly Template IOD

A.62.1 Implant Assembly Template IOD Description

Implant Assembly Templates describe how to combine several implants to fulfill a certain purpose. The Implant Assembly Templates describe the aspects of component assembly that are relevant to planning only. Implants that are made out of several parts but are treated as a single piece may be described as single Implant Template.

A.62.2 Implant Assembly Template IOD Entity Relationship Model

The E-R Model in Figure A.62-1 depicts those entities of the DICOM Information Model that are used in the following IODs.

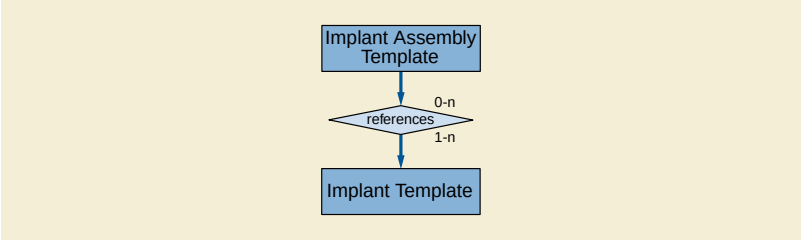


Figure A.62-1. Implant Assembly Template IOD Information Model

A.62.3 Implant Assembly Template IOD Module Table

Table A.62-1 specifies the Modules of the Implant Assembly Template IOD.

Table A.62-1. Implant Assembly Template IOD Modules

IE	Module	Reference	Usage
Implant Assembly	Implant Assembly Template	C.29.2.1	M
	SOP Common	C.12.1	M

A.63 Implant Template Group IOD

A.63.1 Implant Template Group IOD Description

The Implant Template Group IOD facilitates the aggregation of a set of Implant Template Instances in an ordered set.

A.63.2 Implant Template Group IOD Entity Relationship Model

The E-R Model in Figure A.63-1 depicts those entities of the DICOM Information Model that are used in the following IODs.

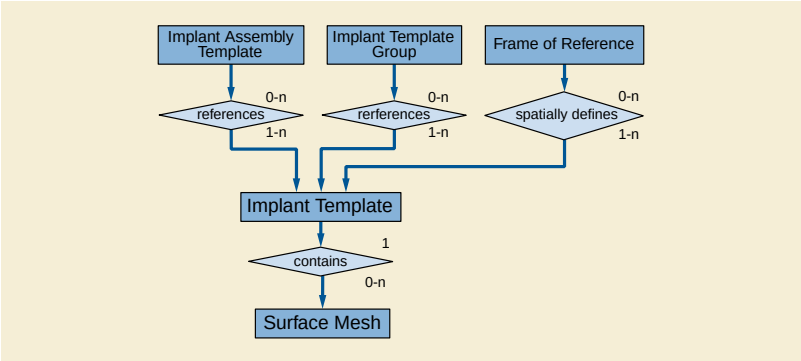


Figure A.63-1. Implant Template Group IOD Information Model

A.63.3 Implant Template Group IOD Module Table

Table A.63-1 specifies the Modules of the Implant Template Group IOD.

Table A.63-1. Implant Template Group IOD Modules

IE	Module	Reference	Usage
Implant Template Group	Implant Template Group	C.29.3	M
	SOP Common	C.12.1	M

A.64 RT Beams Delivery Instruction IOD

A.64.1 RT Beams Delivery Instruction IOD Description

The RT Beams Delivery Instruction IOD contains all the parameters needed to deliver a radiation therapy treatment fraction that are not already described in the referenced RT Plan IOD.

A.64.2 RT Beams Delivery Instruction IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Plan IE below the Series IE.

A.64.3 RT Beams Delivery Instruction IOD Module Table

Table A.64.3-1 specifies the Modules of the RT Beams Delivery Instruction IOD.

Table A.64.3-1. RT Beams Delivery Instruction IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
Plan	RT Beams Delivery Instruction	C.8.8.29	M
	Common Instance Reference	C.12.2	C - Required if not conveyed by a Unified Procedure Step. May be present otherwise.
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

A.64.4 RT Beams Delivery Instruction IOD Content Constraints

A.64.4.1 Modality

The value of modality (0008,0060) shall be PLAN.

A.65 Ophthalmic Visual Field Static Perimetry Measurements IOD

A.65.1 Ophthalmic Visual Field Static Perimetry Measurements IOD Description

The Ophthalmic Visual Field Static Perimetry Measurements IOD is used to encode results of static perimetry with visual field devices.

A.65.2 Ophthalmic Visual Field Static Perimetry Measurements IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Measurements IE below the Series IE.

A.65.3 Ophthalmic Visual Field Static Perimetry Measurements IOD Modules

Table A.65.3-1 specifies the Modules of the Ophthalmic Visual Field Static Perimetry Measurements IOD.

Table A.65.3-1. Ophthalmic Visual Field Static Perimetry Measurements IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M

IE	Module	Reference	Usage
	Clinical Trial Series	C.7.3.2	U
	Visual Field Static Perimetry Measurements Series	C.8.26.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Measurements	Visual Field Static Perimetry Test Parameters	C.8.26.2	M
	Visual Field Static Perimetry Test Reliability	C.8.26.3	M
	Visual Field Static Perimetry Test Measurements	C.8.26.4	M
	Visual Field Static Perimetry Test Results	C.8.26.5	M
	Ophthalmic Patient Clinical Information and Test Lens Parameters	C.8.26.6	U
	SOP Common	C.12.1	M

A.66 Intravascular Optical Coherence Tomography IOD

This Section defines an Information Object to be used with Intravascular Optical Coherence Tomography imaging devices.

A.66.1 Intravascular Optical Coherence Tomography Image IOD Description

The Intravascular Optical Coherence Tomography Image IOD specifies a multi-frame image acquired on an Intravascular Optical Coherence Tomography modality.

The Intravascular Optical Coherence Tomography Image IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for storage of images intended for presentation, and a SOP Class for storage of images intended for further processing before presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the Intravascular OCT Series Module, Presentation Intent Type (0008,0068).

IVOCT stores frames of polar data arranged in a rectangular format when "FOR PROCESSING" is specified. The A-lines in a frame are arranged in row order, with the catheter optics toward the left of the image. A-lines are always stored from top to bottom, in order of acquisition. The A-lines are evenly spaced (in angles) to form a complete 360 degrees of acquisition.

Application entities creating IVOCT FOR PRESENTATION SOP Instances shall apply all needed processing (e.g., Z offset and refractive index correction) to the IVOCT image for correct presentation.

A.66.2 Intravascular Optical Coherence Tomography Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.66.3 Intravascular Optical Coherence Tomography Image IOD Module Table

Table A.66.3-1 specifies the Modules of the Intravascular Optical Coherence Tomography Image IOD.

Table A.66.3-1. Intravascular Optical Coherence Tomography Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
	Intravascular OCT Series	C.8.27.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Supplemental Palette Color Lookup Table	C.7.6.19	C - Required if Pixel Presentation (0008,9205) in the Intravascular OCT Image Module equals COLOR.
	Enhanced Contrast/Bolus	C.7.6.4	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Device	C.7.6.12	U
	Acquisition Context	C.7.6.14	M
	Cardiac Synchronization	C.7.6.18.1	C - Required if cardiac synchronization was used
	Intravascular OCT Image	C.8.27.2	M
	Intravascular OCT Acquisition Parameters	C.8.27.3	M
	Intravascular OCT Processing Parameters	C.8.27.4	C - Required if Presentation Intent Type (0008,0068) is FOR PROCESSING.
	Intravascular Image Acquisition Parameters	C.8.27.5	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.66.3.1 Intravascular Optical Coherence Tomography Image IOD Content Constraints

The following constraints on Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.66.3.1.1 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012) DCID 3850 “Contrast Bolus Substance” shall be used.

A.66.3.1.2 Prohibited Modules

The Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Intravascular Optical Coherence Tomography Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance may be used.

Pseudo-color presentation information may be applied through the use of separate Pseudo-color Softcopy Presentation State SOP Instances.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself and implementers are discouraged from using private extensions to circumvent this restriction.

A.66.4 Intravascular Optical Coherence Tomography Image Functional Group Macros

Table A.66.4.3-1 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Intravascular Optical Coherence Tomography Image IOD.

Table A.66.4.3-1. Intravascular Optical Coherence Tomography Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION.
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Frame Anatomy	C.7.6.16.2.8	M
Cardiac Synchronization	C.7.6.16.2.7	C - Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE May be present otherwise.
Frame VOI LUT	C.7.6.16.2.10	U
Pixel Intensity Relationship LUT	C.7.6.16.2.13	C - Required if Pixel Intensity Relationship (0028,1040) equals LOG. May be present otherwise.
Intravascular OCT Frame Type	C.8.27.6.1	M
Intravascular Frame Content	C.8.27.6.2	C - Required if Intravascular Acquisition (0018,3100) equals MEASURED or Presentation Intent Type (0008,0068) equals FORPRESENTATION.
Intravascular OCT Frame Content	C.8.27.6.3	C - Required if Presentation Intent Type (0008,0068) equals FOR PROCESSING.

A.66.4.1 Intravascular OCT Image Functional Group Macros Content Constraints

A.66.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 3604 “Arterial Lesion Locations” shall be used. for Anatomic Region Modifier Sequence (0008,2220) DCID 3019 “Cardiovascular Anatomic Location Modifiers” shall be used.

A.67 Ophthalmic Thickness Map IOD

A.67.1 Ophthalmic Thickness Map IOD Description

The Ophthalmic Thickness Map IOD is generated by ophthalmic thickness mapping devices, such as retinal nerve fiber layer analyzers and optic nerve head analyzers, to generate measurements that are presented topographically using a monochromatic image and a pseudo-color map.

A.67.2 Ophthalmic Thickness Map IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.67.3 Ophthalmic Thickness Map IOD Modules

Table A.67.3-1 specifies the Modules of the Ophthalmic Thickness Map IOD.

Table A.67.3-1. Ophthalmic Thickness Map IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Ophthalmic Thickness Map Series	C.8.28.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Supplemental Palette Color Lookup Table	C.7.6.19	C - Required if Pixel Presentation (0008,9205) equals COLOR
	Bitmap Display Shutter	C.7.6.15	C - Required if a Shutter is to be applied to the image
	Ophthalmic Thickness Map	C.8.28.2	M
	Ophthalmic Thickness Map Quality Rating	C.8.28.3	C - Required if a quality rating value exists for the ophthalmic map
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M
	Acquisition Context	C.7.6.14	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.67.4 Ophthalmic Thickness Map IOD Content Constraints

The following constraints on Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.67.4.1 Prohibited Modules

The Curve Module (Retired), Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Ophthalmic Thickness Map.

A.68 Surface Scan Mesh IOD

A.68.1 Surface Scan Mesh IOD Description

The Surface Scan Mesh IOD specifies a triangulated surface generated by an optical surface scanner. The Surface Scan Mesh IOD stores a surface including UV mapping combined with device specific parameters.

A.68.2 Surface Scan Mesh IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Surface IE below the Series IE.

A.68.3 Surface Scan Mesh IOD Module Table

Table A.68-1 specifies the Modules of the Surface Scan Mesh IOD.

Table A.68-1. Surface Scan Mesh IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Optical Surface Scanner Series	C.8.29.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Surface	Surface Mesh	C.27.1	M
	UV Mapping	C.27.6	U
	Scan Procedure	C.8.29.2	M
	Specimen	C.7.6.22	U
	SOP Common	C.12.1	M

A.69 Surface Scan Point Cloud IOD

A.69.1 Surface Scan Point Cloud IOD Description

The Surface Scan Point Cloud IOD specifies a point cloud generated by an optical surface scanner. Multiple Point Clouds within the same Series shall be from the same anatomical region, but they do not need to be in the same coordinate system.

A.69.2 Surface Scan Point Cloud IOD Entity Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Surface IE below the Series IE.

A.69.3 Surface Scan Point Cloud IOD Module Table

Table A.69-1 specifies the Modules of the Surface Scan Point Cloud IOD.

Table A.69-1. Surface Scan Point Cloud IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Optical Surface Scanner Series	C.8.29.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Surface	Point Cloud	C.27.5	M

IE	Module	Reference	Usage
	UV Mapping	C.27.6	U
	Scan Procedure	C.8.29.2	M
	Specimen	C.7.6.22	U
	SOP Common	C.12.1	M

A.70 Legacy Converted Enhanced CT Image IOD

A.70.1 Legacy Converted Enhanced CT Image IOD Description

The Legacy Converted Enhanced Computed Tomography (CT) Image Information Object Definition (IOD) specifies an image that has been converted from images originally created by a computed tomography imaging device.

A.70.2 Legacy Converted Enhanced CT Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.70.3 Legacy Converted Enhanced CT Image IOD Module Table

Table A.70-1 specifies the Modules of the Legacy Converted Enhanced CT Image IOD.

Table A.70-1. Legacy Converted Enhanced CT Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	CT Series	C.8.15.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	U
Image	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	U
	Enhanced Contrast/Bolus	C.7.6.4b	U
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	U
	Respiratory Synchronization	C.7.6.18.2	U
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	Enhanced CT Image	C.8.15.2	M

IE	Module	Reference	Usage
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.70.3.1 Legacy Converted Enhanced CT Image IOD Content Constraints

The General Image Module, Overlay Plane Module, VOI LUT Module, Supplemental Palette Color Lookup Table Module and Graphic Annotation Module shall not be used in a Standard Extended SOP Class of the Legacy Converted Enhanced CT Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

Grayscale Softcopy Presentation State Storage Instances that are generated during conversion shall be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the Enhanced CT Image Module. See Section C.8.15.2.

Note

The Curve Module (Retired) has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.70.4 Legacy Converted Enhanced CT Image Functional Group Macros

Table A.70-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Legacy Converted Enhanced CT Image IOD.

Table A.70-2. Legacy Converted Enhanced CT Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if Referenced Image Sequence (0008,1140) was present in any of the Classic Images that were converted.
Derivation Image	C.7.6.16.2.6	C - Required if Source Image Sequence (0008,2112) was present in any of the Classic Images that were converted.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	C - Required if Body Part Examined (0018,0015) is present and contains a value defined in Annex L “Correspondence of Anatomic Region Codes and Body Part Examined Defined Terms” in PS3.16, or Anatomic Region Sequence (0008,2218) was present in any of the Classic Images that were converted.
Frame VOI LUT	C.7.6.16.2.10	M

Functional Group Macro	Section	Usage
Contrast/Bolus Usage	C.7.6.16.2.12	U
Respiratory Synchronization	C.7.6.16.2.17	U
Irradiation Event Identification	C.7.6.16.2.18	C - Required if Irradiation Event UID (0008,3010) was present in any of the Classic Images that were converted.
CT Image Frame Type	C.8.15.3.1	M
CT Pixel Value Transformation	C.8.15.3.10	M
Temporal Position	C.7.6.16.2.23	U
Unassigned Shared Converted Attributes	C.7.6.16.2.25.1	M - May not be used as a Per-Frame Functional Group
Unassigned Per-Frame Converted Attributes	C.7.6.16.2.25.2	M - May not be used as a Shared Functional Group
Image Frame Conversion Source	C.7.6.16.2.25.3	C - Required if created by conversion from a DICOM source; may not be used as a Shared Functional Group

A.71 Legacy Converted Enhanced MR Image IOD

A.71.1 Legacy Converted Enhanced MR Image IOD Description

The Legacy Converted Enhanced Magnetic Resonance (MR) Image Information Object Definition (IOD) specifies an image that has been converted from images originally created by a magnetic resonance imaging device.

A.71.2 Legacy Converted Enhanced MR Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.71.3 Legacy Converted Enhanced MR Image IOD Module Table

Table A.71-1 specifies the Modules of the Legacy Converted Enhanced MR Image IOD.

Table A.71-1. Legacy Converted Enhanced MR Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	MR Series	C.8.13.6	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	U
Image	Image Pixel	C.7.6.3	M
	Contrast/Bolus	C.7.6.4	U
	Enhanced Contrast/Bolus	C.7.6.4b	U
	Multi-frame Functional Groups	C.7.6.16	M

IE	Module	Reference	Usage
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	U
	Respiratory Synchronization	C.7.6.18.2	U
	Bulk Motion Synchronization	C.7.6.18.3	U
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	Enhanced MR Image	C.8.13.1	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.71.3.1 Legacy Converted Enhanced MR Image IOD Content Constraints

The General Image Module, Overlay Plane Module, VOI LUT Module, Supplemental Palette Color Lookup Table Module and Graphic Annotation Module shall not be used in a Standard Extended SOP Class of the Legacy Converted Enhanced MR Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

Grayscale Softcopy Presentation State Storage Instances that are generated during conversion shall be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the Enhanced MR Image Module. See Section C.8.15.2.

Note

The Curve Module (Retired) has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.71.4 Legacy Converted Enhanced MR Image Functional Group Macros

Table A.71-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Legacy Converted Enhanced MR Image IOD.

Table A.71-2. Legacy Converted Enhanced MR Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if Referenced Image Sequence (0008,1140) was present in any of the Classic Images that were converted.

Functional Group Macro	Section	Usage
Derivation Image	C.7.6.16.2.6	C - Required if Source Image Sequence (0008,2112) was present in any of the Classic Images that were converted.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	C - Required if Body Part Examined (0018,0015) is present and contains a value defined in Annex L “Correspondence of Anatomic Region Codes and Body Part Examined Defined Terms” in PS3.16, or Anatomic Region Sequence (0008,2218) was present in any of the Classic Images that were converted.
Pixel Value Transformation	C.7.6.16.2.9	U
Frame VOI LUT	C.7.6.16.2.10	U
Real World Value Mapping	C.7.6.16.2.11	U
Contrast/Bolus Usage	C.7.6.16.2.12	U
Respiratory Synchronization	C.7.6.16.2.17	U
MR Image Frame Type	C.8.13.5.1	M
Temporal Position	C.7.6.16.2.23	U
Unassigned Shared Converted Attributes	C.7.6.16.2.25.1	M - May not be used as a Per-Frame Functional Group
Unassigned Per-Frame Converted Attributes	C.7.6.16.2.25.2	M - May not be used as a Shared Functional Group
Image Frame Conversion Source	C.7.6.16.2.25.3	C - Required if created by conversion from a DICOM source; may not be used as a Shared Functional Group

A.72 Legacy Converted Enhanced PET Image IOD

A.72.1 Legacy Converted Enhanced PET Image IOD Description

The Legacy Converted Enhanced Positron Emission Tomography (PET) Image Information Object Definition (IOD) specifies an image that has been converted from images originally created by a positron emission tomography coincidence imaging device.

A.72.2 Legacy Converted Enhanced PET Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.72.3 Legacy Converted Enhanced PET Image IOD Module Table

Table A.72-1 specifies the Modules of the Legacy Converted Enhanced PET Image IOD.

Table A.72-1. Legacy Converted Enhanced PET Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Enhanced PET Series	C.8.22.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	U
Image	Image Pixel	C.7.6.3	M
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Cardiac Synchronization	C.7.6.18.1	U
	Respiratory Synchronization	C.7.6.18.2	U
	Specimen	C.7.6.22	U
	Enhanced PET Image	C.8.22.3	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.72.3.1 Legacy Converted Enhanced PET Image IOD Content Constraints

The General Image Module, Overlay Plane Module, VOI LUT Module, Supplemental Palette Color Lookup Table Module and Graphic Annotation Module shall not be used in a Standard Extended SOP Class of the Legacy Converted Enhanced PET Image.

Note

In order to annotate images, whether during acquisition or subsequently, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the image SOP Instance, may be used.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself, and implementers are discouraged from using private extensions to circumvent this restriction.

Grayscale Softcopy Presentation State Storage Instances that are generated during conversion shall be referenced from the Image SOP Instance by using the Referenced Grayscale Presentation State Sequence in the Enhanced PET Image Module. See Section C.8.15.2.

Note

The Curve Module (Retired) has been retired from DICOM. It is still not permitted to be present. See PS3.3-2004.

A.72.4 Legacy Converted Enhanced PET Image Functional Group Macros

Table A.72-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Legacy Converted Enhanced PET Image IOD.

Table A.72-2. Legacy Converted Enhanced PET Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.

Functional Group Macro	Section	Usage
Plane Position (Patient)	C.7.6.16.2.3	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Referenced Image	C.7.6.16.2.5	C - Required if Referenced Image Sequence (0008,1140) was present in any of the Classic Images that were converted.
Derivation Image	C.7.6.16.2.6	C - Required if Source Image Sequence (0008,2112) was present in any of the Classic Images that were converted.
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	C - Required if Body Part Examined (0018,0015) is present and contains a value defined in Annex L “Correspondence of Anatomic Region Codes and Body Part Examined Defined Terms” in PS3.16, or Anatomic Region Sequence (0008,2218) was present in any of the Classic Images that were converted.
Pixel Value Transformation	C.7.6.16.2.9	M
Frame VOI LUT	C.7.6.16.2.10	M
Real World Value Mapping	C.7.6.16.2.11	U
Respiratory Synchronization	C.7.6.16.2.17	U
Irradiation Event Identification	C.7.6.16.2.18	C - Required if Irradiation Event UID (0008,3010) was present in any of the Classic Images that were converted.
PET Frame Type	C.8.22.5.1	M
Temporal Position	C.7.6.16.2.23	U
Unassigned Shared Converted Attributes	C.7.6.16.2.25.1	M - May not be used as a Per-Frame Functional Group
Unassigned Per-Frame Converted Attributes	C.7.6.16.2.25.2	M - May not be used as a Shared Functional Group
Image Frame Conversion Source	C.7.6.16.2.25.3	C - Required if created by conversion from a DICOM source; may not be used as a Shared Functional Group

A.73 Corneal Topography Map IOD

A.73.1 Corneal Topography Map IOD Description

The Corneal Topography Map IOD is generated by ophthalmic corneal topography mapping devices, such as reflection-based topography and elevation-based tomography instruments to generate curvature and/or elevation measurements of corneal anterior and posterior surfaces that are presented topographically using a monochromatic image and a pseudo-color map.

A.73.2 Corneal Topography Map IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.73.3 Corneal Topography Map IOD Modules

Table A.73.3-1 specifies the Modules of the Corneal Topography Map IOD.

Table A.73.3-1. Corneal Topography Map IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M

IE	Module	Reference	Usage
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Corneal Topography Map Series	C.8.30.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Palette Color Lookup Table	C.7.9	M
	Corneal Topography Map Image	C.8.30.2	M
	Corneal Topography Map Analysis	C.8.30.3	M
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M
	Acquisition Context	C.7.6.14	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M

A.73.4 Corneal Topography Map IOD Content Constraints

The following constraints on Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.73.4.1 Prohibited Modules

The Curve Module (Retired), Overlay Plane Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Corneal Topography Map.

A.74 Breast Projection X-Ray Image IOD

A.74.1 Breast Projection X-Ray Image IOD Description

The Breast Projection X-Ray Image Information Object Definition specifies an image set that has been created by a digital mammography projection radiography imaging device.

Note

The preferred IOD for traditional digital mammography is Digital Mammography X-Ray Image.

The Breast Projection X-Ray Image IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for storage of images intended for presentation, and a SOP Class for storage of images intended for further processing before presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the DX Series Module, Presentation Intent Type (0008,0068).

A.74.2 Breast Projection X-Ray Image IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.74.3 Breast Projection X-Ray Image IOD Module Table

Table A.74-1 specifies the Modules of the Breast Projection X-Ray Image IOD.

Table A.74-1. Breast Projection X-Ray Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	DX Series	C.8.11.1	M
	Enhanced Mammography Series	C.8.11.10	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Enhanced Mammography Image	C.8.31.1	M
	Breast View	C.8.21.6	M
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast media was applied.
	Device	C.7.6.12	U
	Intervention	C.7.6.13	U
	Acquisition Context	C.7.6.14	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	U
	Patient Orientation	C.7.6.20	M
	Specimen	C.7.6.22	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.74.3.1 Breast Projection X-Ray Image IOD Content Constraints

A.74.3.1.1 Modality Attribute

Modality (0008,0060) shall have the value MG.

A.74.3.1.2 Overlay Plane Module, Curve Module and VOI LUT Module

The Overlay Plane Module, Curve Module (Retired), VOI LUT Module and Softcopy Presentation LUT Module shall not be used in a Standard Extended SOP Class of the Breast Projection X-Ray Image.

Note

The VOI LUT function is provided by a Frame VOI LUT Functional Group.

A.74.4 Breast Projection X-Ray Image Functional Group Macros

Table A.74-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Breast Projection X-Ray Image IOD.

Table A.74-2. Breast Projection X-Ray Image Functional Group Macros

Functional Group Macro	Section	Usage
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the Image Type (0008,0008) Value 1 equals DERIVED or Value 1 is ORIGINAL and Presentation Intent Type equals FOR PRESENTATION. May be present otherwise.
Frame Anatomy	C.7.6.16.2.8	M
Identity Pixel Value Transformation	C.7.6.16.2.9b	M
Frame VOI LUT With LUT	C.7.6.16.2.10b	M
Contrast/Bolus Usage	C.7.6.16.2.12	C - Required if the Enhanced Contrast/Bolus Module is present.
Frame Display Shutter	C.7.6.16.2.16	U
Irradiation Event Identification	C.7.6.16.2.18	M
X-Ray Frame Characteristics	C.8.19.6.1	U
X-Ray Field of View	C.8.19.6.2	M
X-Ray Frame Pixel Data Properties	C.8.19.6.4	M
X-Ray Frame Detector Parameters	C.8.19.6.5	U
X-Ray Calibration Device Usage	C.8.19.6.6	U
X-Ray Frame Acquisition	C.8.19.6.8	U
X-Ray Collimator	C.8.19.6.12	M
Breast X-Ray Positioner	C.8.31.2	C - Required if X-Ray Source moves relative to the Patient. May be present otherwise.
Breast X-Ray Detector	C.8.31.3	C - Required if X-Ray Detector plane is not normal to the X-Ray beam vector. May be present otherwise.
Breast X-Ray Geometry	C.8.31.4	M
Breast X-Ray Acquisition Dose	C.8.31.5	M
Breast X-Ray Isocenter Reference System	C.8.31.6	M
X-Ray Grid	C.8.31.7	U
X-Ray Filter	C.8.31.8	U

A.74.4.1 Breast Projection X-Ray Image Functional Group Macros Content Constraints

A.74.4.1.1 Frame Anatomy Functional Group Macro

For Anatomic Region Sequence (0008,2218) DCID 4013 “Anatomic Region for Mammography” shall be used.

A.75 Parametric Map IOD

A.75.1 Parametric Map IOD Description

The Parametric Map Information Object Definition (IOD) specifies a multi-frame image representing pixels with real world values. Parametric Maps are either integer or floating point.

The Parametric Map IOD does not include the full set of acquisition parameters of any acquired images from which they were derived, e.g., cardiac phase. An application rendering or processing the Parametric Map may need to access the source images for such information.

The Parametric Map IOD requires the presence of VOI LUT (window) information with the intent that at a minimum the image be renderable without special processing. The output space is defined as P-Values to achieve consistency.

Note

- The VOI LUT mechanism specifically supports floating point values, and there is no expectation that it be limited to integer input or output ranges.
- Even though the output of the VOI LUT is not constrained to be integer values, implicit scaling of the output range to the input range of an integer-based Palette Color LUT can be used to apply pseudo-color for display. Pseudo-color mapping information may be encoded with the image. This may be applied at the discretion of the receiving application or it may use a separate DICOM Color Palette IOD or some other mechanism.

The Parametric Map IOD encodes one or more parameters as an image. Other Image IODs may be used to encode related information, and Instances of them may be referenced from the Parametric Map, as the source from which a parameter was derived, or some other relationship.

Note

- The Blending Presentation State IOD may be used to describe how (selected frames of) a Parametric Map Instance may be superimposed on, say, frames of acquired images for anatomical reference encoded as Instances of other Image IODs, as well as the relative opacity and pseudo-color applicable to the overlying frames.
- Commonality of the same Frame of Reference UID also allows an application to relate Parametric Map Instances and other Image Instances, in the absence of explicit references.
- The Parametric Map IOD is not restricted to encoding only a single parameter in one Instance. Since it is a multi-frame object, and since the type of parameter is encoded in the Real World Value Mapping Functional Group Macro, which may vary on a per-frame basis, the parameter may also vary from frame-to-frame. In such cases, the Multi-frame Dimension Module may be used to highlight this, by specifying the Quantity Definition Sequence (0040,9220) as a Dimension Index.

A.75.2 Parametric Map IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Image IE below the Series IE.

A.75.3 Parametric Map IOD Module Table

Table A.75-1. Parametric Map IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U

IE	Module	Reference	Usage
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Parametric Map Series	C.8.32.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	C - Required if integer pixels
	Floating Point Image Pixel	C.7.6.24	C - Required if 32 bit floating point pixels
	Double Floating Point Image Pixel	C.7.6.25	C - Required if 64 bit floating point pixels
	Parametric Map Image	C.8.32.2	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Palette Color Lookup Table	C.7.9	C - Required if Pixel Presentation (0008,9205) in the Parametric Map image Module equals COLOR_RANGE and Palette Color Lookup Table UID (0028,1199) is not present.
	Cardiac Synchronization	C.7.6.18.1	U
	Respiratory Synchronization	C.7.6.18.2	U
	Bulk Motion Synchronization	C.7.6.18.3	U
	Acquisition Context	C.7.6.14	M
	Device	C.7.6.12	U
	Specimen	C.7.6.22	U
	Common Instance Reference	C.12.2	C - Required if Referenced Image Functional Group (Section C.7.6.16.2.5) or Derivation Image Functional Group (Section C.7.6.16.2.6) is present.
	SOP Common	C.12.1	M
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.75.4 Parametric Map IOD Content Constraints

Either the Image Pixel Module or the Floating Point Image Pixel Module or the Double Floating Point Image Pixel Module is required, and only one of these shall be present.

Note

I.e., it is not permitted to have more than one of Pixel Data Provider URL (0028,7FE0), Pixel Data (7FE0,0010), Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) in a Standard Extended SOP Class in the top level Data Set. See PS3.5.

The VOI LUT Module shall not be present.

The Modality LUT Module shall not be present.

The Overlay Plane Module shall not be present.

The Supplemental Palette Color Lookup Table Module shall not be present.

A.75.5 Parametric Map Functional Groups

Table A.75-2 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups Module for the Parametric Map IOD.

Table A.75-2. Parametric Map Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Plane Position (Patient)	C.7.6.16.2.3	C – Required if the Frame of Reference is defined in the patient-relative Reference Coordinate System.
Plane Orientation (Patient)	C.7.6.16.2.4	C – Required if the Frame of Reference is defined in the patient-relative Reference Coordinate System.
Plane Position (Slide)	C.8.12.6.1	C - Required if the Frame of Reference is defined in the Slide Coordinate System and Dimension Organization Type (0020,9311) is not TILED_FULL. May be present otherwise if the Frame of Reference is defined in the Slide Coordinate System.
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Frame Content	C.7.6.16.2.2	M - Shall not be used as a Shared Functional Group
Cardiac Synchronization	C.7.6.16.2.7	U
Frame Anatomy	C.7.6.16.2.8	~~M~~U
Identity Pixel Value Transformation	C.7.6.16.2.9b	M
Frame VOI LUT With LUT	C.7.6.16.2.10b	M
Real World Value Mapping	C.7.6.16.2.11	M
Contrast/Bolus Usage	C.7.6.16.2.12	U
Respiratory Synchronization	C.7.6.16.2.17	U
Stored Value Color Range	C.7.6.16.2.26	C - Required if Pixel Presentation (0008,9205) in the Parametric Map Image Module equals COLOR_RANGE.
Parametric Map Frame Type	C.8.32.3.1	M
Unassigned Shared Converted Attributes	C.7.6.16.2.25.1	U - May not be used as a Per-Frame Functional Group
Unassigned Per-Frame Converted Attributes	C.7.6.16.2.25.2	U - May not be used as a Shared Functional Group

A.75.5.1 Parametric Map Functional Groups Description

For the Derivation Image Functional Group Macro:

- For Purpose of Reference Code Sequence (0040,A170) BCID 7222 “Parametric Map Derivation Image Purpose of Reference” may be used.
- For Derivation Code Sequence (0008,9215) BCID 7203 “Image Derivation” may be used.

For the Real World Value Mapping Functional Group Macro, which defines the type of quantity, the method of generation and the units for the pixel values:

- For Concept Name Code Sequence (0040,A043) of Quantity Definition Sequence (0040,9220) BCID 9000 “Physical Quantity Descriptors” may be used.
- For Concept Code Sequence (0040,A168) for Concept Name of (246205007, SCT, "Quantity") of Quantity Definition Sequence (0040,9220) BCID 7180 “Abstract Multi-dimensional Image Model Component Semantics” may be used.
- For Measurement Units Code Sequence (0040,08EA) BCID 7181 “Abstract Multi-dimensional Image Model Component Units” may be used.

The Unassigned Shared and Per-Frame Converted Attributes Macros are included to allow acquisition-specific Attributes to be conveyed when they are relevant to the use-case. E.g., the echo time, flip angle or diffusion b-value might be useful to interpret a parametric map from an MR acquisition. Since some of these values may vary per-frame, it is appropriate to include them in the Functional Groups, rather than in the top level Data Set.

A.76 Wide Field Ophthalmic Photography Stereographic Projection Image IOD

This Section defines an Information Object to be used with several types of ophthalmic photographic imaging devices that generate wide field OP images, including fundus cameras, slit lamp cameras, scanning laser ophthalmoscopes, stereoscopic cameras, video equipment and digital photographic equipment. It uses the stereographic projection method to represent on-face images of the 3D human retina in 2D on which geometric measurements can be made when the correct mathematical formulae are used.

A.76.1 Wide Field Ophthalmic Photography Stereographic Projection Image IOD Description

The Wide Field Ophthalmic Photography Stereographic Projection Image IOD specifies a multi-frame image acquired on a digital photographic DICOM modality. This IOD can be used to encode single wide field ophthalmic images and other combinations including cine sequences. This IOD captures the projection of the wide field 2D Pixel image to enable anatomically-correct geometric measurements of the retina by taking into account the curved shape of the eye using a sphere to approximate shape.

A.76.2 Wide Field Ophthalmic Photography Stereographic Projection Image IOD Entity-Relationship Model

The Wide Field Stereographic Projection Ophthalmic Photography Image IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2. The Series IE contains only an Image IE.

A.76.3 Wide Field Ophthalmic Photography Stereographic Projection Image IOD Modules

Table A.76-1 specifies the Modules of the Wide Field Stereographic Projection Ophthalmic Photography Image IOD.

Table A.76-1. Wide Field Ophthalmic Photography Stereographic Projection Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Photography Series	C.8.17.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast was administered; see A.76.4.2
	Cine	C.7.6.5	C - Required if there is a sequential temporal relationship between all frames
	Multi-frame	C.7.6.6	M
	Acquisition Context	C.7.6.14	U
	Ophthalmic Photography Image	C.8.17.2	M
	Wide Field Ophthalmic Photography Stereographic Projection	C.8.17.11	M
	Wide Field Ophthalmic Photography Quality Rating	C.8.17.13	C - Required if a quality rating value exists for this SOP Instance
	Ocular Region Imaged	C.8.17.5	M
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M
	Ophthalmic Photographic Parameters	C.8.17.3	M
	ICC Profile	C.11.15	C - Required if Photometric Interpretation (0028,0004) is not MONOCHROME2
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.76.4 Wide Field Ophthalmic Photography Stereographic Projection Image IOD Content Constraints

The following constraints on Series and Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.76.4.1 Bits Allocated, Bits Stored, and High Bit

These Attributes shall be determined based upon the Photometric Interpretation (0028,0004):

Photometric Interpretation (0028,0004)	Bits Allocated (0028,0100)	Bits Stored (0028,0101)	High Bit (0028,0102)
MONOCHROME2	8	8	7
	16	16	15

Photometric Interpretation (0028,0004)	Bits Allocated (0028,0100)	Bits Stored (0028,0101)	High Bit (0028,0102)
RGB YBR_FULL_422 YBR_PARTIAL_420 YBR_ICT YBR_RCT	8	8	7

A.76.4.2 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012) DCID 4200 “Ophthalmic Imaging Agent” shall be used.

A.76.4.3 ICC Profile Module

The ICC Profile Module shall be present for color images. If the color space to be used is not calibrated (i.e., a device-specific ICC Input Profile is not available), then an ICC Input Profile specifying a well-known space (such as sRGB) may be specified.

A.77 Wide Field Ophthalmic Photography 3D Coordinates Image IOD

This Section defines an Information Object to be used with several types of ophthalmic photographic imaging devices that generate wide field OP images, including fundus cameras, slit lamp cameras, scanning laser ophthalmoscopes, stereoscopic cameras, video equipment and digital photographic equipment.

A.77.1 Wide Field Ophthalmic Photography 3D Coordinates Image IOD Description

The Wide Field Ophthalmic Photography 3D Coordinates Image IOD specifies a multi-frame image acquired on a digital photographic DICOM modality. This IOD can be used to encode single wide field ophthalmic images and other combinations including cine sequences. This IOD includes the mapping of the wide field 2D Pixel image to 3D (x,y,z) Cartesian coordinates.

A.77.2 Wide Field Ophthalmic Photography 3D Coordinates Image IOD Entity-Relationship Model

The Wide Field Ophthalmic Photography 3D Coordinates Image IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2. The Series IE contains only an Image IE.

A.77.3 Wide Field Ophthalmic Photography 3D Coordinates Image IOD Modules

Table A.77-1 specifies the Modules of the Wide Field Ophthalmic Photography 3D Coordinates Image IOD.

Table A.77-1. Wide Field Ophthalmic Photography 3D Coordinates Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Photography Series	C.8.17.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M

IE	Module	Reference	Usage
	Synchronization	C.7.4.2	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Pixel	C.7.6.3	M
	Enhanced Contrast/Bolus	C.7.6.4b	C - Required if contrast was administered; see A.77.4.2
	Cine	C.7.6.5	C - Required if there is a sequential temporal relationship between all frames
	Multi-frame	C.7.6.6	M
	Acquisition Context	C.7.6.14	U
	Ophthalmic Photography Image	C.8.17.2	M
	Wide Field Ophthalmic Photography 3D Coordinates	C.8.17.12	M
	Wide Field Ophthalmic Photography Quality Rating	C.8.17.13	C - Required if a quality rating value exists for this SOP Instance
	Ocular Region Imaged	C.8.17.5	M
	Ophthalmic Photography Acquisition Parameters	C.8.17.4	M
	Ophthalmic Photographic Parameters	C.8.17.3	M
	ICC Profile	C.11.15	C - Required if Photometric Interpretation (0028,0004) is not MONOCHROME2
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.77.4 Wide Field Ophthalmic Photography 3D Coordinates Image IOD Content Constraints

The following constraints on Series and Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.77.4.1 Bits Allocated, Bits Stored, and High Bit

These Attributes shall be determined based upon the Photometric Interpretation (0028,0004) :

Photometric Interpretation (0028,0004)	Bits Allocated (0028,0100)	Bits Stored (0028,0101)	High Bit (0028,0102)
MONOCHROME2	8	8	7
	16	16	15

Photometric Interpretation (0028,0004)	Bits Allocated (0028,0100)	Bits Stored (0028,0101)	High Bit (0028,0102)
RGB YBR_FULL_422 YBR_PARTIAL_420 YBR_ICT YBR_RCT	8	8	7

A.77.4.2 Contrast/Bolus Agent Sequence

For Contrast/Bolus Agent Sequence (0018,0012) DCID 4200 “Ophthalmic Imaging Agent” shall be used.

A.77.4.3 ICC Profile Module

The ICC Profile Module shall be present for color images. If the color space to be used is not calibrated (i.e., a device-specific ICC Input Profile is not available), then an ICC Input Profile specifying a well-known space (such as sRGB) may be specified.

A.78 Tractography Results IOD

A.78.1 Tractography Results IOD Description

The Tractography Results IOD encodes tractography results into a collection of track sets. A track set collects a set of tracks containing the set of x, y and z coordinates of each point making up the track. Additional quantities like Fractional Anisotropy values, color, descriptive statistical values, etc. may be associated with track set, track or point.

A.78.2 Tractography Results IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Tractography Results IE below the Series IE.

A.78.3 Tractography Results IOD Module Table

Table A.78-1 specifies the Modules of the Tractography Results IOD.

Table A.78-1. Tractography Results IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Tractography Results Series	C.8.33.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Tractography Results	Tractography Results	C.8.33.2	M
	Specimen	C.7.6.22	U

IE	Module	Reference	Usage
	Common Instance Reference	C.12.2	M
	SOP Common	C.12.1	M

A.79 RT Brachy Application Setup Delivery Instruction IOD

A.79.1 RT Brachy Application Setup Delivery Instruction IOD Description

In order to deliver a Brachytherapy treatment fraction described in an RT Plan IOD, the RT Brachy Application Setup Delivery Instruction IOD describes which part of the RT Plan is to be delivered and contains additional parameters. This information is supplied by a Treatment Management System (TMS) when it creates an RT Brachy Application Setup Delivery Instruction SOP Instance which is referenced by a Unified Procedure Step (UPS) in the Unified Worklist and Procedure Step model.

A.79.2 RT Brachy Application Setup Delivery Instruction IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Plan IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.79.3 RT Brachy Application Setup Delivery Instruction IOD Module Table

Table A.79.3-1 specifies the Modules of the RT Brachy Application Setup Delivery Instruction IOD.

Table A.79.3-1. RT Brachy Application Setup Delivery Instruction IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Plan	RT Brachy Application Setup Delivery Instruction	C.8.8.30	M
	Common Instance Reference	C.12.2	M
	General Reference	C.12.4	U
	SOP Common	C.12.1	M

A.79.4 RT Brachy Application Setup Delivery Instruction IOD Content Constraints

A.79.4.1 Modality

The value of modality (0008,0060) shall be PLAN.

A.80 Volumetric Presentation State Information Object Definitions

A.80.1 Planar MPR Volumetric Presentation State IOD

A.80.1.1 Planar MPR Volumetric Presentation State IOD Description

The Planar MPR Volumetric Presentation State Information Object Definition (IOD) specifies information that defines a Planar MPR presentation from volume ~~datasets~~data sets that are referenced from within the IOD.

It includes capabilities for specifying:

a. spatial registration of the input ~~datasets~~data sets

b. cropping of the volume ~~datasets~~data sets by a bounding box, oblique planes and segmentation objects

c. the generation geometry of thin and slab Multi-Planar Reconstructions

d. the method for rendering slab Multi-Planar Reconstructions

e. scalar to P-Value or RGB Value conversions

f. compositing of multiple renderings

g. clinical description of the specified view

h. volume and display relative annotations, including graphics, text and overlays

i. membership in a collection of related Volumetric Presentation States intended to be processed or displayed together

j. the temporal position within a set of temporally related Volumetric Presentation States

k. recommendations for animating the view

l. reference to an image depicting the view described by the Presentation State

The Planar MPR Volumetric Presentation State IOD is used in two SOP Classes as defined in PS3.4 Storage Service Class, a SOP Class for grayscale Presentation States intended for presenting a single input, and a SOP Class for Presentation States that composite multiple inputs into a single presentation. These are distinguished by their SOP Class UID and by the Enumerated Value of the mandatory Attribute in the MPR Volumetric Presentation State Display Module, Pixel Presentation (0008,9205).

A.80.1.2 Volumetric Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.80.1.3 Planar MPR Volumetric Presentation State IOD Module Table

Table A.80.1-1 specifies the Modules of the Planar MPR Volumetric Presentation State IOD.

Table A.80.1-1. Planar MPR Volumetric Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
	Presentation Series	C.11.9	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Presentation State	Volumetric Presentation State Identification	C.11.22	M
	Volumetric Presentation State Relationship	C.11.23	M
	Volume Cropping	C.11.24	C - Required if Global Crop (0070,120B) or any value of Crop (0070,1204) is YES
	Presentation View Description	C.11.25	M
	Multi-Planar Reconstruction Geometry	C.11.26	M
	MPR Volumetric Presentation State Display	C.11.27	M
	Volumetric Graphic Annotation	C.11.28	U
	Graphic Annotation	C.10.5	U
	Graphic Layer	C.10.7	C - Required if Graphic Layer (0070,0002) is present in the Volumetric Graphic Annotation Module or the Graphic Annotation Module
	Graphic Group	C.10.11	U
	Presentation Animation	C.11.29	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M

A.80.1.4 Planar MPR Volumetric Presentation State IOD Content Constraints

A.80.1.4.1 Presentation Input Restrictions

Presentation Input Type (0070,1202) shall have a value of VOLUME.

If the value of Pixel Presentation (0008,9205) is MONOCHROME, the Volumetric Presentation State Input Sequence (0070,1201) shall have only a single Item.

A.80.1.4.2 Multi-Planar Reconstruction Style

Multi-Planar Reconstruction Style (0070,1501) shall have a value of PLANAR.

A.80.1.4.3 Graphic Annotation Module

The following Attributes, if present, shall have a value of DISPLAY:

- Bounding Box Annotation Units (0070,0003)
- Anchor Point Annotation Units (0070,0004)
- Graphic Annotation Units (0070,0005)
- Compound Graphic Units (0070,0282)

The Display coordinates are relative to the Volumetric Presentation View produced by this Presentation State.

Note

See Annex XXX “Volumetric Presentation States (Informative)” in PS3.17 for guidance on usage of the graphic annotation styles available in this IOD.

A.80.1.4.4 Volume Cropping Module

The values of Volume Cropping Method (0070,1302) shall be selected from the following:

Enumerated Values:

BOUNDING_BOX
OBLIQUE_PLANES
INCLUDE_SEG
EXCLUDE_SEG

A.80.1.4.5 Volumetric Presentation State Reference Coordinate System

All SOP Instances referenced in the Volumetric Presentation State Relationship Module shall be registered to the Volumetric Presentation State Reference Coordinate System. See Section C.11.23.3.

A.80.2 Volume Rendering Volumetric Presentation State IOD

A.80.2.1 Volume Rendering Volumetric Presentation State IOD Description

The Volume Rendering Volumetric Presentation State Information Object Definition (IOD) specifies information that defines a Volume Rendering presentation from volume ~~datasets~~data sets that are referenced from within the IOD.

It includes capabilities for specifying:

a. spatial registration of the input ~~datasets~~data sets

b. cropping of the volume ~~datasets~~data sets by a bounding box, oblique planes and segmentation objects

c. the generation geometry of volume rendered reconstruction

d. shading models

e. scalar to RGB conversions

f. compositing of multiple volume streams and one volume stream with segmentations

g. clinical description of the specified view

h. volume-relative and display-relative annotations, including graphics, text and overlays plus optional references to structured content providing clinical context to annotations.

i. membership in a collection of related Volumetric Presentation States intended to be processed or displayed together

j. the position within a set of sequentially related Volumetric Presentation States

k. animation of the view

l. reference to an image depicting the view described by the Volumetric Presentation State

The Volume Rendering Volumetric Presentation State IOD is used in three SOP Classes as defined in PS3.4:

- one SOP Class allowing a single input volume and excluding segmentation cropping
- one SOP Class allowing a single input volume with multiple input segmentations each with a distinct classification map
- one SOP Class allowing multiple input volumes, segmentations, and classification maps

A.80.2.2 Volume Rendering Volumetric Presentation State IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Presentation State IE below the Series IE.

A.80.2.3 Volume Rendering Volumetric Presentation State IOD Module Table

Table A.80.2.3-1 specifies the Modules of the Volume Rendering Volumetric Presentation State IOD.

Table A.80.2.3-1. Volume Rendering Volumetric Presentation State IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Presentation Series	C.11.9	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Presentation State	Volumetric Presentation State Identification	C.11.22	M
	Volumetric Presentation State Relationship	C.11.23	M
	Volume Cropping	C.11.24	C - Required if Global Crop (0070,120B) or any value of Crop (0070,1204) is YES
	Presentation View Description	C.11.25	M
	Volume Render Geometry	C.11.30	M
	Render Shading	C.11.31	U
	Render Display	C.11.32	M
	Volumetric Graphic Annotation	C.11.28	U
	Graphic Annotation	C.10.5	U
	Graphic Layer	C.10.7	C Required if Graphic Layer (0070,0002) is present in the Volumetric Graphic Annotation Module or Graphic Annotation Module
	Graphic Group	C.10.11	U
	Presentation Animation	C.11.29	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M

A.80.2.4 Volume Rendering Volumetric Presentation State IOD Content Constraints

A.80.2.4.1 Presentation Input Restrictions

Presentation Input Type (0070,1202) shall have a value of VOLUME.

See Section B.5.1.24 “Volume Rendering Volumetric Presentation State Storage SOP Classes” in PS3.4 for SOP Class-specific Presentation Input Restrictions.

A.80.2.4.2 Graphic Annotation Module

The values of the following Attributes, if present, shall be DISPLAY:

- Bounding Box Annotation Units (0070,0003)
- Anchor Point Annotation Units (0070,0004)
- Graphic Annotation Units (0070,0005)
- Compound Graphics Units (0070,0282)

Note

The specified annotation is associated with the specified View and not with the input data, and may have clinical relevance only to the specified View. Therefore, if an application alters the View from that defined by the Presentation State, annotation may no longer be clinically correct.

A.80.2.4.3 Render Shading Module

If the Render Shading Module is omitted for a rendered view, an unshaded volume rendering shall be performed.

A.80.2.4.4 Volumetric Presentation State Reference Coordinate System

All SOP Instances referenced in the Volumetric Presentation State Relationship Module shall be registered to the Volumetric Presentation State Reference Coordinate System. See C.11.23.3.

A.81 Content Assessment Results IOD

A.81.1 Content Assessment Results IOD Description

This IOD represents the results of an assessment of the content of one or more SOP Instance(s). The assessment may be performed automatically without human intervention. There is no provision for encoding verification or approval by a human, although a human may be involved in determining whether the contents meet certain criteria. This IOD is not intended to communicate approval to proceed with the clinical workflow.

The Content Assessment Results SOP Instance is not required to be part of the same Study as the assessed SOP Instances.

A.81.2 Content Assessment Results IOD Entity-Relationship Model

The Content Assessment Results IOD uses the E-R Model in A.1.2, with only the Content Assessment Results IE below the Series IE. The Frame of Reference IE is not a component of this IOD.

A.81.3 Content Assessment Results IOD Module Table

Table A.81.3-1 specifies the Modules of the Content Assessment Results IOD.

Table A.81.3-1. Content Assessment Results IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M

IE	Module	Reference	Usage
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Content Assessment Results	Content Assessment Results	C.33.1	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M

A.81.4 Content Assessment Results IOD Content Constraints

A.81.4.1 Modality

The value of Modality (0008,0060) shall be ASMT.

A.82 Procedure Protocol Information Object Definitions

Procedure Protocol Information Object Definitions (IODs) encode the details of procedure protocols.

Separate IODs are defined for different types of Procedure Protocol, such as a CT image ~~acquistion~~acquisition Procedure Protocol. A CT Performed Procedure Protocol IOD encodes the details of a procedure that has been performed, and a CT Defined Procedure Protocol IOD specifies details of a procedure that may be used for one or more Procedure Protocols to be ~~peformed~~performed in the future.

A.82.1 CT Performed Procedure Protocol IOD

A.82.1.1 CT Performed Procedure Protocol IOD Description

The CT Performed Procedure Protocol IOD describes acquisition and reconstruction protocol parameter values used during a specific performed CT procedure.

A.82.1.2 CT Performed Procedure Protocol IOD Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Procedure Protocol IE below the Series IE.

A.82.1.3 CT Performed Procedure Protocol IOD Module Table

Table A.82.1.3-1. CT Performed Procedure Protocol IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U

IE	Module	Reference	Usage
	Enhanced Series	C.7.3.3	M
	CT Protocol Series	C.34.1	M
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Procedure Protocol	Protocol Context	C.34.2	M
	Patient Protocol Context	C.34.3	U
	Instructions	C.34.7	U
	Patient Positioning	C.34.8	U
	Performed CT Acquisition	C.34.10	U
	Performed CT Reconstruction	C.34.12	U
	Performed Storage	C.34.14	U
	SOP Common	C.12.1	M

A.82.2 CT Defined Procedure Protocol IOD

A.82.2.1 CT Defined Procedure Protocol IOD Description

The CT Defined Procedure Protocol IOD describes acquisition protocol parameters and related details for a defined CT procedure.

See Annex AAAA “Protocol Storage Examples and Concepts (informative)” in PS3.17 for explanatory information and examples.

A.82.2.2 CT Defined Procedure Protocol IOD Entity-Relationship Model

The Procedure Protocol in a CT Defined Procedure Protocol IOD is not associated with a specific Patient, however it is associated with the equipment that created the Instance.

The E-R model for the CT Defined Procedure Protocol IOD is shown in Figure A.82.2.2-1.

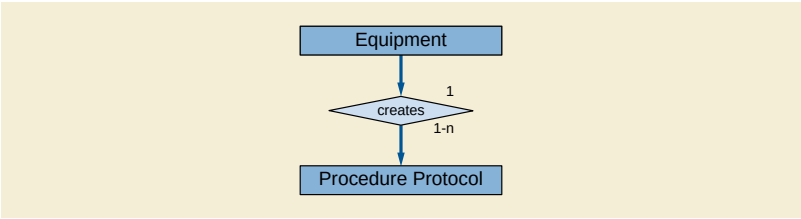


Figure A.82.2.2-1. CT Defined Procedure Protocol IOD E-R Model

A.82.2.3 CT Defined Procedure Protocol IOD Module Table

Table A.82.2.3-1. CT Defined Procedure Protocol IOD Modules

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Procedure Protocol	Protocol Context	C.34.2	M
	Clinical Trial Context	C.34.4	U

IE	Module	Reference	Usage
	Patient Specification	C.34.5	U
	Equipment Specification	C.34.6	M
	Instructions	C.34.7	U
	Patient Positioning	C.34.8	U
	Defined CT Acquisition	C.34.9	U
	Defined CT Reconstruction	C.34.11	U
	Defined Storage	C.34.13	U
	SOP Common	C.12.1	M

A.82.2.3.1 CT Defined Procedure Protocol IOD Content Constraints

A.82.2.3.1.1 Equipment Modality Attribute

The value of Equipment Modality (0008,0221) shall be CT.

Note

An application can query for Protocols by matching on the modality-specific Defined Protocol SOP Class.

A.82.3 Protocol Approval Information Object Definitions

Protocol Approval Information Object Definitions (IODs) record the details of an approval of DICOM Instances that contain protocols.

A.82.3.1 Protocol Approval IOD

A.82.3.1.1 Protocol Approval IOD Description

The Protocol Approval IOD describes approval-related Assertions made by people, organizations and devices about Instances.

A.82.3.1.2 Protocol Approval IOD Entity-Relationship Model

The E-R model for the Protocol Approval IOD is shown in Figure A.82.3.3.2-1.

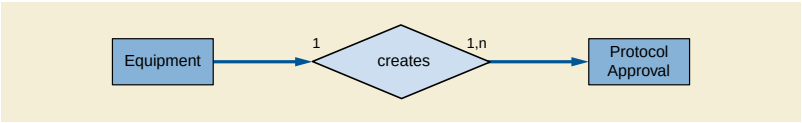


Figure A.82.3.3.2-1. Protocol Approval IOD E-R Model

A.82.3.1.3 Protocol Approval IOD Module Table

Table A.82.3.1.3-1. Protocol Approval IOD Modules

IE	Module	Reference	Usage
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Approval	SOP Common	C.12.1	M
	Protocol Approval	C.34.15	M

A.83 Ophthalmic Optical Coherence Tomography En Face Image IOD

This Section defines an Information Object to be used with several types of en face images that are derived from volumetric images obtained using OCT technology. En face images may be based upon structural OCT volumes and surface mesh information only or structural OCT volumes, surface mesh information and angiographic flow volume information.

A.83.1 Ophthalmic Optical Coherence Tomography En Face Image IOD Description

The Ophthalmic Optical Coherence Tomography En Face Image IOD specifies a single-frame image derived from images obtained using OCT technology. This IOD encodes a single derived en face image.

A.83.2 Ophthalmic Optical Coherence Tomography En Face Image IOD Entity-Relationship Model

The Ophthalmic Optical Coherence Tomography En Face Image IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2. The Series IE contains only an Image IE.

A.83.3 Ophthalmic Optical Coherence Tomography En Face Image IOD Modules

Table A.83-1 specifies the Modules of the Ophthalmic Optical Coherence Tomography En Face Image IOD.

Table A.83-1. Ophthalmic Optical Coherence Tomography En Face Image IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Tomography En Face Series	C.8.17.17	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	General Image	C.7.6.1	M
	Image Pixel	C.7.6.3	M
	Palette Color Lookup Table	C.7.9	C - Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR
	Ophthalmic Optical Coherence Tomography En Face Image	C.8.17.14	M
	Ocular Region Imaged	C.8.17.5	M
	Ophthalmic Optical Coherence Tomography En Face Image Quality Rating	C.8.17.15	C - Required if device calculates quality rating
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.83.4 Ophthalmic Optical Coherence Tomography En Face Image ~~Image~~ IOD Content Constraints

The following constraints on Series and Image Attributes take precedence over the descriptions given in the Module Attribute Tables.

A.83.4.1 Frame of Reference UID

The value for the Frame of Reference UID (0020,0052) in this SOP Instance shall convey the same value as the Frame of Reference UID (0020,0052) of the SOP Instance(s) referenced in Attribute Source Image Sequence (0008,2112).

A.84 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD

This Section defines an Information Object to be used for multi-frame images obtained from the volumetric analysis of ophthalmic tomography B-scans (e.g., ophthalmic tomography angiographic (blood flow) volume information).

A.84.1 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD Description

The Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD specifies a multi-frame image conveying ophthalmic optical coherence tomography volumetric B-scan volume analysis information (e.g., angiographic (blood flow) volume information).

A.84.2 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD Entity-Relationship Model

The Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2.

A.84.3 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD Modules

Table A.84-1 specifies the Modules of the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD.

Table A.84-1. Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Ophthalmic Tomography B-scan Volume Analysis Series	C.8.17.18	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Image	Image Pixel	C.7.6.3	M
	Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image	C.8.17.16	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	SOP Common	C.12.1	M

IE	Module	Reference	Usage
	Common Instance Reference	C.12.2	U
	Frame Extraction	C.12.3	C - Required if the SOP Instance was created in response to a Frame-Level retrieve request

A.84.3.1 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Constraints

The General Image Module, Overlay Plane Module, Modality LUT Module and VOI LUT Module shall not be used in a Standard Extended SOP Class of the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Class.

Note

In order to annotate a B-scan Volume Analysis, SOP Instances of the Grayscale Softcopy Presentation State Storage or the Structured Report Storage SOP Classes that reference the SOP Instance may be used.

Pseudo-color presentation information may be applied through the use of separate Pseudo-color Softcopy Presentation State SOP Instances.

No standard mechanism is provided for inclusion of annotations within the image SOP Instance itself and implementers are discouraged from using private extensions to circumvent this restriction.

A.84.3.2 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Functional Group Macros

Table A.84.3.2-1 specifies the use of the Functional Group Macros used in the Multi-frame Functional Groups ~~ModuleforModule~~ for the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD.

Table A.84.3.2-1. Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Plane Orientation (Patient)	C.7.6.16.2.4	M
Plane Position (Patient)	C.7.6.16.2.3	M
Frame Content	C.7.6.16.2.2	M - May not be used as a Shared Functional Group.
Referenced Image	C.7.6.16.2.5	M
Derivation Image	C.7.6.16.2.6	M - May not be used as a Shared Functional Group (see Section A.84.3.2.1.1 for specialization).
Frame Anatomy	C.7.6.16.2.8	M
Frame VOI LUT With LUT Macro	C.7.6.16.2.10b	M
Real World Value Mapping	C.7.6.16.2.11	U

A.84.3.2.1 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IOD Content Constraints

This source for an Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instance is one or more multi-frame Ophthalmic Tomography SOP Instance(s). The correlation is encoded at the Frame Level and conveyed in the Derivation Image Macro (see Section C.8.17.14.1.7 for examples).

A.84.3.2.1.1 Derivation Image Functional Group

The following constraints to the Derivation Image Macro shall apply:

1. Derivation Image Sequence (0008,9124) shall be Type 1
2. The value for Derivation Code Sequence (0008,9215) shall be (128303, DCM, "OCT B-scan analysis")
3. Source Image Sequence (0008,2112) shall be Type 1 and contain one Item. The referenced SOP Instance shall have the same value for Frame of Reference UID (0020,0052) as this SOP Instance
4. The value for Referenced SOP Class UID (0008,1150) shall be Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4")
5. The value for Purpose of Reference Code Sequence (0040,A170) shall be (128250, DCM, "Structural image for imaging processing")
6. The value for Spatial Locations Preserved (0028,135A) shall be YES

A.85 Encapsulated 3D Manufacturing Model IODs

A.85.1 Encapsulated STL IOD

A.85.1.1 Encapsulated STL IOD Description

The Encapsulated STL Information Object Definition (IOD) describes a 3D model in Stereolithography (STL) format that has been encapsulated within a DICOM Information Object.

A.85.1.2 Encapsulated STL Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Encapsulated Document IE below the Series IE.

A.85.1.3 Encapsulated STL IOD Module Table

Table A.85.1-1 specifies the Encapsulated STL IOD Modules.

Table A.85.1-1. Encapsulated STL IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	Manufacturing 3D Model	C.35.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M

IE	Module	Reference	Usage
	Common Instance Reference	C.12.2	C - Required if other Instances are referenced

Note

The Specimen Identification Module was previously included in this IOD but has been retired. See PS3.3-2008.

A.85.1.4 Encapsulated STL IOD Content Constraints

A.85.1.4.1 Encapsulated Document

The Encapsulated Document (0042,0011) Attribute shall contain a binary STL byte stream [STL 1989]. The encapsulated document may include negative vertex coordinates.

Note

1. The original STL specification in 1989 required that all 3 vertex coordinates of each triangle be located in the positive quadrant. The creators of the standard (3D Systems) later relaxed this restriction and negative coordinates were allowed. It is common practice in medical usage for STL models to align with the coordinate system of the source DICOM data, which will often result in negative vertex coordinates.
2. The Frame Of Reference UID (0020,0052) is an identifier for the origin and axes implicit in the STL data.

A.85.1.4.2 MIME Type of Encapsulated Document

Enumerated Values:

model/stl

A.85.1.4.3 Modality

Enumerated Values:

M3D

A.85.2 Encapsulated OBJ IOD

A.85.2.1 Encapsulated OBJ IOD Description

The Encapsulated OBJ Information Object Definition (IOD) describes a 3D model in OBJ format. Any supporting material library file (MTL) and supporting 2D texture map image files are addressed in other distinct IODs (see Section A.85.3.1 and Section A.8.5.4).

A.85.2.2 Encapsulated OBJ Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Encapsulated Document IE below the Series IE.

A.85.2.3 Encapsulated OBJ IOD Module Table

Table A.85.2-1 specifies the Encapsulated OBJ IOD Modules.

Table A.85.2-1. Encapsulated OBJ IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	Manufacturing 3D Model	C.35.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	C - Required if other Instances are referenced

A.85.2.4 Encapsulated OBJ IOD Content Constraints

A.85.2.4.1 Encapsulated Document

The Encapsulated Document (0042,0011) Attribute shall contain an ASCII OBJ byte stream [OBJ].

Note

The Frame Of Reference UID (0020,0052) is an identifier for the origin and axes implicit in the OBJ data.

A.85.2.4.2 MIME Type of Encapsulated Document

Enumerated Values:

model/obj

A.85.2.4.3 Modality

Enumerated Values:

M3D

A.85.3 Encapsulated MTL IOD

A.85.3.1 Encapsulated MTL IOD Description

The Encapsulated MTL Information Object Definition (IOD) describes in MTL format a materials library used by an Encapsulated OBJ 3D model (see Section A.85.2.1).

A.85.3.2 Encapsulated MTL Entity-Relationship Model

This IOD uses the E-R Model in Section A.1.2, with only the Encapsulated Document IE below the Series IE.

A.85.3.3 Encapsulated MTL IOD Module Table

Table A.85.3-1 specifies the Encapsulated MTL IOD Modules.

Table A.85.3-1. Encapsulated MTL IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	Encapsulated Document Series	C.24.1	M
	Clinical Trial Series	C.7.3.2	U
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Encapsulated Document	Encapsulated Document	C.24.2	M
	Manufacturing 3D Model	C.35.1	M
	ICC Profile	C.11.15	U
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	C - Required if other Instances are referenced

A.85.3.4 Encapsulated MTL IOD Content Constraints

A.85.3.4.1 Encapsulated Document

The Encapsulated Document (0042,0011) Attribute shall contain an ASCII MTL byte stream [OBJ].

A.85.3.4.2 MIME Type of Encapsulated Document

Enumerated Values:

model/mtl

A.85.3.4.3 Modality

Enumerated Values:

M3D

A.86 RT Second Generation

A.86.1 RT Second Generation Objects

This section provides a brief description of the IODs of RT Second Generation. Specifically, this description includes:

- The Real-World Object which is represented by the IOD.
- Information as to the scope of the represented object, if appropriate.

A.86.1.1 RT Second Generation Common Information

This section provides a description of the Module structure which is shared by the RT Second Generation IODs.

A.86.1.1.1 RT Second Generation Entity-Relationship Model

The E-R Model in Figure A.86.1.1.1-1 depicts those components of the DICOM Information Model that are relevant to RT Second Generation IODs.

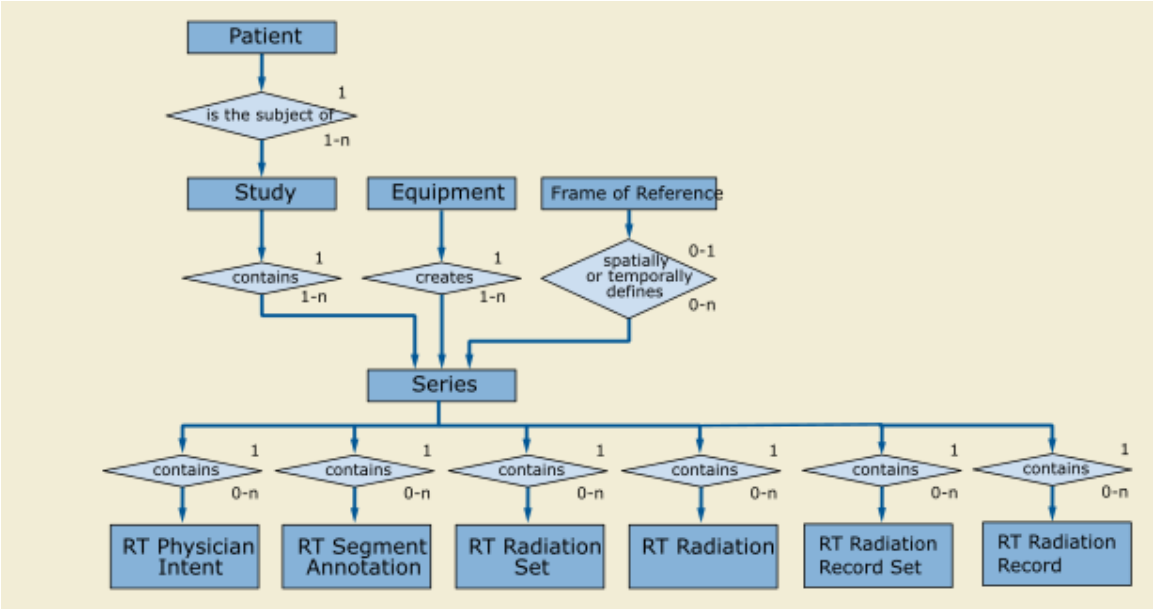


Figure A.86.1.1.1-1. RT Second Generation IOD Information Model

A.86.1.1.1.1 Use of Study and Series in RT Second Generation Radiotherapy

For first generation IODs, no specific semantics are attached to a Study or a Series in RT. Similarly, for RT Second Generation IODs, internal references shall be used to relate and locate SOP Instances rather than making assumptions about how related SOP Instances are grouped into Studies or Series. For practical reasons it may be indicated to create a new Study separate from imaging Studies that are used for radiotherapeutic planning because of billing or reimbursement for Series that contain RT Instances.

Implementers should also note that the DICOM Standard, in general, does place some restrictions on how such SOP Instances should be grouped, as defined in Section A.1.2.3.

For non-image modalities like radiotherapy, the Series may not be the most efficient way to search for objects. Instead, an application might find it easier to use references in the RT Course object, Key Object Selection objects or Unified Worklist Procedure Steps to directly retrieve required Instances rather than search for them.

A.86.1.2 RT Physician Intent IOD

A.86.1.2.1 RT Physician Intent IOD Description

The RT Physician Intent IOD carries the prescriptions by which the physician describes the therapeutic goal and strategy for the radiotherapeutic treatment.

A.86.1.2.2 RT Physician Intent IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.2.3 RT Physician Intent IOD Module Table

Table A.86.1.2-1. RT Physician Intent IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
RT Physician Intent	General Reference	C.12.4	M
	RT Physician Intent	C.36.5	M
	RT Enhanced Prescription	C.36.6	U
	RT Treatment Phase Intent	C.36.7	C - Required if RT Treatment Phase Intent Presence Flag (3010,0045) equals YES.
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.2.4 RT Physician Intent IOD Constraints

A.86.1.2.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTINTENT.

A.86.1.2.4.2 Radiotherapy Common Instance Module

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9536 “Radiotherapy Prescribing and Segmenting Person Roles” shall be used.

A.86.1.3 RT Segment Annotation IOD

A.86.1.3.1 RT Segment Annotation IOD Description

The RT Segment Annotation IOD annotates any general-purpose entity that represents geometric information such as Segmentation IOD, Surface Segmentation IOD, and RT Structure Set IOD with radiotherapy-specific information that cannot be encoded in the content of the annotated SOP Instance, or overrides that content with new or additional interpretation.

A.86.1.3.2 RT Segment Annotation IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.3.3 RT Segment Annotation IOD Module Table

Table A.86.1.3-1. RT Segment Annotation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U

IE	Module	Reference	Usage
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
RT Segment Annotation	RT Segment Annotation	C.36.8	M
	Segment Reference	C.36.9	M
	General Reference	C.12.4	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.3.4 RT Segment Annotation IOD Constraints

A.86.1.3.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTSEGANN.

A.86.1.3.4.2 Radiotherapy Common Instance Module

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9536 “Radiotherapy Prescribing and Segmenting Person Roles” shall be used.

A.86.1.4 RT Radiation Set IOD

A.86.1.4.1 RT Radiation Set IOD Description

The RT Radiation Set IOD represents an RT Radiation Set, which is a set of radiation deliveries that are intended to be delivered together in a single fraction (see Section 7.14.5). The RT Radiation Set also contains a description of the fractionation pattern, the intended number of fractions and the associated dose contributions.

A.86.1.4.2 RT Radiation Set IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.4.3 RT Radiation Set IOD Module Table

Table A.86.1.4-1. RT Radiation Set IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M

IE	Module	Reference	Usage
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
RT Radiation Set	General Reference	C.12.4	M
	RT Radiation Set	C.36.10	M
	RT Dose Contribution	C.36.11	C - Required if the dose delivered is tracked.
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.4.4 RT Radiation Set IOD Constraints

A.86.1.4.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.4.4.2 RT Radiation Set and Referenced RT Radiation Instances

The User Content Label (3010,0033) in each RT Radiation Instance shall be unique across all SOP Instances referenced by an Instance of the RT Radiation Set.

A.86.1.4.4.3 Radiotherapy Common Instance Module

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9555 “Radiotherapy Treatment Planning Person Roles” shall be used.

A.86.1.4.4.4 RT Dose Contribution Module

Where dose contributions are not available at the time of RT Radiation Set definition and application (e.g., for emergency treatments) this Module may be absent. This does not exclude retrospective dose calculation and creation of associated RT Dose Image objects.

A.86.1.5 C-Arm Photon-Electron Radiation IOD

A.86.1.5.1 C-Arm Photon-Electron Radiation IOD Description

The C-Arm Photon-Electron Radiation IOD describes a radiotherapy treatment to be performed on a C-Arm delivery device using photon or electron radiation.

A.86.1.5.2 C-Arm Photon-Electron Radiation IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.5.3 C-Arm Photon-Electron Radiation IOD Module Table

Table A.86.1.5-1. C-Arm Photon-Electron Radiation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
RT Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Common	C.36.13	M
	C-Arm Photon-Electron Delivery Device	C.36.14	M
	C-Arm Photon-Electron Beam	C.36.15	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.5.4 C-Arm Photon-Electron Radiation IOD Constraints

A.86.1.5.4.1 Modality Attribute

The Value of Modality (0008,0060) shall be RTRAD.

A.86.1.5.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference; see Section C.36.12.2.1.

The Frame of Reference identifies the Patient Coordinate System used to define the geometric setup of the radiation beam with respect to the patient. The relationship of the patient-based coordinates to the Equipment Frame of Reference is specified by a transformation (see Section 10.39).

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9552 “C-Arm Photon-Electron Dosimeter Units”.

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.5.4.3 RT Radiation Common Module

The value of RT Record Flag (300A,0639) shall be NO.

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9511 “General External Radiotherapy Procedure Techniques”.
Treatment Machine Special Mode Code Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”.

A.86.1.5.4.4 Radiotherapy Common Instance Module

The following Code Sequences shall have a value from the specified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	Organizational Role Code Sequence (0044,010A) DCID 9555 “Radiotherapy Treatment Planning Person Roles”

A.86.1.6 Tomotherapeutic Radiation IOD

A.86.1.6.1 Tomotherapeutic Radiation IOD Description

The Tomotherapeutic Radiation IOD represents the information required to describe a radiotherapy treatment on a serial or helical tomotherapeutic delivery device.

A.86.1.6.2 Tomotherapeutic Radiation IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.6.3 Tomotherapeutic Radiation IOD Module Table

Table A.86.1.6-1. Tomotherapeutic Radiation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
RT Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Common	C.36.13	M
	Tomotherapeutic Delivery Device	C.36.16	M
	Tomotherapeutic Beam	C.36.17	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M

IE	Module	Reference	Usage
	Radiotherapy Common Instance	C.36.4	M

A.86.1.6.4 Tomotherapeutic Radiation IOD Constraints

A.86.1.6.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.6.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference; see Section C.36.12.2.1.

The Frame of Reference identifies the Patient Coordinate System used to define the geometric setup of the radiation beam with respect to the patient. The relationship of the patient-based coordinates to the Equipment Frame of Reference is specified by a transformation (see Section 10.39).

The following Code Sequence shall have a value from the identified CID:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9557 “Tomotherapeutic Dosimeter Units”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.6.4.3 RT Radiation Common Module

The value of RT Record Flag (300A,0639) shall be NO.

The following Code Sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9512 “Tomotherapeutic Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Code Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.6.4.4 Radiotherapy Common Instance Module

The following code sequence shall have a value from the identified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	Organizational Role Code Sequence (0044,010A) DCID 9555 “Radiotherapy Treatment Planning Person Roles”

A.86.1.7 Robotic-Arm Radiation IOD

A.86.1.7.1 Robotic-Arm Radiation IOD Description

The Robotic-Arm Radiation IOD specifies the Robotic Path and collimation parameters required to describe a radiotherapy treatment on a robotic-arm delivery device. A Robotic Path is a sequence of Robotic Nodes. A Robotic Node specifies a Radiation Source location for a Robotic-Arm delivery device.

A.86.1.7.2 Robotic-Arm Radiation IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.7.3 Robotic-Arm Radiation IOD Module Table

Table A.86.1.7-1. Robotic-Arm Radiation IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
RT Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Common	C.36.13	M
	Robotic-Arm Delivery Device	C.36.18	M
	Robotic-Arm Path	C.36.19	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.7.4 Robotic-Arm Radiation IOD Module Constraints

A.86.1.7.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.7.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.2, which identifies the Standard Robotic-Arm Coordinate System Frame of Reference; see Section C.36.12.2.2.

The Frame of Reference identifies the Patient Coordinate System used to define the geometric setup of the radiation beam with respect to the patient. The relationship of the patient-based coordinates to the Equipment Frame of Reference is specified by a transformation (see Section 10.39).

The following code sequences shall have a value from the identified CID:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9559 “Robotic Delivery Device Dosimeter Units”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, “Nominal Radiation Source Location”).

A.86.1.7.4.3 RT Radiation Common Module

The value of RT Record Flag (300A,0639) shall be NO.

The following code sequences shall have a value from the identified CID:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9523 “Robotic Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Code Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.7.4.4 Radiotherapy Common Instance Module

The following code sequence shall have a value from the identified CID:

Code Sequence	CID
Author Identification Sequence (3010,0019)	Organizational Role Code Sequence (0044,010A) DCID 9555 “Radiotherapy Treatment Planning Person Roles”

A.86.1.8 RT Radiation Record Set IOD

The RT Radiation Record Set IOD contains the record of a radiotherapy treatment that has been performed based on an RT Radiation Set SOP Instance.

A.86.1.8.1 RT Radiation Record Set IOD Description

A.86.1.8.2 RT Radiation Record Set IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.8.3 RT Radiation Record Set IOD Module Table

Table A.86.1.8-1. RT Radiation Record Set IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
RT Delivered Radiation	General Reference	C.12.4	M
	RT Radiation Record Set	C.36.20	M
	RT Dose Contribution Record	C.36.21	C - Required if the dose delivered is tracked.
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.8.4 RT Radiation Record Set IOD Constraints

A.86.1.8.4.1 RT Dose Contribution Record

Where dose contributions are not available at the time of delivery of the radiotherapeutic treatments specified by the RT Radiation Set IOD (e.g., for emergency treatments), the RT Dose Contribution Record Module may be absent. This does not exclude retrospective dose calculation and creation of associated RT Dose Image objects.

A.86.1.9 RT Radiation Salvage Record IOD

A.86.1.9.1 RT Radiation Salvage Record IOD Description

The RT Radiation Salvage Record IOD contains the record of a complete or partial fraction of therapeutic radiation delivered using any therapeutic device where recording by the modality-specific RT Radiation Record IOD was not possible.

A device usually creates RT Radiation Record SOP Instances using modality-specific RT Radiation Record IODs and transfers these Instances to a system that captures treatment records. If this process fails (e.g. because of failed transfer operations) and the recorded SOP Instances are not recoverable from the device, the RT Radiation Salvage Record IOD may be used to represent radiation delivery captured by a manual entry of the delivered treatment. Systems providing manual entry capabilities might not be able to create a modality-specific RT Radiation Record SOP Instance covering all device-specific parameters in question and/or the user might not know all the details. Therefore, the modality-specific RT Radiation Record IODs cannot be properly populated. The RT Radiation Salvage Record IOD allows essential information to be recorded.

A.86.1.9.2 RT Radiation Salvage Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.9.3 RT Radiation Salvage Record IOD Module Table

Table A.86.1.9-1. RT Radiation Salvage Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	U
RT Delivered Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.22	M
	RT Radiation Salvage Record ~~Module~~	C.36.23	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.9.4 RT Radiation Salvage Record IOD Constraints

A.86.1.9.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.9.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall have the value used by the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	Defined CID is the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

A.86.1.9.4.3 RT Radiation Record Common Module

The value of RT Record Flag (300A,0639) shall be YES.

The value of Treatment Record Content Origin (300A,0709) shall be USER.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	Defined CID is the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.
Treatment Machine Special Mode Sequence (300A,0635)	Defined CID is the CID specified for the SOP Instance referenced in the Referenced RT Instance Sequence (300A,0631) of the RT Radiation Record Common Module.

A.86.1.9.4.4 Radiotherapy Common Instance Module

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9562 “Radiotherapy Treatment Delivery Person Roles” shall be used.

A.86.1.9.4.5 Frame of Reference Module

The Frame of Reference UID (0020,0052) identifies the patient-based Frame of Reference while the therapeutic radiation was delivered. The Frame of Reference UID relates the geometric parameters of this SOP Instance to other SOP Instances such as Images, Segmentations, etc. If the patient moves with respect to the patient positioning device between the delivery recorded by the current SOP Instance and another SOP Instance, a new Frame of Reference UID shall be issued for any SOP Instances created after the move. See also Section C.7.4.1.

The relationship between the patient-oriented coordinate system identified by this Frame of Reference and the Equipment Coordinate System is described in Section 10.39.1.

A.86.1.10 C-Arm Photon-Electron Radiation Record IOD

A.86.1.10.1 C-Arm Photon-Electron Radiation Record IOD Description

The C-Arm Photon-Electron Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a C-Arm Photon-Electron Radiation SOP Instance.

A.86.1.10.2 C-Arm Photon-Electron Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.10.3 C-Arm Photon-Electron Radiation Record IOD Module Table

Table A.86.1.10.3-1. C-Arm Photon-Electron Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
RT Delivered Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.22	M
	C-Arm Photon-Electron Delivery Device	C.36.14	M
	C-Arm Photon-Electron Beam	C.36.15	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.10.4 C-Arm Photon-Electron Radiation Record IOD Constraints

A.86.1.10.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.10.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference, see Section C.36.12.2.1.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9552 “C-Arm Photon-Electron Dosimeter Units”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, "Nominal Radiation Source Location").

A.86.1.10.4.3 RT Radiation Record Common Module

The value of RT Record Flag (300A,0639) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) shall be IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9511 “General External Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.10.4.4 Radiotherapy Common Instance Module

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9562 “Radiotherapy Treatment Delivery Person Roles” shall be used.

A.86.1.10.4.5 Frame of Reference Module

See Section A.86.1.9.4.5.

A.86.1.11 Tomotherapeutic Radiation Record IOD

A.86.1.11.1 Tomotherapeutic Radiation Record IOD Description

The Tomotherapeutic Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a Tomotherapeutic Radiation SOP Instance.

A.86.1.11.2 Tomotherapeutic Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.11.3 Tomotherapeutic Radiation Record IOD Module Table

Table A.86.1.11-1. Tomotherapeutic Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied

IE	Module	Reference	Usage
RT Delivered Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.22	M
	Tomotherapeutic Delivery Device	C.36.16	M
	Tomotherapeutic Beam	C.36.17	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.11.4 Tomotherapeutic Radiation Record IOD Constraints

A.86.1.11.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.11.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be1.2.840.10008.1.4.3.1, which identifies the IEC 61217 Fixed Coordinate System Frame of Reference, see Section C.36.12.2.1.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9557 “Tomotherapeutic Dosimeter Units”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, "Nominal Radiation Source Location").

A.86.1.11.4.3 RT Radiation Record Common Module

The value of RT Record Flag (300A,0639) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) shall be IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9512 “Tomotherapeutic Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.11.4.4 Radiotherapy Common Instance Module

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Author Identification Sequence (3010,0019)	Organizational Role Code Sequence (0044,010A) DCID 9562 “Radiotherapy Treatment Delivery Person Roles”.

A.86.1.11.4.5 Frame of Reference Module

See Section A.86.1.9.4.5.

A.86.1.12 Robotic-Arm Radiation Record IOD

A.86.1.12.1 Robotic-Arm Radiation Record IOD Description

The Robotic-Arm Radiation Record IOD contains the record of a radiotherapy treatment that has been performed using a Robotic-Arm Radiation SOP Instance.

A.86.1.12.2 Robotic-Arm Radiation Record IOD Entity-Relationship Model

See Figure A.86.1.1.1-1.

A.86.1.12.3 Robotic-Arm Radiation Record IOD Module Table

Table A.86.1.12-1. Robotic-Arm Radiation Record IOD Modules

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
	Enhanced RT Series	C.36.3	M
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C - Required if time synchronization was applied
RT Delivered Radiation	General Reference	C.12.4	M
	RT Delivery Device Common	C.36.12	M
	RT Radiation Record Common	C.36.22	M
	Robotic-Arm Delivery Device	C.36.18	M
	Robotic-Arm Path	C.36.19	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	M
	Radiotherapy Common Instance	C.36.4	M

A.86.1.12.4 Robotic-Arm Radiation Record IOD Constraints

A.86.1.12.4.1 Modality Attribute

The value of Modality (0008,0060) shall be RTRAD.

A.86.1.12.4.2 RT Delivery Device Common Module

The Equipment Frame of Reference UID (300A,0675) shall be 1.2.840.10008.1.4..3.2, which identifies the Standard Robotic-Arm Coordinate System Frame of Reference, see Section C.36.12.2.2.

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Radiation Dosimeter Unit Sequence (300A,0658)	DCID 9559 “Robotic Delivery Device Dosimeter Units”

The RT Device Distance Reference Location Code Sequence (300A,0659) shall contain the value (130358, DCM, "Nominal Radiation Source Location").

A.86.1.12.4.3 RT Radiation Record Common Module

The value of RT Record Flag (300A,0639) shall be YES. The value of RT Radiation Physical and Geometric Content Detail Flag (300A,0638) shall be IDENT_ONLY.

The following code sequences shall have a value from the identified CIDs:

Code Sequence	CID
RT Treatment Technique Code Sequence (3010,0080)	DCID 9523 “Robotic Radiotherapy Procedure Techniques”
Treatment Machine Special Mode Sequence (300A,0635)	DCID 9543 “Radiotherapy Treatment Machine Modes”

A.86.1.12.4.4 Radiotherapy Common Instance Module

The following code sequences shall have values from the identified CIDs:

Code Sequence	CID
Author Identification Sequence (3010,0019)	For Organizational Role Code Sequence (0044,010A) DCID 9562 “Radiotherapy Treatment Delivery Person Roles” shall be used.

A.86.1.12.4.5 Frame of Reference Module

See Section A.86.1.9.4.5.

B Normalized Information Object Definitions (Normative)

B.1 Patient Information Object Definition

Retired. See PS3.3-2004.

B.2 Visit Information Object Definition

Retired. See PS3.3-2004.

B.3 Study Information Object Definition

Retired. See PS3.3-2004.

B.4 Study Component Information Object Definition

Retired. See PS3.3-2004.

B.5 Results Information Object Definition

Retired. See PS3.3-2004.

B.6 Interpretation Information Object Definition

Retired. See PS3.3-2004.

B.7 Basic Film Session Information Object Definition

B.7.1 IOD Description

The Basic Film Session Information Object Definition describes the presentation parameters that are common for all the films of a film session (e.g., number of films, film destination).

B.7.2 IOD Modules

Table B.7-1. Film Session IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Film Session Presentation	C.13.1	Contains Film Session presentations information
Basic Film Session Relationship	C.13.2	References to related SOP Classes

B.8 Basic Film Box Information Object Definition

B.8.1 IOD Description

The Basic Film Box Information Object Definition is an abstraction of the presentation of one film of the film session. The Basic Film Box IOD describes the presentation parameters that are common for all images on a given sheet of film.

B.8.2 IOD Modules

Table B.8-1. Basic Film Box IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Film Box Presentation	C.13.3	Contains Film Box presentation information
Basic Film Box Relationship	C.13.4	References to related SOP Classes

B.9 Basic Image Box Information Object Definition

B.9.1 IOD Description

The Basic Image Box Information Object Definition is an abstraction of the presentation of an image and image related data in the image area of a film. The Basic Image Box IOD describes the presentation parameters and image pixel data that apply to a single image of a sheet of film.

B.9.2 IOD Modules

Table B.9-1. Basic Image Box IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Image Box Presentation	C.13.5	Contains Image Box presentation information

The Image Box Relationship Module (Retired) was previously defined in DICOM. It is now retired. See PS3.3-1998.

B.10 Basic Annotation Box Information Object Definition

B.10.1 IOD Description

The Basic Annotation Box Information Object Definition is an abstraction of the presentation of an annotation (e.g., text string) on a film. The Basic Annotation Box IOD describes the most used text related presentation parameters.

B.10.2 IOD Modules

Table B.10-1. Basic Annotation Box IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Basic Annotation Presentation	C.13.7	Contains annotation presentation information

B.11 Print Job Information Object Definition

B.11.1 IOD Description

The Print Job Information Object Definition is an abstraction of the print job transaction and is the basic information entity to monitor the execution of the print process. A print job contains one film or multiple films, all belonging to the same film session.

B.11.2 IOD Modules

Table B.11-1. Print Job IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Print Job	C.13.8	Contains print job transaction information

B.12 Printer Information Object Definition

B.12.1 IOD Description

The Printer Information Object Definition is an abstraction of the hardcopy printer and is the basic information entity to monitor the status of the printer.

B.12.2 IOD Modules

Table B.12-1. Printer IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information
Printer	C.13.9	Contains status information to monitor the printer

B.13 VOI LUT Box Information Object Definition (Retired)

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

B.14 Image Overlay Box Information Object Definition (Retired)

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

B.15 Storage Commitment Information Object Definition

B.15.1 Storage Commitment IOD Description

The Storage Commitment IOD describes the Attributes that may be present in a Storage Commitment Request or Response. The SOP Instances referenced by the Storage Commitment IOD are not restricted to images and may include other SOP Instances.

B.15.2 Storage Commitment IOD Modules

Table B.15-1 identifies and defines the Modules that comprise this IOD. The requirements for whether Attributes in these Modules are mandatory or optional are as specified in PS3.4.

Table B.15-1. Storage Commitment IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Storage Commitment	C.14	Contains references to the SOP Instances and associated information that are contained in Storage Commitment.

B.16 Print Queue Information Object Definition

Retired. See PS3.3-2004.

B.17 Modality Performed Procedure Step Information Object Definition

B.17.1 IOD Description

A "Modality Performed Procedure Step Information Object Definition" is an abstraction of the information that describes the activities, conditions and results of an imaging procedure performed on a modality. It contains information about the Modality Performed Procedure Step (MPPS) and its relations to other Information Entities of the DICOM real-world model as introduced in this Part.

A Modality Performed Procedure Step is related to the actual imaging procedure carried out at the modality. Other types of Performed Procedure Steps, e.g., reporting or image processing, are not covered by the Modality Performed Procedure Step IOD. The information gathered includes data about the performance of the procedure itself, and data for billing and material management. The Modality Performed Procedure Step IOD includes general PPS Modules and image acquisition specific ones, such as Image Acquisition Results, and Billing and Material Management.

B.17.2 IOD Modules

Table B.17.2-1 lists the Modules that make up the Modality Performed Procedure Step IOD.

Table B.17.2-1. Modality Performed Procedure Step IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Performed Procedure Step Relationship	C.4.13	References the related SOPs and IEs.
Performed Procedure Step Information	C.4.14	Includes identifying and status information as well as place and time
Image Acquisition Results	C.4.15	Identifies Series and Images related to this PPS and specific image acquisition conditions.
Billing and Material Management Codes	C.4.17	Contains codes for billing and material management.

Note

The Radiation Dose Module has been retired. See PS3.3 2017c.

B.18 Presentation LUT Information Object Definition

B.18.1 IOD Description

The Presentation LUT Information Object is an abstraction of a Presentation LUT. The objective of the Presentation LUT is to realize image display tailored for specific modalities, applications, and user preferences. It is used to prepare image pixel data for display on devices that conform to the Grayscale Standard Display Function defined in PS3.14.

The output of the Presentation LUT is Presentation Values (P-Values). P-Values are approximately related to human perceptual response. They are intended to facilitate common input for both hardcopy and softcopy display devices. P-Values are intended to be independent of the specific class or characteristics of the display device.

B.18.2 IOD Modules

Table B.18.2-1. Presentation LUT IOD Modules

Module	Reference	Module Description
SOP Common Information	C.12.1	
Presentation LUT	C.11.4	

B.19 Pull Print Request Information Object Definition

Retired. See PS3.3-2004.

B.20 Printer Configuration Information Object Definition

B.20.1 IOD Description

The Printer Configuration IOD describes key imaging characteristics of the printer.

B.20.2 IOD Modules

Table B.20-1. Printer Configuration IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common Information
Printer	C.13.9	Contains information about the printer
Printer Configuration	C.13.13	Contains Printer Configuration Information

B.21 Basic Print Image Overlay Box Information Object Definition

Retired. See PS3.3-2004.

B.22 General Purpose Scheduled Procedure Step Information Object Definition (Retired)

Retired. See PS3.3-2011.

B.23 General Purpose Performed Procedure Step Information Object Definition (Retired)

Retired. See PS3.3-2011.

B.24 Instance Availability Notification Information Object Definition

B.24.1 IOD Description

An "Instance Availability Notification Information Object Definition" is a summary of the information that describes the availability of a set of Composite Instances.

B.24.2 IOD Modules

Table B.24.2-1 lists the Modules that make up the Instance Availability Notification IOD.

Table B.24.2-1. Instance Availability Notification IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Instance Availability Notification	C.4.23	References the related SOPs and IEs.

B.25 Media Creation Management Information Object Definition

B.25.1 IOD Description

A "Media Creation Management Information Object Definition" is an abstraction of the information that describes the Attributes and the status of a media creation request.

B.25.2 IOD Modules

Table B.25.2-1 lists the Modules that make up the Media Creation Management IOD.

Table B.25.2-1. Media Creation Management IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Media Creation Management	C.22.1	Contains references to the SOP Instances to be used for this media creation request, and the information about its status.

B.26 Unified Procedure Step Information Object Definition

B.26.1 IOD Description

A Unified Procedure Step (UPS) describes the details of a procedure step that has been scheduled, the progress details during performance, and the details of the procedure step actually performed in response.

B.26.2 IOD Modules

Table B.26.2-1 lists the Modules that make up the Unified Procedure Step IOD.

Table B.26.2-1. Unified Procedure Step IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Unified Procedure Step Relationship	C.30.4	References the related SOPs and IEs
Unified Procedure Step Scheduled Procedure Information	C.30.2	Describes the UPS task to be performed including information about place, time, priority and input data
Unified Procedure Step Progress Information	C.30.1	Describes the progress of a UPS task
Unified Procedure Step Performed Procedure Information	C.30.3	Describes the work performed including information about status, place, time and result data
Patient Demographic	C.2.3	Describes the Patient at the time of scheduling
Patient Medical	C.2.4	Describes the Patient's medical state or history
Visit Identification	C.3.2	Attributes relevant to identifying a Visit
Visit Status	C.3.3	Attributes relevant to the Patient's stay with the healthcare provider
Visit Admission	C.3.4	Attributes relevant to admitting a Patient during a Visit

B.27 RT Conventional Machine Verification Information Object Definition

B.27.1 IOD Description

The RT Conventional Machine Verification IOD describes the Attributes that are required by an external Machine Parameter Verifier (MPV) when performing verification of a conventional (photon or electron) radiation therapy treatment, prior to delivery.

B.27.2 IOD Modules

Table B.27.2-1. RT Conventional Machine Verification IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common Information

Module	Reference	Module Description
RT General Machine Verification	C.31.1	Contains general delivery verification information
RT Conventional Machine Verification	C.31.2	Contains delivery verification information specific to conventional (photon or electron) machines

B.28 RT Ion Machine Verification Information Object Definition

B.28.1 IOD Description

The RT Ion Machine Verification IOD describes the Attributes that are required by an external Machine Parameter Verifier (MPV) when performing verification of an ion radiation therapy treatment, prior to delivery.

B.28.2 IOD Modules

Table B.28.2-1. RT Ion Machine Verification IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common Information
RT General Machine Verification	C.31.1	Contains general delivery verification information
RT Ion Machine Verification	C.31.3	Contains delivery verification information specific to ion machines

B.29 Display System Information Object Definition

B.29.1 IOD Description

An Instance of the Display System IOD describes all of the Display Subsystems in a given Display System.

Display Subsystems are described in terms of their equipment identification, display performance (luminance, uniformity, etc.) and the corresponding configurations. Although a variety of components (controllers, cables, display devices, etc.) contribute to the performance of the Display Subsystem to which they belong, these details are not exposed in the abstraction of the Display Subsystem. Similarly, each Display Subsystem is addressed independently even though one controller might drive display devices in multiple Display Subsystems or multiple controllers might drive a single display device. Effectively, the Display Subsystem represents the display device and any components involved behind it.

The IOD only describes emissive display systems.

Note

Hanging Protocols manage Screens based on their physical location and arrangement. This IOD does not describe the spatial positioning of Display Devices. There is usually a 1:1 relationship between a Display Subsystem in this IOD and a Hanging Protocol Screen.

Table B.29-1. Display System IOD Modules

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP Common information.
Display System	C.32.1	Describes the Display System. The Display System has one or more Display Subsystem. A Display Subsystem corresponds to one Display Device.
Target Luminance Characteristics	C.32.2	Describes the target luminance characteristics of the Display Subsystem(s)
QA Results	C.32.3	Describes the results of QA performed on the Display Subsystem(s).

C Information Module Definitions (Normative)

C.1 Elements of a Module Definition

A Module Definition is composed of the following Sections

a. Module Description

b. Module Definition

c. Attribute Description (Optional)

Section C.1.1, Section C.1.2 and Section C.1.3 define the requirements of a. through c. above.

C.1.1 Module Description

This Section briefly describes the Module and references the Module Definition.

C.1.2 Module Definition

This Section contains a table that enumerates each Attribute contained in the Module. For each Attribute in the table the following information is given:

a. Attribute Name (see Section C.1.2.1)

b. Data Element Tag (see Section C.1.2.2)

c. Type Designation (see Section C.1.2.3)

d. Attribute Definition (see Section C.1.2.4)

C.1.2.1 Attribute Name

This name shall be used whenever referencing the Attribute. This name shall also identify the Attribute in PS3.6.

C.1.2.2 Attribute Tag

Each Attribute has a Data Element Tag that uniquely identifies the Attribute (also used for encoding into a Data Set - see PS3.5). This tag also serves as an index into the Data Dictionary of PS3.6.

C.1.2.3 Type Designation

Each Attribute contained in a Module referenced by a Composite IOD defines a Type designation that indicates if a specific Attribute is required for all DIMSE operations/notifications associated with a SOP Class using this Module. PS3.5 defines a choice of generic Type designations available for DICOM Attributes.

Note

The Type designation specified is generally determined by the value most appropriate for the C-STORE DIMSE Service.

The Type designation given in a Module is a default value and as such may be overridden by an IOD referencing the Module. Some Attributes may also be contained in more than one Module for the IOD. In that case, the Type designation applicable for the Attribute of the specific IOD is the lowest Type value (e.g., if type 2 is specified in one Module and type 3 in another, then type 2 shall apply), unless explicitly stated by the Attribute description.

The Type designation given in a Module (and/or IOD) may also be overridden by Service Class Definitions referencing the IOD containing the Module. PS3.4 specifies the Service Class Definitions.

Modules referenced only by Normalized IODs do not contain Type designations. Modules referenced by both Normalized IODs and Composite IODs will contain a Type designation that only applies to Composite IODs and any specific conditions for Conditional Types (type 1C and 2C) also only apply to Composite IODs.

C.1.2.4 Attribute Definition

A brief definition will be provided for each Attribute in the Module definition table. The description shall provide a context for the use of the Attribute and provide general elucidation. Defined Terms and Enumerated Values applicable to the Attribute may also be listed in the Attribute Description.

C.1.3 Attribute Descriptions

Additional information may be provided if necessary for selected Attributes. Such information shall be placed following the Module definition table. Dependencies between Attributes may be specified in this Section.

C.2 Patient Modules

The following Sections specify Modules used for Patient management.

C.2.1 Patient Relationship Module

Table C.2-1 defines the Attributes that reference SOP Instances related to this SOP Class.

Table C.2-1. Patient Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with the Patient SOP Instance. One or more Items shall be included in this Sequence. See Section 10.6.1.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Visit Sequence	(0008,1125)	Uniquely identifies the Visit SOP Instances associated with this Patient SOP Instance. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Patient Alias Sequence	(0038,0004)	Uniquely identifies any Patient SOP Instances that also describe this Patient. These SOP Instances are aliases. Zero or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		

C.2.2 Patient Identification Module

Table C.2-2 defines the Attributes relevant to identifying a Patient.

Table C.2-2. Patient Identification Module Attributes

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full name

Attribute Name	Tag	Attribute Description
Patient ID	(0010,0020)	Primary identifier for the Patient. Note In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.
Include Table 10-18 "Issuer of Patient ID Macro Attributes"		
Type of Patient ID	(0010,0022)	The type of identifier in the Patient ID (0010,0020). Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the Scheduled Procedure Step Module, if present.
Other Patient IDs Sequence	(0010,1002)	A Sequence of identification numbers or codes used to identify the Patient, which may or may not be human readable, and may or may not have been obtained from an implanted or attached device such as an RFID or barcode. One or more Items are permitted in this Sequence. Note This Attribute replaces the use of Other Patient IDs (0010,1000), which did not specify an issuer for each other identifier, and which has been retired.
>Patient ID	(0010,0020)	An identifier for the Patient.
>Include Table 10-18 "Issuer of Patient ID Macro Attributes"		
>Type of Patient ID	(0010,0022)	The type of identifier in the Patient ID (0010,0020) in this Item. Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the Scheduled Procedure Step Module, if present.

Attribute Name	Tag	Attribute Description
Other Patient Names	(0010,1001)	Other names used to identify the Patient.
Patient's Birth Name	(0010,1005)	Patient's birth name.
Patient's Mother's Birth Name	(0010,1060)	Birth name of Patient's mother.
Referenced Patient Photo Sequence	(0010,1100)	A photo to confirm the identity of a Patient. Only a single Item is permitted in this Sequence. See C.2.2.1.1.
>Include Table 10-3b "Referenced Instances and Access Macro Attributes"		
Include Table C.7.1.4-1 "Patient Group Macro Attributes"		

Note

Previously, Other Patient IDs (0010,1000) and Medical Record Locator (0010,1090) were included in this table. These Attributes have been retired. See PS3.3 2017a.

C.2.2.1 Patient Identification Module Attributes

C.2.2.1.1 Referenced Patient Photo Sequence

A Patient Photo may be provided as an additional means to confirm the identity of the Patient.

When the Referenced SOP Sequence (0008,1199) is present, the Referenced SOP Class UID (0008,1150) shall be either VL Photographic Image Storage (1.2.840.10008.5.1.4.1.1.77.1.4) or Secondary Capture Image Storage (1.2.840.10008.5.1.4.1.1.7).

When the WADO Retrieval Sequence (0040,E023) or WADO-RS Retrieval Sequence (0040,E025) is present, the Retrieve URI (0040,E010) shall refer to a JPEG image if the referenced server is not WADO-compliant.

C.2.3 Patient Demographic Module

Table C.2-3 defines the Attributes relevant to generally describing a Patient at a specific point in time, e.g., at the time of admission.

Table C.2-3. Patient Demographic Module Attributes

Attribute Name	Tag	Attribute Description
Patient's Age	(0010,1010)	Age of the Patient.
Occupation	(0010,2180)	Occupation of the Patient.
Confidentiality Constraint on Patient Data Description	(0040,3001)	Special indication to the modality operator about confidentiality of Patient information (e.g., that he should not use the Patient's name where other patients are present).
Patient's Birth Date	(0010,0030)	Date of birth of the named Patient
Patient's Birth Time	(0010,0032)	Time of birth of the named Patient
Patient's Sex	(0010,0040)	Sex of the named Patient. Enumerated Values: **M** male **F** female **O** other

Attribute Name	Tag	Attribute Description
Quality Control Subject	(0010,0200)	Indicates whether or not the subject is a quality control phantom. Enumerated Values: **YES** **NO** If this Attribute is absent, then the subject may or may not be a phantom. This Attribute describes a characteristic of the Imaging Subject. It is distinct from Quality Control Image (0028,0300) in the General Image Module, which is used to describe an image acquired.
Patient's Insurance Plan Code Sequence	(0010,0050)	A Sequence that conveys the Patient's insurance plan. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Patient's Primary Language Code Sequence	(0010,0101)	The languages that can be used to communicate with the Patient. Zero or more Items shall be included in this Sequence. The Items are ordered by preference (most preferred language to least preferred language).
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 5000 "Languages".*
>Patient's Primary Language Modifier Code Sequence	(0010,0102)	A modifier for a Patient's Primary Language. Can be used to specify a national language variant. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 5001 "Countries".*
Patient's Size	(0010,1020)	Patient's height or length in meters
Patient's Weight	(0010,1030)	Weight of the Patient in kilograms
Patient's Size Code Sequence	(0010,1021)	Patient's size category code One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 7039 "Pediatric Size Categories" for pediatric patients.*
Patient's Address	(0010,1040)	Legal address of the named Patient
Military Rank	(0010,1080)	Military rank of Patient
Branch of Service	(0010,1081)	Branch of the military. The country allegiance may also be included (e.g., U.S. Army).
Country of Residence	(0010,2150)	Country in which Patient currently resides
Region of Residence	(0010,2152)	Region within Patient's country of residence
Patient's Telephone Numbers	(0010,2154)	Telephone numbers at which the Patient can be reached

Attribute Name	Tag	Attribute Description
Patient's Telecom Information	(0010,2155)	The Patient's personal telecommunication contact information, including telephone, email, or other telecom addresses. Note 1. This Attribute may have internal format or structure in accordance with local agreement or profile. 2. It is recommended that this Attribute be treated as equivalent to HL7v2 fields PID-13 and PID-14, or PID-40 (v2.7 and later), and be formatted in accordance with the HL7v2 XTN data type (without escapes for HL7 message structure reserved characters).
Ethnic Group	(0010,2160)	Ethnic group or race of Patient
Patient's Religious Preference	(0010,21F0)	The religious preference of the Patient
Patient Comments	(0010,4000)	User-defined comments about the Patient
Responsible Person	(0010,2297)	Name of person with medical or welfare decision making authority for the Patient.
Responsible Person Role	(0010,2298)	Relationship of Responsible Person to the Patient. See Section C.7.1.1.1.2 for Defined Terms.
Responsible Organization	(0010,2299)	Name of organization with medical or welfare decision making authority for the Patient.
Patient Species Description	(0010,2201)	The taxonomic rank value (e.g., genus, subgenus, species or subspecies) of the Patient. See Section C.7.1.1.1.3.
Patient Species Code Sequence	(0010,2202)	The taxonomic rank value (e.g., genus, subgenus, species or subspecies) of the Patient. See Section C.7.1.1.1.3. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 7454 “Animal Taxonomic Rank Values”.*
Patient Breed Description	(0010,2292)	The breed of the Patient. See Section C.7.1.1.1.1.
Patient Breed Code Sequence	(0010,2293)	The breed of the Patient. See Section C.7.1.1.1.1. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 7480 “Breed”.*
Breed Registration Sequence	(0010,2294)	Information identifying an animal within a breed registry. Zero or more Items shall be included in this Sequence.
>Breed Registration Number	(0010,2295)	Identification number of a veterinary patient within the registry.
>Breed Registry Code Sequence	(0010,2296)	Identification of the organization with which an animal is registered. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 7481 “Breed Registry”.*
Strain Description	(0010,0212)	The strain of the Patient. See Section C.7.1.1.1.4.
Strain Nomenclature	(0010,0213)	The nomenclature used for Strain Description (0010,0212). See Section C.7.1.1.1.4.

Attribute Name	Tag	Attribute Description
Strain Code Sequence	(0010,0219)	A coded identification of the strain of the Patient. See Section C.7.1.1.1.4. One or more Items are permitted in this Sequence. If more than one Item is present, each Item represents the same information but encoded using a different coding scheme (rather than post-coordinated modifiers).
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Strain Additional Information	(0010,0218)	Additional information about the strain of the Patient that is not encoded in the formal nomenclature used in Strain Description (0010,0212). See Section C.7.1.1.1.4.
Strain Stock Sequence	(0010,0216)	Information identifying an animal within a strain stock. Only a single Item is permitted in this Sequence.
>Strain Stock Number	(0010,0214)	The stock number of the strain of the Patient issued by the organization identified by Strain Source (0010,0217). See Section C.7.1.1.1.4.
>Strain Source	(0010,0217)	Identification of the organization that is the source of the animal, issued by the registry identified by Strain Source Registry Code Sequence (0010,0215). See Section C.7.1.1.1.4.
>Strain Source Registry Code Sequence	(0010,0215)	Identification of the organization that is the registry of sources of animals. See Section C.7.1.1.1.4. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*DCID 7490 "Research Animal Source Registries".*
Genetic Modifications Sequence	(0010,0221)	The genetic modifications of the Patient. One or more Items are permitted in this Sequence. See Section C.7.1.1.1.4.
>Genetic Modifications Description	(0010,0222)	The genetic modifications of the Patient described using a specific nomenclature.
>Genetic Modifications Nomenclature	(0010,0223)	The nomenclature used for Genetic Modifications Description (0010,0222).
>Genetic Modifications Code Sequence	(0010,0229)	A coded identification of the genetic modifications of the Patient. One or more Items are permitted in this Sequence. If more than one Item is present, each Item represents the same information but encoded using a different coding scheme (rather than post-coordinated modifiers).
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*

Note

The language codes specified in CID 5000 "Languages", used in Patient's Primary Language Code Sequence (0010,0101), optionally allow the encoding of the country of language in the code value for the language. Encoding of the country of language in a subsidiary Patient's Primary Language Modifier Code Sequence (0010,0102) is allowed for backward compatibility with previous editions of the Standard.

C.2.4 Patient Medical Module

Table C.2-4 defines the Attributes relevant to a Patient's medical state or history.

Table C.2-4. Patient Medical Module Attributes

Attribute Name	Tag	Attribute Description
Medical Alerts	(0010,2000)	Conditions to which medical staff should be alerted (e.g., contagious condition, drug allergies, etc.)
Allergies	(0010,2110)	Description of prior reaction to contrast agents, or other Patient allergies or adverse reactions.
Smoking Status	(0010,21A0)	Indicates whether Patient smokes. Enumerated Values: **YES** **NO** **UNKNOWN**
Additional Patient History	(0010,21B0)	Additional information about the Patient's medical history
Pregnancy Status	(0010,21C0)	Describes pregnancy state of Patient. Enumerated Values: **0001** not pregnant **0002** possibly pregnant **0003** definitely pregnant **0004** unknown
Last Menstrual Date	(0010,21D0)	Date of onset of last menstrual period
Patient's Sex Neutered	(0010,2203)	Whether or not a procedure has been performed in an effort to render the Patient sterile. Enumerated Values: **ALTERED** Altered/Neutered **UNALTERED** Unaltered/intact
Patient's Body Mass Index	(0010,1022)	Body Mass Index of the Patient in kg/m2.
Measured AP Dimension	(0010,1023)	The thickness in mm of the body part being scanned, in the antero-posterior dimension (per AAPM Report 204). Note These values are normally derived from a scanned image, but might also be obtained using physical calipers, e.g., for children.
Measured Lateral Dimension	(0010,1024)	The side-to-side (left to right) dimension in mm of the body part being scanned (per AAPM Report 204). Note These values are normally derived from a scanned image, but might also be obtained using physical calipers, e.g., for children.
Special Needs	(0038,0050)	Medical and social needs (e.g., wheelchair, oxygen, translator, etc.)
Patient State	(0038,0500)	Description of Patient state (comatose, disoriented, vision impaired, etc.)
Pertinent Documents Sequence	(0038,0100)	List of Documents (e.g., SR, or CDA) that contain information considered pertinent for the Patient medical condition. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
>Purpose of Reference Code Sequence	(0040,A170)	Describes the purpose for which the document reference is made. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Document Title	(0042,0010)	Title of the referenced document.
Pertinent Resources Sequence	(0038,0101)	List of resources that contain information considered pertinent for the Patient medical condition. Zero or more Items shall be included in this Sequence.
>Retrieve URI	(0040,E010)	Retrieval access path to resource. Includes fully specified scheme, authority, path, and query in accordance with [RFC3986]. Note The VR of this Data Element has changed from UT to UR.
>Resource Description	(0038,0102)	Description or title of the resource.
Patient Clinical Trial Participation Sequence	(0038,0502)	Sequence of identifiers for clinical trials or research in which the Patient participates. Zero or more Items shall be included in this Sequence.
>Clinical Trial Sponsor Name	(0012,0010)	The name of the clinical trial or research sponsor, responsible for conducting the clinical trial and for defining the Clinical Trial Protocol.
>Clinical Trial Protocol ID	(0012,0020)	Identifier for the noted protocol, used by the Clinical Trial Sponsor to uniquely identify the investigational protocol.
>Clinical Trial Protocol Name	(0012,0021)	The name or title of the clinical trial or research protocol.
>Clinical Trial Site ID	(0012,0030)	The identifier, issued by the Clinical Trial Sponsor, of the site responsible for submitting clinical trial or research data.
>Clinical Trial Site Name	(0012,0031)	Name of the site responsible for submitting clinical trial or research data.
>Clinical Trial Subject ID	(0012,0040)	The assigned identifier for the Patient as a clinical trial or research subject.
>Clinical Trial Subject Reading ID	(0012,0042)	Identifies the Patient as a clinical trial or research subject for blinded evaluations.

Note

The Patient Clinical Trial Participation Sequence (0038,0502) identifies potentially multiple trials or research projects in which the Patient is enrolled. Application behavior in the presence of multiple Items is outside the scope of the Standard.

C.3 Visit Modules

The following Sections specify Modules relevant to a Real World Patient visit.

C.3.1 Visit Relationship Module

Table C.3-1 defines the Attributes that reference SOP Instances related to this SOP Class.

Table C.3-1. Visit Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with the Visit SOP Instance. One or more Items shall be included in this Sequence. See Section 10.6.1.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance that relates to the Visit SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"		

C.3.2 Visit Identification Module

Table C.3-2 defines the Attributes relevant to identifying a Visit.

Table C.3-2. Visit Identification Module Attributes

Attribute Name	Tag	Attribute Description
Institution Name	(0008,0080)	Institution where the equipment is located
Institution Address	(0008,0081)	Mailing Address of the institution where the equipment is located
Institution Code Sequence	(0008,0082)	A Sequence that conveys the healthcare facility identification. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Institutional Department Name	(0008,1040)	The Department, Unit or Service within the healthcare facility.
Institutional Department Type Code Sequence	(0008,1041)	A coded description of the type of Department or Service within the healthcare facility. Note This might be obtained from a corresponding HL7v2 message containing PV1:10 Hospital Service. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 7030 "Institutional Departments, Units and Services".*
Admission ID	(0038,0010)	Identification number of the Visit as assigned by the healthcare provider Note Visit and Admission are used interchangeably here. In the broader sense, an admission is a type of visit at an institution where there is an admission process for patients.
Issuer of Admission ID Sequence	(0038,0014)	Identifier of the Assigning Authority that issued the Admission ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
Reason for Visit	(0032,1066)	Reason(s) for this visit by the patient to the facility or provider.

Attribute Name	Tag	Attribute Description
Reason for Visit Code Sequence	(0032,1067)	Coded reason(s) for this visit by the patient to the facility or provider. Note If an HL7 message is available with a PV2 segment corresponding to this visit, potential codes may be found in Admit Reason PV2-3. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Service Episode ID	(0038,0060)	Identifier of the Service Episode as assigned by the healthcare provider
Issuer of Service Episode ID Sequence	(0038,0064)	Identifier of the Assigning Authority that issued the Service Episode ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
Service Episode Description	(0038,0062)	Description of the type of service episode.

C.3.3 Visit Status Module

Table C.3-3 defines the Attributes relevant to the Patient's stay with the healthcare provider.

Table C.3-3. Visit Status Module Attributes

Attribute Name	Tag	Attribute Description
Visit Status ID	(0038,0008)	Identifies the state of the Visit. Defined Terms: **CREATED** Created but not yet scheduled **SCHEDULED** Scheduled but not yet admitted **ADMITTED** Patient admitted to institution **DISCHARGED** Patient Discharged
Current Patient Location	(0038,0300)	Describes the current known location of the Patient
Patient's Institution Residence	(0038,0400)	Primary location where Patient resides (ward, floor, room, etc. or outpatient)
Visit Comments	(0038,4000)	User-defined comments about the Visit

C.3.4 Visit Admission Module

Table C.3-4 defines the Attributes relevant to admitting a Patient during a Visit.

Table C.3-4. Visit Admission Module Attributes

Attribute Name	Tag	Attribute Description
Referring Physician's Name	(0008,0090)	Patient's primary referring physician for this Visit
Referring Physician's Address	(0008,0092)	Referring physician's address
Referring Physician's Telephone Numbers	(0008,0094)	Referring physician's telephone numbers

Attribute Name	Tag	Attribute Description
Referring Physician Identification Sequence	(0008,0096)	Identification of the Patient's referring physician. Only a single Item shall be included in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”		Note *The Person's Telecom Information (0040,1104) Attribute in this Sequence may be treated as equivalent to HL7v2 field ROL-12 associated with the referring physician identified in PV1-8.*
Consulting Physician's Name	(0008,009C)	Consulting physician(s) for this Patient Visit.
Consulting Physician Identification Sequence	(0008,009D)	Identification of the consulting physician(s). One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Consulting Physician's Name (0008,009C), if present.
>Include Table 10-1 “Person Identification Macro Attributes Description”		Note *The Person's Telecom Information (0040,1104) Attribute in this Sequence may be treated as equivalent to HL7v2 field ROL-12 associated with the consulting physician.*
Admitting Diagnoses Description	(0008,1080)	Description of admitting diagnosis (diagnoses).
Admitting Diagnoses Code Sequence	(0008,1084)	A Sequence that conveys the admitting diagnosis (diagnoses). One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Route of Admissions	(0038,0016)	Mode of admission: emergency, normal
Admitting Date	(0038,0020)	Date Patient Visit began
Admitting Time	(0038,0021)	Time Patient Visit began

C.3.5 Visit Discharge Module

Retired. See PS3.3-2004.

C.3.6 Visit Scheduling Module

Retired. See PS3.3-2004.

C.4 Study Modules

The following Sections specify Modules relevant to a Real World diagnostic imaging Study performed on a Patient.

C.4.1 Study Relationship Module

Retired. See PS3.3-2004.

C.4.2 Study Identification Module

Retired. See PS3.3-2004.

C.4.3 Study Classification Module

Retired. See PS3.3-2004.

C.4.4 Study Scheduling Module

Retired. See PS3.3-2004.

C.4.5 Study Acquisition Module

Retired. See PS3.3-2004.

C.4.6 Study Read Module

Retired. See PS3.3-2004.

C.4.7 Study Component Module

Retired. See PS3.3-2004.

C.4.8 Study Component Relationship Module

Retired. See PS3.3-2004.

C.4.9 Study Component Acquisition Module

Retired. See PS3.3-2004.

C.4.10 Scheduled Procedure Step Module

Table C.4-10. Scheduled Procedure Step Module Attributes

Attribute Name	Tag	Attribute Description
Scheduled Procedure Step Sequence	(0040,0100)	One or more Scheduled Procedure Steps for one Requested Procedure.
>Scheduled Station AE Title	(0040,0001)	The AE title of the modality on which the Scheduled Procedure Step is scheduled to be performed.
>Scheduled Station Name	(0040,0010)	An institution defined name for the modality on which the Scheduled Procedure Step is scheduled to be performed.
>Scheduled Procedure Step Location	(0040,0011)	The location at which the Procedure Step is scheduled to be performed.
>Referenced Defined Protocol Sequence	(0018,990C)	Defined Procedure Protocol Instance(s) specified for the Scheduled Procedure Step.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Referenced Performed Protocol Sequence	(0018,990D)	Prior Performed Procedure Protocol Instance(s) that is to be repeated for the Scheduled Procedure Step.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>Scheduled Procedure Step Start Date	(0040,0002)	Date on which the Scheduled Procedure Step is scheduled to start.
>Scheduled Procedure Step Start Time	(0040,0003)	Time at which the Scheduled Procedure Step is scheduled to start.
>Scheduled Procedure Step End Date	(0040,0004)	Date on which the Scheduled Procedure Step is scheduled to end.
>Scheduled Procedure Step End Time	(0040,0005)	Time at which the Scheduled Procedure Step is scheduled to end.
>Scheduled Performing Physician's Name	(0040,0006)	Name of the physician scheduled to administer the Scheduled Procedure Step.

Attribute Name	Tag	Attribute Description
>Scheduled Performing Physician Identification Sequence	(0040,000B)	Identification of the physician scheduled to administer the Scheduled Procedure Step. Only a single Item shall be included in this Sequence.
>>Include Table 10-1 "Person Identification Macro Attributes Description"		
>Scheduled Procedure Step Description	(0040,0007)	Institution-generated description or classification of the Scheduled Procedure Step to be performed. Note The purpose of this Attribute is to store a description or classification that is used at a local level (e.g., a hospital or a managed care network), and this description need not comply to an accepted standard.
>Scheduled Protocol Code Sequence	(0040,0008)	Sequence describing the Scheduled Protocol following a specified coding scheme. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>>Protocol Context Sequence	(0040,0440)	Sequence that specifies the context for the Scheduled Protocol Code Sequence (0040,0008) Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.
>>>Include Table 10-2 "Content Item Macro Attributes Description"		*No Baseline TID is defined.*
>>>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.
>>>>Include Table 10-2 "Content Item Macro Attributes Description"		*No Baseline TID is defined.*
>Scheduled Procedure Step ID	(0040,0009)	Identifier that identifies the Scheduled Procedure Step.
>Scheduled Procedure Step Status	(0040,0020)	A Real World condition that may affect the selection of the Scheduled Procedure Step. Defined Terms: **SCHEDULED** Procedure Step scheduled **ARRIVED** Patient is available for the Scheduled Procedure Step **READY** all Patient and other necessary preparation for this step has been completed **STARTED** at least one Performed Procedure Step has been created that references this Scheduled Procedure Step **DEPARTED** Patient is no longer available for the Scheduled Procedure Step
>Comments on the Scheduled Procedure Step	(0040,0400)	User-defined comments on the Scheduled Procedure Step. Note The Comments Attribute is intended to transmit non-structured information, which can be displayed to the operator of the Modality.

Attribute Name	Tag	Attribute Description
>Modality	(0008,0060)	Source equipment for the image. See Section C.7.3.1.1.1 for Defined Terms.
>Requested Contrast Agent	(0032,1070)	Contrast agent requested for use in the Scheduled Procedure Step.
>Pre-Medication	(0040,0012)	Medication to be administered at the beginning of the Scheduled Procedure Step, e.g., Nuclear Medicine radiopharmaceutical.
>Anatomical Orientation Type	(0010,2210)	The anatomical orientation type appropriate for this Patient. Enumerated Values: **BIPED** **QUADRUPED**
Scheduled Specimen Sequence	(0040,0500)	Sequence of Items identifying specimens to be imaged in the identified Scheduled Procedure Step(s), with their characteristics.
>Include Table C.7.6.22-2 "Specimen Macro Attributes"		
Barcode Value	(2200,0005)	Barcode interpreted from a scanned label. Note 1. In the case of a scanned patient label, this may be the same as Patient ID (0010,0020), but it is included in the Scheduled Procedure Step Module rather than the Patient Identification Module since barcodes may also be used to identify lower level entities and/or different forms of patient identifier may be in use. 2. In the case of a scanned slide label, this may be the same as Container Identifier (0040,0512).

C.4.10.1 Protocol Context Sequence

The Protocol Context Sequence (0040,0440) allows the specification of parameters that further qualify the scheduled protocol, provided through a set of generic name/value pairs of context Content Items.

Note

This allows the specification of clinical, acquisition, or procedural qualifiers for the scheduled protocol, such as a specific body part, imaging technique, or parameters of a preparatory event (e.g., radionuclide injection). Specific uses of this Sequence may be documented in a Template defined in accordance with PS3.16.

C.4.11 Requested Procedure Module

Table C.4-11. Requested Procedure Module Attributes

Attribute Name	Tag	Attribute Description
Requested Procedure ID	(0040,1001)	Identifier that identifies the Requested Procedure in the Imaging Service Request.
Reason for the Requested Procedure	(0040,1002)	Reason for requesting this imaging procedure.
Requested Procedure Comments	(0040,1400)	User-defined comments on the Requested Procedure.
Reason for Requested Procedure Code Sequence	(0040,100A)	Coded Reason for requesting this procedure. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*

Attribute Name	Tag	Attribute Description
Requested Procedure Code Sequence	(0032,1064)	A Sequence that conveys the Requested Procedure of one Procedure Type.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Study Instance UID	(0020,000D)	Unique identifier to be used to identify the Study
Study Date	(0008,0020)	Date the Study started, if any previous procedure steps within the same Study have already been performed.
Study Time	(0008,0030)	Time the Study started, if any previous procedure steps within the same Study have already been performed.
Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instances associated with this SOP Instance. One or more Items shall be included in this Sequence. See Section 10.6.1.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
Requested Procedure Description	(0032,1060)	Institution-generated administrative description or classification of Requested Procedure
Requested Procedure Priority	(0040,1003)	Requested Procedure Type Urgency. Defined Terms: **STAT** **HIGH** **ROUTINE** **MEDIUM** **LOW**
Patient Transport Arrangements	(0040,1004)	Mode of transportation of the Patient to the location of examination.
Requested Procedure Location	(0040,1005)	Physical location at which the Requested Procedure is to be performed.
Confidentiality Code	(0040,1008)	Confidentiality Constraints on the Requested Procedure by the party filling the order.
Reporting Priority	(0040,1009)	Requested Reporting Priority. Defined Terms: **HIGH** **ROUTINE** **MEDIUM** **LOW**
Names of Intended Recipients of Results	(0040,1010)	Names of the physicians, who are intended recipients of results.
Intended Recipients of Results Identification Sequence	(0040,1011)	Identification of the physicians who are intended recipients of results. One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Names of Intended Recipients of Results (0040,1010), if present.
>Include Table 10-1 "Person Identification Macro Attributes Description"		

Note

Attributes (0040,1006) Placer Order Number/Procedure and (0040,1007) Filler Order Number/Procedure were previously defined in DICOM. They are now retired (see PS3.3-1998).

C.4.12 Imaging Service Request Module

Table C.4-12. Imaging Service Request Module Attributes

Attribute Name	Tag	Attribute Description
Imaging Service Request Comments	(0040,2400)	User-defined comments on the Imaging Service Request. Note This Attribute is intended to transmit non-structured information, which can be displayed to the operator of the equipment (e.g., Modality).
Requesting Physician	(0032,1032)	Name of the physician who requested the Imaging Service Request.
Requesting Physician Identification Sequence	(0032,1031)	Identification of the physician who requested the Imaging Service Request. Only a single Item shall be included in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”		Note *The Person's Telecom Information (0040,1104) Attribute in this Sequence may be treated as equivalent to HL7v2 field ROL-12 associated with the requesting physician identified in ORC-12 or OBR-16.*
Referring Physician's Name	(0008,0090)	Name of the Patient's referring physician for this Imaging Service Request.
Referring Physician Identification Sequence	(0008,0096)	Identification of the Patient's referring physician. Only a single Item shall be included in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”		Note *The Person's Telecom Information (0040,1104) Attribute in this Sequence may be treated as equivalent to HL7v2 field ROL-12 associated with the referring physician identified in PV1-8.*
Requesting Service	(0032,1033)	Institutional department, unit or service where the request initiated. See Note 3.
Requesting Service Code Sequence	(0032,1034)	Institutional department, unit or service where the request initiated. Equivalent to HL7 v2.x ORC-17. See Note 3. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 7030 “Institutional Departments, Units and Services”.*
Accession Number	(0008,0050)	A departmental IS generated number that identifies the order for the Imaging Service Request.
Issuer of Accession Number Sequence	(0008,0051)	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
Issue Date of Imaging Service Request	(0040,2004)	Date on which the Imaging Service Request was issued by the requester.
Issue Time of Imaging Service Request	(0040,2005)	Time at which the Imaging Service Request was issued by the requester.
Placer Order Number / Imaging Service Request	(0040,2016)	The order number assigned to the Imaging Service Request by the party placing the order.
Order Placer Identifier Sequence	(0040,0026)	Identifier of the Assigning Authority that issued the Placer Order Number. Only a single Item shall be included in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
Filler Order Number / Imaging Service Request	(0040,2017)	The order number assigned to the Imaging Service Request by the party filling the order.
Order Filler Identifier Sequence	(0040,0027)	Identifier of the Assigning Authority that issued the Filler Order Number. Only a single Item shall be included in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
Order Entered By	(0040,2008)	The person who entered the Imaging Service Request into an Information System. Note This Attribute may be treated as equivalent to HL7v2 field ORC-10.
Order Enterer's Location	(0040,2009)	The location at which the Imaging Service Request was entered. Note This Attribute may be treated as equivalent to HL7v2 field ORC-13.
Order Callback Phone Number	(0040,2010)	Telephone Number at which additional information can be retrieved.
Order Callback Telecom Information	(0040,2011)	The telecommunication contact information, including telephone, email, or other telecom addresses, at which additional information about the order can be retrieved. Note 1. This Attribute may have internal format or structure in accordance with local agreement or profile. 2. It is recommended that this Attribute be treated as equivalent to HL7v2 fields ORC-12 and OBR-17, and be formatted in accordance with the HL7v2 XTN data type (without escapes for HL7 message structure reserved characters).

Attribute Name	Tag	Attribute Description
Admission ID	(0038,0010)	Identification number of the Visit as assigned by the healthcare provider Note Visit and Admission are used interchangeably here. In the broader sense, an admission is a type of visit at an institution where there is an admission process for patients.
Issuer of Admission ID Sequence	(0038,0014)	Identifier of the Assigning Authority that issued the Admission ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
Reason for Visit	(0032,1066)	Reason(s) for this visit by the patient to the facility or provider.
Reason for Visit Code Sequence	(0032,1067)	Coded reason(s) for this visit by the patient to the facility or provider. Note If an HL7 message is available with a PV2 segment corresponding to this visit, potential codes may be found in Admit Reason PV2-3. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*

Note

1. Attributes (0040,2016) and (0040,2017) Placer Order Number and Filler Order Number/Imaging Service Request are intended to convey the corresponding order numbers as defined in HL7, in the case where interoperability with an HL7 environment is the objective.

2. Attributes (0040,2001), (0040,2006) and (0040,2007) were previously defined in DICOM. They are now retired (see PS3.3-1998).

3. Both Requesting Service (0032,1033) and Requesting Service Code Sequence (0032,1034) are defined in this table; the latter is preferred, but the former may be copied from an HL7 message whether or not there is also the ability to map it to a coded form (e.g., with only ORC-17 component 1 valued).

C.4.13 Performed Procedure Step Relationship

Table C.4-13 specifies the Attributes used to reference other SOP Classes and other Information Entities of the DICOM real-world model as defined in Section 7.3.1.6.

Table C.4-13. Performed Procedure Step Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full legal name.
Patient ID	(0010,0020)	Primary identifier for the Patient. Note In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.
Include Table 10-18 "Issuer of Patient ID Macro Attributes"		

Attribute Name	Tag	Attribute Description
Patient's Birth Date	(0010,0030)	Date of birth of the named Patient
Patient's Birth Date in Alternative Calendar	(0010,0033)	Date of birth of the named Patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.
Patient's Death Date in Alternative Calendar	(0010,0034)	Date of death of the named Patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.
Patient's Alternative Calendar	(0010,0035)	The Alternative Calendar used for Patient's Birth Date in Alternative Calendar (0010,0033) and Patient's Death Date in Alternative Calendar (0010,0034). See Section C.7.1.5 for Defined Terms. Required if either Patient's Birth Date in Alternative Calendar (0010,0033) or Patient's Alternative Death Date in Calendar (0010,0034) is present.
Patient's Sex	(0010,0040)	Sex of the named Patient Enumerated Values: **M** male **F** female **O** other
Referenced Patient Sequence	(0008,1120)	Uniquely identifies the Patient SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Admission ID	(0038,0010)	Identification number of the Visit as assigned by the healthcare provider.
Issuer of Admission ID Sequence	(0038,0014)	Identifier of the Assigning Authority that issued the Admission ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
Service Episode ID	(0038,0060)	Identifier of the Service Episode as assigned by the healthcare provider
Issuer of Service Episode ID Sequence	(0038,0064)	Identifier of the Assigning Authority that issued the Service Episode ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
Service Episode Description	(0038,0062)	Description of the type of service episode.
Scheduled Step Attributes Sequence	(0040,0270)	Sequence containing Attributes that are related to the scheduling of the Procedure Step. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>Study Instance UID	(0020,000D)	Unique identifier for the Study.
>Referenced Study Sequence	(0008,1110)	Uniquely identifies the Study SOP Instance associated with this Scheduled Procedure Step. Only a single Item shall be included in this Sequence. See Section 10.6.1.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
>Accession Number	(0008,0050)	A departmental IS generated number that identifies the order for the Study.
>Issuer of Accession Number Sequence	(0008,0051)	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item shall be included in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
>Placer Order Number/Imaging Service Request	(0040,2016)	The order number assigned to the Imaging Service Request by the party placing the order.
>Order Placer Identifier Sequence	(0040,0026)	Identifier of the Assigning Authority that issued the Placer Order Number. Only a single Item shall be included in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
>Filler Order Number/Imaging Service Request	(0040,2017)	The order number assigned to the Imaging Service Request by the party filling the order.
>Order Filler Identifier Sequence	(0040,0027)	Identifier of the Assigning Authority that issued the Filler Order Number. Only a single Item shall be included in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
>Requested Procedure ID	(0040,1001)	Identifier of the related Requested Procedure.
>Requested Procedure Description	(0032,1060)	Institution-generated administrative description or classification of Requested Procedure.
>Requested Procedure Code Sequence	(0032,1064)	A Sequence that conveys the Procedure Type of the requested procedure. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Scheduled Procedure Step ID	(0040,0009)	Identifier of the related Scheduled Procedure Step.
>Scheduled Procedure Step Description	(0040,0007)	Institution-generated description or classification of the Scheduled Procedure Step to be performed.
>Scheduled Protocol Code Sequence	(0040,0008)	Sequence describing the Scheduled Protocol following a specific coding scheme. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>>Protocol Context Sequence	(0040,0440)	Sequence that specifies the context for the Scheduled Protocol Code Sequence (0040,0008) Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.

Attribute Name	Tag	Attribute Description
>>>Include Table 10-2 "Content Item Macro Attributes Description"		*No Baseline TID is defined.*
>>>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.
>>>>Include Table 10-2 "Content Item Macro Attributes Description"		*No Baseline TID is defined.*

Note

1. The Patient information is included in order to relate the Modality Performed Procedure Step SOP Instance to the Study Management SOP Instance and other associated IODs in case the SCU (the modality) is unable to obtain or use the Study Instance UID created by the Information System.2. Attributes (0040,2016) and (0040,2017) Placer Order Number and Filler Order Number/Imaging Service Request are intended to convey the corresponding order numbers as defined in HL7, in the case where interoperability with an HL7 environment is the objective.

2. Attributes (0040,2006) and (0040,2007) were previously defined in DICOM. They are now retired (see PS3.3-1998).

3. Attributes (0040,1006) Placer Order Number/Procedure and (0040,1007) Filler Order Number/Procedure were previously defined in DICOM. They are now retired (see PS3.3-1998).

C.4.14 Performed Procedure Step Information

Table C.4-14 defines the general Attributes that may be used by all specific Procedure Steps.

Table C.4-14. Performed Procedure Step Information Module Attributes

Attribute Name	Tag	Attribute Description
Performed Station AE Title	(0040,0241)	AE title of the modality on which the Performed Procedure Step was performed.
Performed Station Name	(0040,0242)	An institution defined name for the modality on which the Performed Procedure Step was performed.
Performed Location	(0040,0243)	Description of the location at which the Performed Procedure Step was performed.
Performed Procedure Step Start Date	(0040,0244)	Date on which the Performed Procedure Step started. Note This value may be used to determine the earliest date to use as Study Date (0008,0020) in Composite Instances and in updated Modality Scheduled Procedure Steps in order to allow Study level Attributes to have consistent values if additional Procedure Steps are performed.
Performed Procedure Step Start Time	(0040,0245)	Time at which the Performed Procedure Step started. Note This value may be used to determine the earliest time to use as Study Time (0008,0030) in Composite Instances and in updated Modality Scheduled Procedure Steps in order to allow Study level Attributes to have consistent values if additional Procedure Steps are performed.
Performed Procedure Step ID	(0040,0253)	User or equipment generated identifier of that part of a Procedure that has been carried out within this step.
Performed Procedure Step End Date	(0040,0250)	Date on which the Performed Procedure Step ended.

Attribute Name	Tag	Attribute Description
Performed Procedure Step End Time	(0040,0251)	Time at which the Performed Procedure Step ended.
Performed Procedure Step Status	(0040,0252)	Contains the state of the Performed Procedure Step. Enumerated Values: **IN PROGRESS** Started but not complete **DISCONTINUED** Canceled or unsuccessfully terminated **COMPLETED** Successfully completed
Performed Procedure Step Description	(0040,0254)	Institution-generated description or classification of the Procedure Step that was performed.
Comments on the Performed Procedure Step	(0040,0280)	User-defined comments on the Performed Procedure Step.
Performed Procedure Type Description	(0040,0255)	A description of the type of procedure performed.
Procedure Code Sequence	(0008,1032)	A Sequence that conveys the (single) type of procedure performed. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Reason For Performed Procedure Code Sequence	(0040,1012)	Coded reason(s) for performing this procedure. Note May differ from the values in Reason for the Requested Procedure (0040,100A) in Request Attribute Sequence (0040,0275), for example if what was performed differs from what was requested. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Performed Procedure Step Discontinuation Reason Code Sequence	(0040,0281)	The reason the Performed Procedure Step Status (0040,0252) was set to DISCONTINUED.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 9300 “Procedure Discontinuation Reasons”.*

C.4.15 Image Acquisition Results Module

Table C.4-15 specifies Attributes that describe the acquisition of images during the performance of the Procedure Step and that provide references to the Series, Images and other Composite SOP Instances associated with this Modality Performed Procedure Step.

Table C.4-15. Image Acquisition Results Module Attributes

Attribute Name	Tag	Attribute Description
Modality	(0008,0060)	Type of equipment that originally acquired the data used to create the images associated with this Modality Performed Procedure Step. See Section C.7.3.1.1.1 for Defined Terms. Note A Modality value in the created SOP Instances may be different from the MPPS Modality value. For example, multiple Series may have been created during the MPPS (images, waveforms, softcopy presentation states and/or structured reports) with SOP Instances in different Series having different modality values.
Study ID	(0020,0010)	User or equipment generated Study Identifier.
Performed Protocol Code Sequence	(0040,0260)	Sequence describing the Protocol performed for this Procedure Step. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
>Protocol Context Sequence	(0040,0440)	Sequence that specifies the context for the Performed Protocol Code Sequence (0040,0260) Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.
>>Include Table 10-2 “Content Item Macro Attributes Description”		*No Baseline TID is defined.*
>>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items shall be included in this Sequence. See Section C.4.10.1.
>>>Include Table 10-2 “Content Item Macro Attributes Description”		*No Baseline TID is defined.*
Performed Series Sequence	(0040,0340)	Attributes of the Series that comprise this Modality Performed Procedure Step. Zero or more Items shall be included in this Sequence.
>Performing Physician's Name	(0008,1050)	Name of the physician(s) administering this Series.
>Performing Physician Identification Sequence	(0008,1052)	Identification of the physician(s) administering the Series. One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Performing Physician's Name (0008,1050), if present.
>>Include Table 10-1 “Person Identification Macro Attributes Description”		
>Operators' Name	(0008,1070)	Name(s) of the operator(s) who supporting this Series.
>Operator Identification Sequence	(0008,1072)	Identification of the operator(s) supporting the Series. One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Operators' Name (0008,1070), if present.
>>Include Table 10-1 “Person Identification Macro Attributes Description”		

Attribute Name	Tag	Attribute Description
>Protocol Name	(0018,1030)	User-defined description of the conditions under which the Series was performed. Note This Attribute conveys Series-specific protocol identification and may or may not be identical to the one presented in the Performed Protocol Code Sequence (0040,0260).
>Series Instance UID	(0020,000E)	Unique Identifier of the Series.
>Series Description	(0008,103E)	Description of the Series
>Series Description Code Sequence	(0008,103F)	A coded description of the Series. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity where the Images and other Composite SOP Instances in this Series may be retrieved on the network. Note The duration for which this location remains valid is unspecified.
>Archive Requested	(0040,A494)	The Instances in this Series are expected to be archived in the long term archive. Enumerated Values: **NO** **YES**
>Referenced Image Sequence	(0008,1140)	A Sequence that provides reference to Composite SOP Instances created during the acquisition of the procedure step. Zero or more Items shall be included in this Sequence. Note The use of Referenced Image Sequence is historical, and in this context it allows the reference of any Composite SOP Instance.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
>>Container Identifier	(0040,0512)	The identifier for the container that contains the specimen(s) imaged.
>>Specimen Description Sequence	(0040,0560)	Sequence of identifiers and detailed description of the specimen(s) imaged. One or more Items shall be included in this Sequence.
>>>Specimen Identifier	(0040,0551)	A departmental information system identifier for the Specimen.
>>>Specimen UID	(0040,0554)	Unique identifier for the Specimen.
>Referenced Non-Image Composite SOP Instance Sequence	(0040,0220)	Uniquely identifies Instances, other than images, of any SOP Class that conforms to the DICOM Composite IOD Information Model, such as Waveforms, Presentation States or Structured Reports, created during the acquisition of the procedure step, and that are not referenced in Referenced Image Sequence (0008,1140). Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"		

C.4.16 Radiation Dose Module

This Module has been retired. See PS3.3 2017c

C.4.17 Billing and Material Management Code Module

The Attributes defined in Table C.4-17 provide a means to transmit billing and material management codes from a modality to an Information System. It is beyond the scope of this Standard to define all the required coding schemes and the relevant codes.

Table C.4-17. Billing and Material Management Code Module Attributes

Attribute name	Tag	Attribute Description
Billing Procedure Step Sequence	(0040,0320)	Contains billing codes for the Procedure Type performed within the Procedure Step. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Film Consumption Sequence	(0040,0321)	Information about the film consumption for this Performed Procedure Step. Zero or more Items shall be included in this Sequence.
>Number of Films	(2100,0170)	Number of films actually printed.
>Medium Type	(2000,0030)	Type(s) of medium on which images were printed. For Defined Terms see Table C.13-1.
>Film Size ID	(2010,0050)	Size(s) of film on which images were printed. For Defined Terms see Table C.13-3.
Billing Supplies and Devices Sequence	(0040,0324)	Chemicals, supplies and devices for billing used in the Performed Procedure ~~Step.One~~Step. One or more Items shall be included in this Sequence.
>Billing Item Sequence	(0040,0296)	Code values of chemicals, supplies or devices required for billing. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Quantity Sequence	(0040,0293)	Sequence containing the quantity of used chemicals or devices. Zero or one Item shall be included in this Sequence.
>>Quantity	(0040,0294)	Numerical quantity value.
>>Measuring Units Sequence	(0040,0295)	Unit of measurement. Zero or one Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 82 "Units of Measurement".*

C.4.18 General Purpose Scheduled Procedure Step Relationship Module (Retired)

Retired. See PS3.3-2011.

C.4.19 General Purpose Scheduled Procedure Step Information Module (Retired)

Retired. See PS3.3-2011.

C.4.20 General Purpose Performed Procedure Step Relationship Module (Retired)

Retired. See PS3.3-2011.

C.4.21 General Purpose Performed Procedure Step Information Module (Retired)

Retired. See PS3.3-2011.

C.4.22 General Purpose Results (Retired)

Retired. See PS3.3-2011.

C.4.23 Instance Availability Notification Module

Table C.4.23-1 specifies the Attributes used to describe which Instances are available and their relationships.

Table C.4.23-1. Instance Availability Notification Module Attributes

Attribute Name	Tag	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	Uniquely identifies the Performed Procedure Step SOP Instance to which this availability notification Instance is related, if any. Zero or one Item shall be included in this Sequence. Note 1. This may refer to a different PPS than that encoded in the Composite Instances themselves. 2. It is typically used for notification about Instances created as a consequence of some scheduled activity.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
>Performed Workitem Code Sequence	(0040,4019)	A Sequence that conveys the (single) type of procedure performed. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*BCID 9231 “Workitem Definition”.*
Study Instance UID	(0020,000D)	Unique identifier for the Study of which all the Instances referenced in this notification are part.
Referenced Series Sequence	(0008,1115)	Sequence of Items where each Item includes references to Instances within the same Series. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	Unique identifier of the Series of which all the Instances referenced in this Item are part.
>Referenced SOP Sequence	(0008,1199)	Sequence of Items where each Item includes a reference to a single Instance within this Series. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
>>Instance Availability	(0008,0056)	The availability of the referenced Instance. See Section C.4.23.1.1

Attribute Name	Tag	Attribute Description
>>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity from which the referenced Instance may or may not be retrievable, i.e., the scope for which Instance Availability (0008,0056) applies. See Section C.4.23.1.1.
>>Retrieve Location UID	(0040,E011)	Unique identifier of the system where the Composite Object(s) may be retrieved on the network.
>>Retrieve URI	(0040,E010)	Fully specified URI/URL (see [RFC3986]) the location of the referenced Instance. Note The VR of this Data Element has changed from UT to UR.
>>Retrieve URL	(0008,1190)	URL specifying the location of the referenced Instance(s). See Section 10.4 “Retrieve Transaction” in PS3.18.
>>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies the offline storage media on which the Instance resides.
>>Storage Media File-Set UID	(0088,0140)	Uniquely identifies the offline storage media on which the Instance resides.

C.4.23.1 Instance Availability Notification Module Attribute Definitions

C.4.23.1.1 Instance Availability

Enumerated Values:

ONLINE The Instances are immediately available from the Retrieve AE Title (0008,0054), and if a C-MOVE were to be requested, it would succeed in a reasonably short time.

NEARLINE The Instances need to be retrieved from relatively slow media such as optical disk or tape, and if a C-MOVE were to be requested from the Retrieve AE Title (0008,0054), it would succeed, but may take a considerable time.

OFFLINE A manual intervention is needed before the Instances may be retrieved, and if a C-MOVE were to be requested from the Retrieve AE Title (0008,0054), it would fail (e.g., by timeout) without such manual intervention.

UNAVAILABLE The Instances cannot be retrieved from the Retrieve AE Title (0008,0054), and if a C-MOVE were to be requested, it would fail.

Note

SOP Instances that are unavailable from this AE may be available from other AEs, or may have an alternate representation that is available from this AE.

C.5 Results Modules

Retired. See PS3.3-2004.

C.6 Interpretation Modules

Retired. See PS3.3-2004.

C.7 Common Composite Image IOD Modules

This Section defines the Modules that are common to all Composite Image IODs.

C.7.1 Common Patient IE Modules

The following Patient IE Module is common to all Composite Image IODs that reference the Patient IE.

C.7.1.1 Patient Module

Table C.7-1 specifies the Attributes of the Patient that describe and identify the Patient who is the subject of a Study. This Module contains Attributes of the Patient that are needed for interpretation of the Composite Instances and are common for all Studies performed on the Patient. It contains Attributes that are also included in the Patient Modules in Section C.2.

Table C.7-1. Patient Module Attributes

Attribute Name	Tag	Type	Attribute Description
Patient's Name	(0010,0010)	2	Patient's full name.
Patient ID	(0010,0020)	2	Primary identifier for the Patient. Note In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.
Include Table 10-18 “Issuer of Patient ID Macro Attributes”			
Type of Patient ID	(0010,0022)	3	The type of identifier in the Patient ID (0010,0020). Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the SOP Common Module, if present.
Patient's Birth Date	(0010,0030)	2	Birth date of the Patient.
Patient's Birth Date in Alternative Calendar	(0010,0033)	3	Date of birth of the named Patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.
Patient's Death Date in Alternative Calendar	(0010,0034)	3	Date of death of the named Patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.

Attribute Name	Tag	Type	Attribute Description
Patient's Alternative Calendar	(0010,0035)	1C	The Alternative Calendar used for Patient's Birth Date in Alternative Calendar (0010,0033) and Patient's Death Date in Alternative Calendar (0010,0034). See Section C.7.1.5 for Defined Terms. Required if either Patient's Birth Date in Alternative Calendar (0010,0033) or Patient's Alternative Death Date in Calendar (0010,0034) is present.
Patient's Sex	(0010,0040)	2	Sex of the named Patient. Enumerated Values: **M** male **F** female **O** other
Referenced Patient Photo Sequence	(0010,1100)	3	A photo to confirm the identity of a Patient. Only a single Item is permitted in this Sequence. See C.2.2.1.1.
>Include Table 10-3b "Referenced Instances and Access Macro Attributes"			
Quality Control Subject	(0010,0200)	3	Indicates whether or not the subject is a quality control phantom. Enumerated Values: **YES** **NO** If this Attribute is absent, then the subject may or may not be a phantom. This Attribute describes a characteristic of the Imaging Subject. It is distinct from Quality Control Image (0028,0300) in the General Image Module, which is used to describe an image acquired.
Referenced Patient Sequence	(0008,1120)	3	A Sequence that provides reference to a Patient SOP Class/Instance pair. Only a single Item is permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Patient's Birth Time	(0010,0032)	3	Birth time of the Patient.
Other Patient IDs Sequence	(0010,1002)	3	A Sequence of identification numbers or codes used to identify the Patient, which may or may not be human readable, and may or may not have been obtained from an implanted or attached device such as an RFID or barcode. One or more Items are permitted in this Sequence. Note This Attribute replaces the use of Other Patient IDs (0010,1000), which did not specify an issuer for each other identifier, and which has been retired.

Attribute Name	Tag	Type	Attribute Description
>Patient ID	(0010,0020)	1	An identifier for the Patient. Note In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1.
>Include Table 10-18 "Issuer of Patient ID Macro Attributes"			
>Type of Patient ID	(0010,0022)	1	The type of identifier in the Patient ID (0010,0020) in this Item. Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the SOP Common Module, if present.
Other Patient Names	(0010,1001)	3	Other names used to identify the Patient.
Ethnic Group	(0010,2160)	3	Ethnic group or race of the Patient.
Patient Comments	(0010,4000)	3	User-defined additional information about the Patient.
Patient Species Description	(0010,2201)	1C	The taxonomic rank value (e.g., genus, subgenus, species or subspecies) of the Patient. See Section C.7.1.1.1.3. Required if the Patient is an animal and if Patient Species Code Sequence (0010,2202) is not present. May be present otherwise.
Patient Species Code Sequence	(0010,2202)	1C	The taxonomic rank value (e.g., genus, subgenus, species or subspecies) of the Patient. See Section C.7.1.1.1.3. Only a single Item shall be included in this Sequence. Required if the Patient is an animal and if Patient Species Description (0010,2201) is not present. May be present otherwise.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7454 "Animal Taxonomic Rank Values".*
Patient Breed Description	(0010,2292)	2C	The breed of the Patient. See Section C.7.1.1.1.1. Required if the Patient is an animal and if Patient Breed Code Sequence (0010,2293) is empty. May be present otherwise.
Patient Breed Code Sequence	(0010,2293)	2C	The breed of the Patient. See Section C.7.1.1.1.1. Zero or more Items shall be included in this Sequence. Required if the Patient is an animal.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7480 "Breed".*

Attribute Name	Tag	Type	Attribute Description
Breed Registration Sequence	(0010,2294)	2C	Information identifying an animal within a breed registry. Zero or more Items shall be included in this Sequence. Required if the Patient is an animal.
>Breed Registration Number	(0010,2295)	1	Identification number of an animal within the registry.
>Breed Registry Code Sequence	(0010,2296)	1	Identification of the organization with which an animal is registered. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7481 “Breed Registry”.*
Strain Description	(0010,0212)	3	The strain of the Patient. See Section C.7.1.1.1.4.
Strain Nomenclature	(0010,0213)	3	The nomenclature used for Strain Description (0010,0212). See Section C.7.1.1.1.4.
Strain Code Sequence	(0010,0219)	3	A coded identification of the strain of the Patient. See Section C.7.1.1.1.4. One or more Items are permitted in this Sequence. If more than one Item is present, each Item represents the same information but encoded using a different coding scheme (rather than post-coordinated modifiers).
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Strain Additional Information	(0010,0218)	3	Additional information about the strain of the Patient that is not encoded in the formal nomenclature used in Strain Description (0010,0212). See Section C.7.1.1.1.4.
Strain Stock Sequence	(0010,0216)	3	Information identifying an animal within a strain stock. Only a single Item is permitted in this Sequence.
>Strain Stock Number	(0010,0214)	1	The stock number of the strain of the Patient issued by the organization identified by Strain Source (0010,0217). See Section C.7.1.1.1.4.
>Strain Source	(0010,0217)	1	Identification of the organization that is the source of the animal, issued by the registry identified by Strain Source Registry Code Sequence (0010,0215). See Section C.7.1.1.1.4.
>Strain Source Registry Code Sequence	(0010,0215)	1	Identification of the organization that is the registry of sources of animals. See Section C.7.1.1.1.4. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7490 “Research Animal Source Registries”.*
Genetic Modifications Sequence	(0010,0221)	3	The genetic modifications of the Patient. One or more Items are permitted in this Sequence. See Section C.7.1.1.1.4.
>Genetic Modifications Description	(0010,0222)	1	The genetic modifications of the Patient described using a specific nomenclature.
>Genetic Modifications Nomenclature	(0010,0223)	1	The nomenclature used for Genetic Modifications Description (0010,0222).

Attribute Name	Tag	Type	Attribute Description
>Genetic Modifications Code Sequence	(0010,0229)	3	A coded identification of the genetic modifications of the Patient. One or more Items are permitted in this Sequence. If more than one Item is present, each Item represents the same information but encoded using a different coding scheme (rather than post-coordinated modifiers).
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Responsible Person	(0010,2297)	2C	Name of person with medical or welfare decision making authority for the Patient. Required if the Patient is an animal. May be present otherwise.
Responsible Person Role	(0010,2298)	1C	Relationship of Responsible Person to the Patient. See Section C.7.1.1.1.2 for Defined Terms. Required if Responsible Person is present and has a value.
Responsible Organization	(0010,2299)	2C	Name of organization with medical or welfare decision making authority for the Patient. Required if Patient is an animal. May be present otherwise.
Patient Identity Removed	(0012,0062)	3	The true identity of the Patient has been removed from the Attributes and the Pixel Data Enumerated Values: **YES** **NO**
De-identification Method	(0012,0063)	1C	A description or label of the mechanism or method use to remove the Patient's identity. May be multi-valued if successive de-identification steps have been performed. Note 1. This may be used to describe the extent or thoroughness of the de-identification, for example whether or not the de-identification is for a "Limited Data Set" (as per HIPAA Privacy Rule). 2. The characteristics of the de-identifying equipment and/or the responsible operator of that equipment may be recorded as an additional Item of the Contributing Equipment Sequence (0018,A001) in the SOP Common Module. De-identifying equipment may use a Purpose of Reference of (109104, DCM, "De-identifying Equipment"). Required if Patient Identity Removed (0012,0062) is present and has a value of YES and De-identification Method Code Sequence (0012,0064) is not present. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
De-identification Method Code Sequence	(0012,0064)	1C	A code describing the mechanism or method use to remove the Patient's identity. One or more Items shall be included in this Sequence. Multiple Items are used if successive de-identification steps have been performed or to describe options of a defined profile. Required if Patient Identity Removed (0012,0062) is present and has a value of YES and De-identification Method (0012,0063) is not present. May be present otherwise.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7050 “De-identification Method”.*
Include Table C.7.1.4-1 “Patient Group Macro Attributes”			

Note

Previously, Other Patient IDs (0010,1000) was included in this table. This Attribute have been retired. See PS3.3 2017a.

C.7.1.1.1 Patient Module Attributes

C.7.1.1.1.1 Patient Breed Description and Code Sequence

The breed of an animal, if known, shall be encoded in either Patient Breed Description (0010,2292) or Patient Breed Code Sequence (0010,2293) or both.

In the case of a mixed breed, it shall be either:

1. described in plain text in Patient Breed Description (0010,2292), e.g., "Border Collie American Bulldog mix", or just "Mixed", or
2. coded as multiple specific breeds by composing the mix as multiple Items of Patient Breed Code Sequence (0010,2293), e.g., (132561000, SCT, "Border Collie dog breed") followed by (132534000, SCT, "American Bulldog breed"), or
3. encoded non-specifically with a code that means "mixed breed" of the appropriate species, as defined in CID 7486 “Mixed Breeds”, which is included in CID 7480 “Breed”, e.g., (132619000, SCT, "Mixed breed dog").

Note

The absence of a value for both Patient Breed Description (0010,2292) and Patient Breed Code Sequence (0010,2293) implies that the breed is unknown, not that it is mixed.

C.7.1.1.1.2 Responsible Person Role

Defined Terms:

OWNER
PARENT
CHILD
SPOUSE
SIBLING
RELATIVE
GUARDIAN
CUSTODIAN
AGENT
INVESTIGATOR
VETERINARIAN

C.7.1.1.1.3 Patient Species (Taxonomic Rank Value)

If the species is not known then the Patient Species Description (0010,2201) or Patient Species Code Sequence (0010,2202) may describe a more general taxonomic rank value, such as a genus or subgenus, family or subfamily.

Note

E.g., "Mus" rather than "Mus musculus".

If the subspecies is known then the Patient Species Description (0010,2201) or Patient Species Code Sequence (0010,2202) may describe the subspecies.

Note

E.g., "Canis lupus familiaris" rather than "Canis lupus".

C.7.1.1.1.4 Patient Strain and Genetic Modifications

The strain of an animal (group of animals that is genetically uniform), if known, may be encoded in Strain Description (0010,0212). The nomenclature used may be encoded in Strain Nomenclature (0010,0213). A precoordinated code identifying the strain may be encoded in Strain Code Sequence (0010,0219).

Defined Terms for Strain Nomenclature (0010,0213) and Genetic Modifications Nomenclature (0010,0223):

MGI_2013 International Committee on Standardized Genetic Nomenclature for Mice, Rat Genome and Nomenclature Committee. MGI-Guidelines for Nomenclature of Mouse and Rat Strains. 2013/10. Available from: http://www.informatics.jax.org/mgihome/nomen/strains.shtml

Note

- A pair of text and nomenclature Attributes are used, since standard nomenclatures typically define values that are constructed from multiple components, and do not distinguish between value and meaning. These are distinct from the precoordinated codes used in Strain Code Sequence (0010,0219).
- Some strain and genetic modification nomenclatures make use of superscripts. To encode these superscripts consistently in an unformatted string, the convention of enclosing the superscript text in "<" and ">" pairs may be used. E.g., "D2.B6-Ahr^{b-1}/J" would be encoded as "D2.B6-Ahr<b-1>/J".
- Relevant information that is not encoded in the formal description of the strain (i.e., not defined in the nomenclature used), such as the number of transgenes, may be encoded as plain text in Strain Additional Information (0010,0218).

The strain of an animal may be more specifically identified by the Attributes within Strain Stock Sequence (0010,0216).

Note

- The MGI-Guidelines for Nomenclature of Mouse and Rat Strains recommends the use of the laboratory codes assigned by the Institute of Laboratory Animal Research (ILAR). See the International Laboratory Code Registry (ILCR) http://dels.nas.edu/global/ilar/lab-codes.
- Because allele names are closely tied to gene names/symbols it is necessary to have a unique and permanent code for any allele that is part of a genotype of interest. For mice, MGI is the authoritative source of the nomenclature for genes and alleles and maintains unique, permanent codes for these entities. The MGI provides a report of all precoordinated MGI codes that are assigned to specific strains at http://www.informatics.jax.org/downloads/reports/MGI_Strain.rpt. These may be used in Strain Code Sequence (0010,0219) and Genetic Modifications Code Sequence (0010,0229) with a coding scheme of "MGI".
- Another source of pre-coordinated codes for strains is the NCI Thesaurus, which includes a snapshot of strains from the International Mouse Strain Resource (IMSR), as children of (C14421, NCIt, "Inbred Mouse Strains"). See http://ncit.nci.nih.gov/ncitbrowser/pages/concept_details.jsf?dictionary=NCI_Thesaurus&code=C14421.
- For example, a C57BL/6J mouse strain from The Jackson Laboratory might be identified as:

  Strain Description (0010,0212) = "C57BL/6J"

  Strain Nomenclature (0010,0213) = "MGI_2013"

  Strain Code Sequence (0010,0219)

>Code Value (0008,0100) = "3028467"

>Coding Scheme Designator (0008,0102) = "MGI"

>Code Meaning (0008,0104) = "C57BL/6J"

Strain Stock Sequence (0010,0216)

>Strain Stock Number (0010,0214) = "000664"

>Strain Source (0010,0217) = "Jrep"

>Strain Source Registry Code Sequence (0010,0215)

>>Code Value (0008,0100) = 126850

>>Coding Scheme Designator (0008,0102) = "DCM"

>>Code Meaning (0008,0104) = "ILCR"

- For example, a FVB/N mouse with a Tg(MMTV-Erbb2*)NDL2-5Mul transgene might be identified as:

Strain Description (0010,0212) = "FVB/N-Tg(MMTV-Erbb2*)NDL2-5Mul"

Strain Nomenclature (0010,0213) = "MGI_2013"

Genetic Modifications Sequence (0010,0221)

>Genetic Modifications Description (0010,0222) = "Tg(MMTV-Erbb2*)NDL2-5Mul"

>Genetic Modifications Nomenclature (0010,0223) = "MGI_2013"

>Genetic Modifications Code Sequence (0010,0229)

>>Code Value (0008,0100) = "3793949"

>>Coding Scheme Designator (0008,0102) = "MGI"

>>Code Meaning (0008,0104) = "Tg(MMTV-Erbb2*)NDL2-5Mul"

In this example, a precoordinated code for the genetic modification is defined in MGI, but not for the mouse strain.

C.7.1.2 Specimen Identification Module

Retired. See PS3.3-2008.

Note

The functionality of the Specimen Identification Module has been replaced by the Specimen Module. See Section C.7.6.22.

C.7.1.3 Clinical Trial Subject Module

Table C.7-2b contains Attributes that identify a Patient as a clinical trial or research Subject.

Table C.7-2b. Clinical Trial Subject Module Attributes

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Sponsor Name	(0012,0010)	1	The name of the clinical trial or research sponsor. See Section C.7.1.3.1.1.
Clinical Trial Protocol ID	(0012,0020)	1	Identifier for the noted protocol. See Section C.7.1.3.1.2.
Clinical Trial Protocol Name	(0012,0021)	2	The name of the clinical trial or research protocol. See Section C.7.1.3.1.3.

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Site ID	(0012,0030)	2	The identifier of the site responsible for submitting clinical trial or research data. See Section C.7.1.3.1.4.
Clinical Trial Site Name	(0012,0031)	2	Name of the site responsible for submitting clinical trial or research data. See Section C.7.1.3.1.5
Clinical Trial Subject ID	(0012,0040)	1C	The assigned identifier for the clinical trial or research subject. See Section C.7.1.3.1.6. Shall be present if Clinical Trial Subject Reading ID (0012,0042) is absent. May be present otherwise.
Clinical Trial Subject Reading ID	(0012,0042)	1C	Identifies the subject for blinded evaluations. Shall be present if Clinical Trial Subject ID (0012,0040) is absent. May be present otherwise. See Section C.7.1.3.1.7.
Clinical Trial Protocol Ethics Committee Name	(0012,0081)	1C	Name of the Ethics Committee or Institutional Review Board (IRB) or Institutional Animal Care and Use Committees (IACUC) responsible for approval of the Clinical Trial or research. Required if Clinical Trial Protocol Ethics Committee Approval Number (0012,0082) is present.
Clinical Trial Protocol Ethics Committee Approval Number	(0012,0082)	3	Approval number issued by committee described in Clinical Trial Protocol Ethics Committee Name (0012,0081).

C.7.1.3.1 Clinical Trial Subject Attribute Descriptions

Identification of subjects in clinical trials or research generally requires a combination of the following four Attributes:

1. Clinical Trial Sponsor Name (0012,0010),
2. Clinical Trial Protocol ID (0012,0020),
3. Clinical Trial Subject ID (0012,0040) (or Clinical Trial Subject Reading ID (0012,0042) for blinded evaluations), and
4. Clinical Trial Site ID (0012,0030).

For trials in which subject identifiers are unique within the scope of the Clinical Trial Protocol (e.g., if subject identifiers are centrally assigned or contain the site identifier) the Clinical Trial Site ID (0012,0030) is not required to identify subjects.

C.7.1.3.1.1 Clinical Trial Sponsor Name

The Clinical Trial Sponsor Name (0012,0010) identifies the entity responsible for conducting the clinical trial or research and for defining the Clinical Trial Protocol ID (0012,0020).

C.7.1.3.1.2 Clinical Trial Protocol ID

The Clinical Trial Protocol ID (0012,0020) is the number or character sequence used by the Clinical Trial Sponsor to uniquely identify the investigational protocol in which the subject has been enrolled.

C.7.1.3.1.3 Clinical Trial Protocol Name

The Clinical Trial Protocol Name (0012,0021) contains the title of the investigational protocol in which the subject has been enrolled.

Note

It is recommended that the phase of the clinical trial or research be noted in the Clinical Trial Protocol Name, if applicable.

C.7.1.3.1.4 Clinical Trial Site ID

The Clinical Trial Site ID (0012,0030) is the identification number or character string (issued by the entity identified by the Clinical Trial Sponsor Name (0012,0010)) used to identify the site responsible for submitting clinical trial or research data.

C.7.1.3.1.5 Clinical Trial Site Name

The Clinical Trial Site Name (0012,0031) is a character string used to identify the site responsible for submitting clinical trial or research data.

C.7.1.3.1.6 Clinical Trial Subject ID

The Clinical Trial Subject ID (0012,0040) identifies the subject within the investigational protocol specified by Clinical Trial Protocol ID (0012,0020).

Note

The Clinical Trial Subject ID (0012,0040) may, but is not required to be, the same as Patient ID (0010,0020).

C.7.1.3.1.7 Clinical Trial Subject Reading ID

The Clinical Trial Subject Reading ID (0012,0042) identifies the subject in the context of blinded evaluations.

C.7.1.4 Patient Group Macro

Table C.7.1.4-1 specifies the Attributes of the Patient Group Macro that describe multiple imaging subjects (such as small animals for pre-clinical research) imaged at the same time as a group. This Macro may be included in the Section C.2.2 Patient Identification Module and the Section C.7.1.1 Patient Module.

Table C.7.1.4-1. Patient Group Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Source Patient Group Identification Sequence	(0010,0026)	3	A Sequence containing the value used for Patient ID (0010,0020) and related Attributes in the source Composite Instances that contained a group of subjects whose data was acquired at the same time, from which this Composite Instance was extracted. See Section C.7.1.4.1.1. Only a single Item is permitted in this Sequence.
>Patient ID	(0010,0020)	1	Primary identifier for the group of subjects.
>Include Table 10-18 “Issuer of Patient ID Macro Attributes”			
Group of Patients Identification Sequence	(0010,0027)	3	A Sequence containing the identifiers and locations of the individual subjects whose data was acquired at the same time (as a group) and encoded in this Composite Instance. See Section C.7.1.4.1.1. One or more Items are permitted in this Sequence.
>Patient ID	(0010,0020)	1	Primary identifier for an individual subject.
>Include Table 10-18 “Issuer of Patient ID Macro Attributes”			
>Subject Relative Position in Image	(0010,0028)	3	The position in the image pixel data of the individual subject identified in this Sequence relative to the other subjects. See Section C.7.1.4.1.1.1.
>Patient Position	(0018,5100)	3	Patient position descriptor relative to the equipment. See Section C.7.1.4.1.1.1. See Section C.7.3.1.1.2 for Defined Terms and further explanation.

C.7.1.4.1 Patient Group Macro Attributes

C.7.1.4.1.1 Groups of Subjects

It is common to image multiple small animals for pre-clinical research as a group at the same time.

In such cases, the single value of Patient ID (0010,0020) corresponds to the identification of the entire group. The same applies to related Attributes, if present, such as Issuer of Patient ID (0010,0021). Other Attributes of the Patient Module that are present shall be those shared by the entire group of animals, otherwise they shall be absent or empty (e.g., Patient's Sex (0010,0040)). Any acquisition-related Attributes that are Patient-specific (e.g., injected contrast or radiopharmaceutical dose) shall also be absent or empty (and the information may be communicated in separate acquisition context Instances).

The Group of Patients Identification Sequence (0010,0027) provides a means of describing the identifiers and locations of the individual subjects, if known at the time of acquisition, regardless of whether or not the group images are later segmented into individual images.

It is also common to segment the acquired images of the group of animals and extract the image pixel data for each animal into separate images.

The Source Patient Group Identification Sequence (0010,0026) provides a "backward reference" within the segmented (individual subject) images to the Patient ID (0010,0020) used to identify the whole group.

Note

1. Individual derived SOP Instances may reference the source image explicitly by its SOP Instance UID. Additional objects, such as Segmentations, may be created to encode the regions segmented for individual animals, and referenced from the derived images. See also Annex VVV “Segmentation of Images of Groups of Animals (Informative)” in PS3.17.

2. For example, an image of a group of 6 mice in a 3 column, 2 row single longitudinal plane array might be described as:

   - Patient ID (0010,0020) = "Inv234_Exp_56_Group78"
   - Issuer of Patient ID (0010,0021) = "MyMouseLab"
   - Group of Patients Identification Sequence (0010,0027)
   - >Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse01"
   - >Issuer of Patient ID (0010,0021) = "MyMouseLab"
   - >Subject Relative Position in Image (0010,0028) = 1\1\1
   - ...
   - >Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse06"
   - >Issuer of Patient ID (0010,0021) = "MyMouseLab"
   - >Subject Relative Position in Image (0010,0028) = 3\2\1

   In this example, the optional Issuer of Patient ID (0010,0021) is shown to emphasize that if it is needed, it should be repeated; i.e., there is no "inheritance" of the issuer from the Data Set enclosing the Sequence.

   The naming of the group and the individual animals in the identifier is purely illustrative; it is not meant to imply preference for one local convention or another, or for using a discrete identifier for the group as opposed to, say, a concatenated list of individual animal identifiers used as the group identifier.

   See Figure C.7.1.4-1.

3. For example, segmented images of an individual animal derived from the group image might be described as:

   - Patient ID (0010,0020) = "Inv234_Exp_56_Group78_Mouse04"
   - Issuer of Patient ID (0010,0021) = "MyMouseLab"
   - Source Patient Group Identification Sequence (0010,0026)
   - >Patient ID (0010,0020) = "Inv234_Exp_56_Group78"
   - >Issuer of Patient ID (0010,0021) = "MyMouseLab"

C.7.1.4.1.1.1 Subject Relative Position in Image and Patient Position

Subject Relative Position in Image (0010,0028) shall be encoded as a 3D ordinal position in machine-relative orthogonal dimensions, such that when facing the front of the machine (gantry):

- the first value starts at one for the left most subject holder and monotonically increases by one for each successive subject holder towards the right,
- the second value starts at one for the top most subject holder and monotonically increases by one for each successively lower subject holder,
- the third value starts at one for the outer most subject holder and monotonically increases by one for each successive subject holder inwards (i.e., increasing values from the front to the back of the gantry along the direction orthogonal to the first two dimensions, usually the long axis of the table).

Note

- The order and sign of the machine-relative directions is consistent with the Axis Definition in ACR-NEMA 300 1985.
- Image-relative positions are not used, since there may be multiple acquisitions in different orientations. The machine-relative positions are applicable regardless of whether acquired images are cross-sections or projections.
- Patient-relative positions are not used, since the animals may not be arranged in the same direction (e.g., a pair of animals may be arranged head-to-head).
- There is no requirement that there be the same number of animals in each dimension. E.g., one in the top "row"and two below, in one longitudinal plane, would be represented as 1\1\1, 1\2\1, 2\1\1.
- The goal is to describe only the relative locations of animals in any form of multiple animal holder ("mouse hotel"), without attempting to specify the exact physical dimensions or absolute locations, regardless of whether the holder is regular or symmetric in any particular dimension or not (e.g., to include "revolver-like" and hexagonal arrangements). Nor is the "distance" between each animal described.
- The position is defined in terms of subject holders rather than subjects, since some holders may be empty or unused but still partially or completely visible in some of the images. In such cases the relative positions need to be consistently encoded by the acquisition device and recognized by automated segmentation algorithms. E.g., if the top row of in a two row holder is unoccupied, then the animals in the bottom row will be identified with a row position of 2, not 1.
- Due to field of view and anatomical region of interest considerations, adjacent animals may sometimes be partially overlapped (e.g., Cheng TE et al. A rat head holder for simultaneous scanning of two rats in small animal PET scanners: Design, construction, feasibility testing and kinetic validation. Journal of Neuroscience Methods. 2009 Jan 15;176(1):24–33. http://dx.doi.org/10.1016/j.jneumeth.2008.08.031 and Xu S et al. In vivo multiple-mouse imaging at 1.5 T. Magnetic Resonance in Medicine. 2003;49(3):551–7. http://dx.doi.org/10.1002/mrm.10397); such cases may be described as a either a single plane or two planes of animals, as long as there is sufficient information to identify which animal is which.

  See Figure C.7.1.4-3.
- The description of the physical relative locations of the animals does not account for any spatial distortion that may occur in the images due to the acquisition technique used (e.g., aliasing in MRI).

Patient Position (0018,5100) may be used to describe the machine-relative position of each animal when the animals are not all arranged in the same direction.

Note

- Patient Position (0018,5100) is used rather than Patient Orientation Code Sequence (0054,0410) because Patient Position (0018,5100) is present in the IODs for those modalities most commonly used for small animal imaging in preclinical research.
- For example, a pair of prone animals arranged head-to-head longitudinally along the bore of the machine would be described as:
  - Subject Relative Position in Image = 1\1\1 and Patient Position = HFP

Subject Relative Position in Image = 1\1\2 and Patient Position = FFP

See Figure C.7.1.4-2.

The presence of Subject Relative Position in Image (0010,0028) and Patient Position (0018,5100) within Group of Patients Identification Sequence (0010,0027) within the Patient Module implies that the relative locations and orientations of multiple animals within a group cannot change over time. I.e., a "group", identified by a particular Patient ID (0010,0020) (the unique key of the Patient entity in the Information Model), is defined not only by the animals that comprise it but also their relative locations and positioning. If the same animals are imaged together but in a different arrangement, a different Patient ID (0010,0020) for the group shall be used.

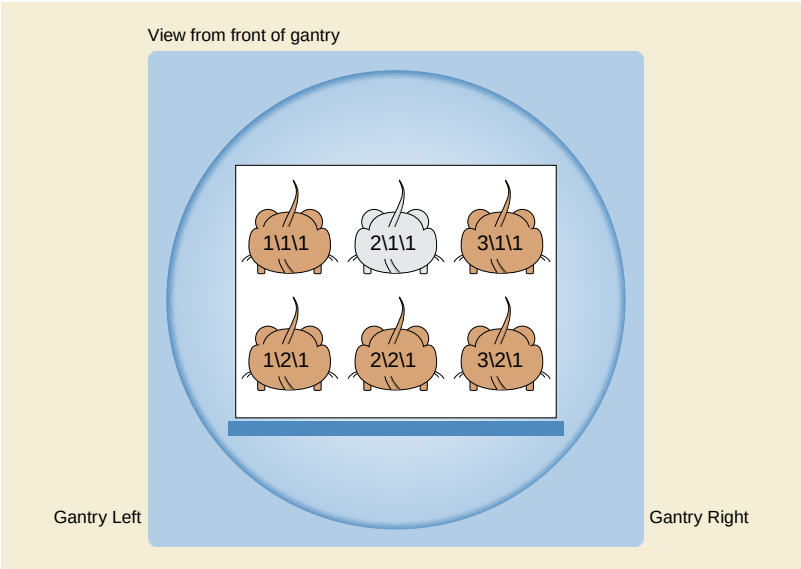


Figure C.7.1.4-1. Example of Subject Relative Position in Image for group of 6 mice in a 3 column, 2 row single longitudinal plane array, all feet first prone

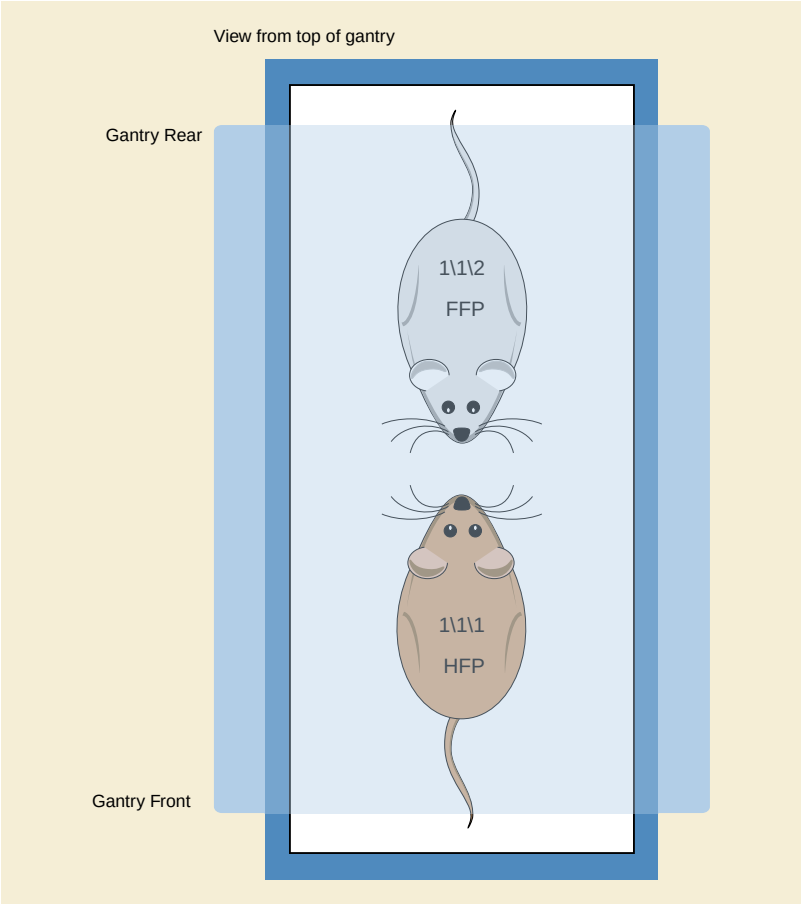


Figure C.7.1.4-2. Example of Subject Relative Position in Image and differing Patient Position for group of 2 mice head-to-head

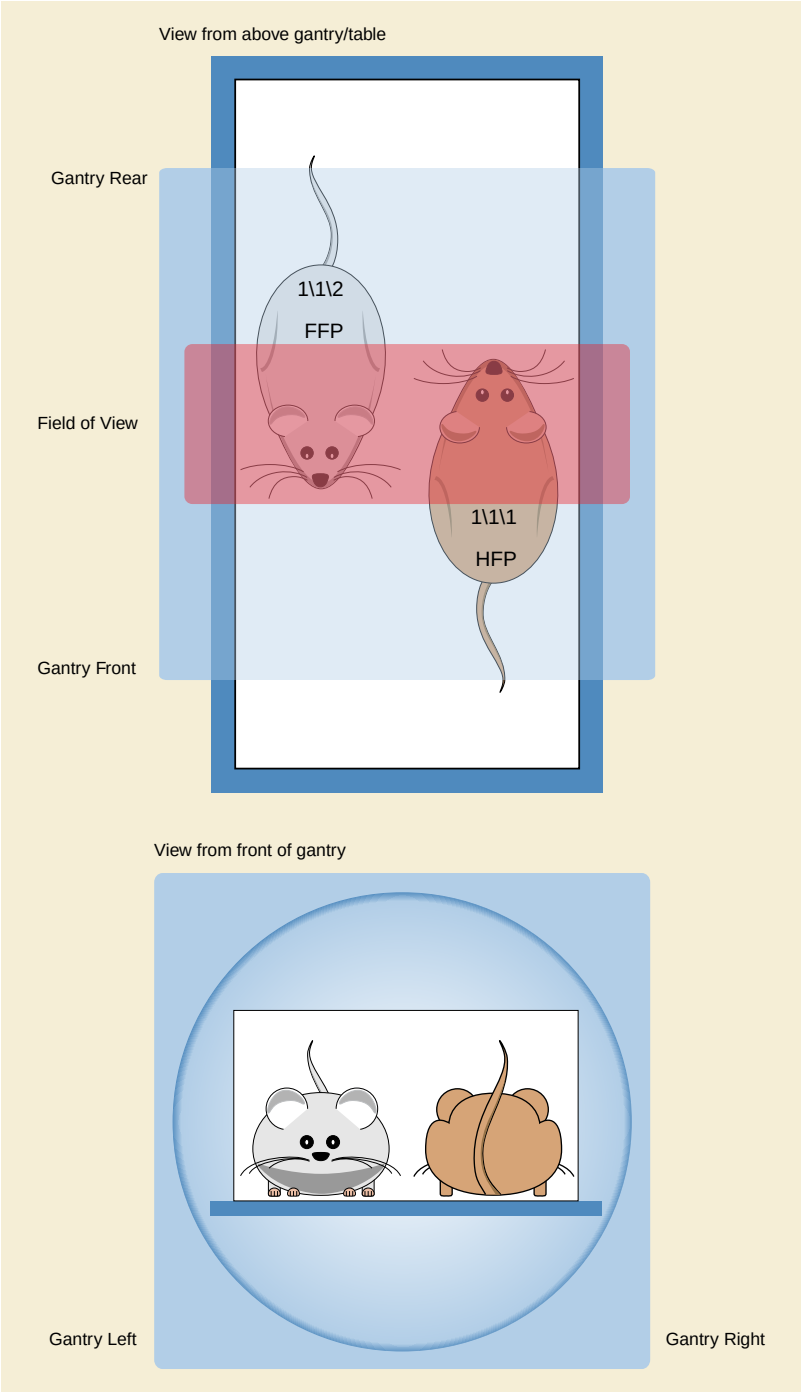


Figure C.7.1.4-3. Example of Subject Relative Position in Image and overlapping narrow field of view group of 2 mice head-to-head

C.7.1.5 Patient's Alternative Calendar

Enumerated Values:

PROLEPTIC GREGN
JULIAN
PROLEPTIC JULIAN

EGYPTIAN REGNAL
HEBREW
HIJRI

C.7.2 Common Study IE Modules

The following Study IE Modules are common to all Composite Image IODs that reference the Study IE. These Modules contain Attributes of the Patient and Study that are needed for interpretation of the Composite Instances. They contain Attributes that are also in the Patient Modules in Section C.2 and Study Modules in Section C.4.

C.7.2.1 General Study Module

Table C.7-3 specifies the Attributes that describe and identify the Study performed upon the Patient.

Table C.7-3. General Study Module Attributes

Attribute Name	Tag	Type	Attribute Description
Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
Study Date	(0008,0020)	2	Date the Study started.
Study Time	(0008,0030)	2	Time the Study started.
Referring Physician's Name	(0008,0090)	2	Name of the Patient's referring physician
Referring Physician Identification Sequence	(0008,0096)	3	Identification of the Patient's referring physician. Only a single Item is permitted in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Consulting Physician's Name	(0008,009C)	3	Consulting physician(s) for this Patient Visit.
Consulting Physician Identification Sequence	(0008,009D)	3	Identification of the consulting physician(s). One or more Items shall be included in this Sequence. If more than one Item, the number and order shall correspond to the value of Consulting Physician's Name (0008,009C), if present.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Study ID	(0020,0010)	2	User or equipment generated Study identifier.
Accession Number	(0008,0050)	2	A RIS generated number that identifies the order for the Study.
Issuer of Accession Number Sequence	(0008,0051)	3	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item is permitted in this Sequence.
>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”			
Study Description	(0008,1030)	3	Institution-generated description or classification of the Study (component) performed.
Physician(s) of Record	(0008,1048)	3	Names of the physician(s) who are responsible for overall Patient care at time of Study (see Section C.7.3.1 for Performing Physician)
Physician(s) of Record Identification Sequence	(0008,1049)	3	Identification of the physician(s) who are responsible for overall Patient care at time of Study. One or more Items are permitted in this Sequence. If more than one Item, the number and order shall correspond to the value of Physician(s) of Record (0008,1048), if present.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-1 "Person Identification Macro Attributes Description"			
Name of Physician(s) Reading Study	(0008,1060)	3	Names of the physician(s) reading the Study.
Physician(s) Reading Study Identification Sequence	(0008,1062)	3	Identification of the physician(s) reading the Study. One or more Items are permitted in this Sequence. If more than one Item, the number and order shall correspond to the value of Name of Physician(s) Reading Study (0008,1060), if present.
>Include Table 10-1 "Person Identification Macro Attributes Description"			
Requesting Service	(0032,1033)	3	Institutional department, unit or service where the request initiated. See Note 1 and Note 2.
Requesting Service Code Sequence	(0032,1034)	3	Institutional department, unit or service where the request initiated. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7030 "Institutional Departments, Units and Services".*
Referenced Study Sequence	(0008,1110)	3	A Sequence that provides reference to a Study SOP Class/Instance pair. One or more Items are permitted in this Sequence. See Section 10.6.1.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Procedure Code Sequence	(0008,1032)	3	A Sequence that conveys the type of procedure performed. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Reason For Performed Procedure Code Sequence	(0040,1012)	3	Coded reason(s) for performing this procedure. Note May differ from the values in Reason for the Requested Procedure (0040,100A) in Request Attribute Sequence (0040,0275), for example if what was performed differs from what was requested. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*

Note

1. Both Requesting Service (0032,1033) and Requesting Service Code Sequence (0032,1034) are defined in this table; the latter is preferred, but the former may be copied from an HL7 message whether or not there is also the ability to map it to a coded form (e.g., with only ORC-17 component 1 valued).

2. Requesting Service (0032,1033) and/or Requesting Service Code Sequence (0032,1034) may be used in the absence of a specific request or order, to describe the service involved or associated with acquiring the Study.

C.7.2.1.1 General Study Attribute Descriptions

C.7.2.1.1.1 Referring Physician, Physician of Record, Physician Reading Study, Consulting Physician

The model used for application of Attributes related to different functions of Physicians involved in the care of a Patient is shown in Figure C.7.2-1. Figure C.7.2-1 shows some of the relationships and information flows between physician roles that might be present in some healthcare business models.

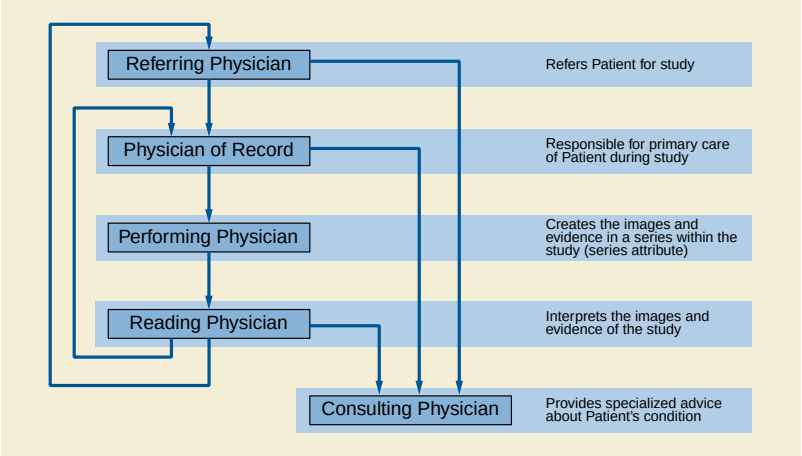


Figure C.7.2-1. Functions of Physicians

There can be an overlap of functions provided by any given physician. In this case, the various Attributes specifying the different roles would convey the same physician name.

C.7.2.2 Patient Study Module

Table C.7-4a defines Attributes that provide information about the Patient at the time the Study started.

Note

In the case of imaging a group of small animals simultaneously, the Attributes in this Module can only have values that apply to the entire group, otherwise they are absent (e.g., Patient's Weight (0010,1030)) or empty (e.g., Patient's Sex Neutered (0010,2203).

Table C.7-4a. Patient Study Module Attributes

Attribute Name	Tag	Type	Attribute Description
Admitting Diagnoses Description	(0008,1080)	3	Description of the admitting diagnosis (diagnoses)
Admitting Diagnoses Code Sequence	(0008,1084)	3	A Sequence that conveys the admitting diagnosis (diagnoses). One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Patient's Age	(0010,1010)	3	Age of the Patient.
Patient's Size	(0010,1020)	3	Length or size of the Patient, in meters.
Patient's Weight	(0010,1030)	3	Weight of the Patient, in kilograms.
Patient's Body Mass Index	(0010,1022)	3	Body Mass Index of the Patient in kg/m2.

Attribute Name	Tag	Type	Attribute Description
Measured AP Dimension	(0010,1023)	3	The thickness in mm of the body part being scanned, in the antero-posterior dimension (per AAPM Report 204). Note These values are normally derived from a scanned image, but might also be obtained using physical calipers, e.g., for children.
Measured Lateral Dimension	(0010,1024)	3	The side-to-side (left to right) dimension in mm of the body part being scanned (per AAPM Report 204). Note These values are normally derived from a scanned image, but might also be obtained using physical calipers, e.g., for children.
Patient's Size Code Sequence	(0010,1021)	3	Patient's size category code One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7039 “Pediatric Size Categories” for pediatric patients* *BCID 7041 “Calcium Scoring Patient Size Categories” for CT calcium scoring*
Medical Alerts	(0010,2000)	3	Conditions to which medical staff should be alerted (e.g., contagious condition, drug allergies, etc.)
Allergies	(0010,2110)	3	Description of prior reaction to contrast agents, or other patient allergies or adverse reactions.
Smoking Status	(0010,21A0)	3	Indicates whether Patient smokes. Enumerated Values: **YES** **NO** **UNKNOWN**
Pregnancy Status	(0010,21C0)	3	Describes pregnancy state of Patient. Enumerated Values: **0001** not pregnant **0002** possibly pregnant **0003** definitely pregnant **0004** unknown
Last Menstrual Date	(0010,21D0)	3	Date of onset of last menstrual period
Patient State	(0038,0500)	3	Description of Patient state (comatose, disoriented, vision impaired, etc.)
Occupation	(0010,2180)	3	Occupation of the Patient.
Additional Patient History	(0010,21B0)	3	Additional information about the Patient's medical history.
Admission ID	(0038,0010)	3	Identifier of the Visit as assigned by the healthcare provider Note Visit and Admission are used interchangeably here. In the broader sense, an admission is a type of visit at an institution where there is an admission process for patients.

Attribute Name	Tag	Type	Attribute Description
Issuer of Admission ID Sequence	(0038,0014)	3	Identifier of the Assigning Authority that issued Admission ID (0038,0010). Only a single Item is permitted in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
Reason for Visit	(0032,1066)	3	Reason(s) for this visit by the patient to the facility or provider.
Reason for Visit Code Sequence	(0032,1067)	3	Coded reason(s) for this visit by the patient to the facility or provider. Note If an HL7 message is available with a PV2 segment corresponding to this visit, potential codes may be found in Admit Reason PV2-3. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Service Episode ID	(0038,0060)	3	Identifier of the Service Episode as assigned by the healthcare provider
Issuer of Service Episode ID Sequence	(0038,0064)	3	Identifier of the Assigning Authority that issued the Service Episode ID (0038,0060). Only a single Item is permitted in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
Service Episode Description	(0038,0062)	3	Description of the type of service episode.
Patient's Sex Neutered	(0010,2203)	2C	Whether or not a procedure has been performed in an effort to render the Patient sterile. Enumerated Values: **ALTERED** Altered/Neutered **UNALTERED** Unaltered/intact Note If this Attribute is present but has no value then the status is unknown. Required if Patient is an animal. May be present otherwise.

C.7.2.3 Clinical Trial Study Module

Table C.7-4b contains Attributes that identify a Study in the context of a clinical trial or research.

Table C.7-4b. Clinical Trial Study Module Attributes

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Time Point ID	(0012,0050)	2	An identifier specifying the one or more Studies that are grouped together as a clinical time point or submission in a clinical trial or research. See Section C.7.2.3.1.1.
Clinical Trial Time Point Description	(0012,0051)	3	A description of a set of one or more Studies that are grouped together to represent a clinical time point or submission in a clinical trial or research. See Section C.7.2.3.1.1.

Attribute Name	Tag	Type	Attribute Description
Longitudinal Temporal Offset from Event	(0012,0052)	3	An offset in days from a particular event of significance. May be fractional. In the context of a clinical trial, this is often the days since enrollment, or the baseline imaging Study.
Longitudinal Temporal Event Type	(0012,0053)	1C	The type of event to which Longitudinal Temporal Offset from Event (0012,0052) is relative. Defined Terms: **ENROLLMENT** Relative to enrollment of the subject in the research activity or clinical trial. **BASELINE** Relative to the baseline imaging Study. Required if Longitudinal Temporal Offset from Event (0012,0052) is present.
Consent for Clinical Trial Use Sequence	(0012,0083)	3	A Sequence that conveys information about consent for Clinical Trial or research use of the Composite Instances within this Study. One or more Items are permitted in this Sequence. See Section C.7.2.3.1.2.
>Distribution Type	(0012,0084)	1C	The type of distribution for which consent to distribute has been granted. Defined Terms: **NAMED_PROTOCOL** **RESTRICTED_REUSE** **PUBLIC_RELEASE** See Section C.7.2.3.1.2. Required if Consent for Distribution Flag (0012,0085) equals YES or WITHDRAWN.
>Clinical Trial Protocol ID	(0012,0020)	1C	The identifier of the protocol for which consent to distribute has been granted. Required if Distribution Type (0012,0084) is NAMED_PROTOCOL and the protocol is not that which is specified in Clinical Trial Protocol ID (0012,0020) in the Clinical Trial Subject Module.
>Consent for Distribution Flag	(0012,0085)	1	Whether or not consent to distribute has been granted for the purpose described in Distribution Type (0012,0084). Enumerated Values: **NO** **YES** **WITHDRAWN** See Section C.7.2.3.1.2. Note Under some circumstances, consent may be withdrawn. The purpose of encoding this is to warn receiving systems that further distribution may not be appropriate, but no semantics are defined by the Standard for what action is appropriate under such circumstances, such as what to do with previously received images that had a value of YES.

C.7.2.3.1 Clinical Trial Study Attribute Descriptions

C.7.2.3.1.1 Clinical Trial Time Point

The Clinical Trial Time Point ID (0012,0050) Attribute identifies an imaging Study within the context of an investigational protocol. This Attribute is used to define a set of Studies that are grouped together as a clinical time point or data submission in a clinical trial or research. The Clinical Trial Time Point Description (0012,0051) Attribute can be used to give a description of the Clinical Trial Time Point to which the set of Studies belongs.

C.7.2.3.1.2 Consent For Clinical Trial Use Sequence

For applications such as clinical trials or research, the distribution of Composite Instances in Studies, whether containing identifying information or partially or completely de-identified, may need to be controlled. Permission for distribution is usually granted under the control of the Patient (through informed consent), the ethics committee or institutional review board responsible for the Study, and the sponsor of the Study through contractual means. The Consent for Clinical Trial Use Sequence (0012,0083) is intended to encode the result of the consent process to allow appropriate subsequent handling of the Instances.

The Defined Terms for Distribution Type (0012,0084) mean that consent has been issued to distribute for the following purposes:

Defined Terms:

NAMED_PROTOCOL conducting the protocol named in Clinical Trial Protocol ID (0012,0020)
RESTRICTED_REUSE re-use for restricted purposes (not specified here) other than those for which the Instances were originally created
PUBLIC_RELEASE release to the general public for re-use without restriction

Note

1. There is no intent to convey in this Sequence further details of the often complex consent and approval process. Further information about the protocol and ethics committee may be found in the Clinical Trials Modules, if present.

2. There is no identification of an individual responsible for the approval or granting consent, since in the case of a clinical trial or research subject granting informed consent, the presence of this information would breach de-identification requirements.

3. Multiple Sequence Items may be present; for example a Study may be approved for distribution for conducting multiple explicitly named protocols.

4. Whether or not the Instances have been adequately de-identified for any particular purpose of distribution is not defined by the Attributes in the Consent for Clinical Trial Use Sequence (0012,0083). Other Attributes address this, such as Patient Identity Removed (0012,0062), De-identification Method (0012,0063), De-identification Method Code Sequence (0012,0064) and Burned In Annotation (0028,0301). See also Annex E “Attribute Confidentiality Profiles” in PS3.15.

5. It is possible that the list of Defined Terms for Distribution Type (0012,0084) may be extended in future for other purposes, not necessarily related to the conduct of clinical trials or research.

C.7.3 Common Series IE Modules

The following Series IE Modules are common to all Composite Image IODs that reference the Series IE.

C.7.3.1 General Series Module

Table C.7-5a specifies the Attributes that identify and describe general information about the Series within a Study.

Table C.7-5a. General Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. See Section C.7.3.1.1.1 for Defined Terms.
Series Instance UID	(0020,000E)	1	Unique identifier of the Series.

Attribute Name	Tag	Type	Attribute Description
Series Number	(0020,0011)	2	A number that identifies this Series.
Laterality	(0020,0060)	2C	Laterality of (paired) body part examined. Required if the body part examined is a paired structure and Image Laterality (0020,0062) or Frame Laterality (0020,9072) or Measurement Laterality (0024,0113) are not present. Enumerated Values: **R** right **L** left Note 1. Some IODs support Image Laterality (0020,0062) at the Image level or Frame Laterality (0020,9072) at the Frame level in the Frame Anatomy Functional Group Macro or Measurement Laterality (0024,0113) at the Measurement level, which can provide a more comprehensive mechanism for specifying the laterality of the body part(s) being examined. 2. There is no value for both left and right, for which Image Laterality (0020,0062) at the Image level or Frame Laterality (0020,9072) may be used instead. 3. There is no value for median, for which Primary Anatomic Structure Modifier Sequence (0008,2230) or Anatomic Region Modifier Sequence (0008,2220) may be used instead.
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Performing Physician's Name	(0008,1050)	3	Name of the physician(s) administering the Series.
Performing Physician Identification Sequence	(0008,1052)	3	Identification of the physician(s) administering the Series. One or more Items are permitted in this Sequence. If more than one Item, the number and order shall correspond to the value of Performing Physician's Name (0008,1050), if present.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Protocol Name	(0018,1030)	3	User-defined description of the conditions under which the Series was performed. Note This Attribute conveys Series-specific protocol identification and may or may not be identical to the protocol described in the Performed Protocol Code Sequence (0040,0260) in the Performed Protocol Code Sequence (0040,0260) in Table 10-16 “Performed Procedure Step Summary Macro Attributes”.

Attribute Name	Tag	Type	Attribute Description
Referenced Defined Protocol Sequence	(0018,990C)	1C	Defined Procedure Protocol SOP Instance(s) that were used to create Instances in this Series. Required if this Instance is a Performed Procedure Protocol that resulted from a Defined Procedure Protocol. May be present otherwise. One or more Items shall be included in this Sequence. Note Multiple Items in this Sequence may represent a group case where several Defined Procedure Protocols were performed together as a single Performed Procedure Protocol.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Referenced Performed Protocol Sequence	(0018,990D)	1C	Uniquely identifies the Performed Procedure Protocol SOP Instance(s) that describe the conditions by which this Series was generated. Required if a related Performed Procedure Protocol SOP Instance was created. One or more Items shall be included in this Sequence. Note If the acquisition and reconstruction were recorded in separate Performed Procedure Protocol SOP Instances, it is recommended to reference both. However, it is not intended that this Sequence reference Defined or prior Performed Protocol SOP Instances on which the current Performed Procedure Protocol SOP Instance was based. Such references may be found inside the current Performed Procedure Protocol SOP Instance itself.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Series Description	(0008,103E)	3	Description of the Series
Series Description Code Sequence	(0008,103F)	3	A coded description of the Series. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Operators' Name	(0008,1070)	3	Name(s) of the operator(s) supporting the Series.
Operator Identification Sequence	(0008,1072)	3	Identification of the operator(s) supporting the Series. One or more Items are permitted in this Sequence. If more than one Item, the number and order shall correspond to the value of Operators' Name (0008,1070), if present.
>Include Table 10-1 "Person Identification Macro Attributes Description"			
Referenced Performed Procedure Step Sequence	(0008,1111)	3	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item is permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Related Series Sequence	(0008,1250)	3	Identification of Series significantly related to this Series. One or more Items are permitted in this Sequence. Note 1. For example, for a combined CT and PET acquisition, the CT images and PET images would be in separate Series that could cross-reference each other with multiple purpose of reference codes meaning same anatomy, simultaneously acquired and same indication. 2. The related Series may have different Frames of Reference and hence require some sort of registration before spatial coordinates can be directly compared. 3. This Attribute is not intended for conveying localizer reference information, for which Referenced Image Sequence (0008,1140) should be used.
>Study Instance UID	(0020,000D)	1	Instance UID of Study to which the related Series belongs
>Series Instance UID	(0020,000E)	1	Instance UID of Related Series
>Purpose of Reference Code Sequence	(0040,A170)	2	Describes the purpose for which the reference is made. Zero or more Items shall be included in this Sequence. When absent, implies that the reason for the reference is unknown.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7210 "Related Series Purposes of Reference".*
Body Part Examined	(0018,0015)	3	Text description of the part of the body examined. See Annex L "Correspondence of Anatomic Region Codes and Body Part Examined Defined Terms" in PS3.16 for Defined Terms Note Some IODs support the Anatomic Region Sequence (0008,2218), which can provide a more comprehensive mechanism for specifying the body part being examined.
Patient Position	(0018,5100)	2C	Patient position descriptor relative to the equipment. Required for images where Patient Orientation Code Sequence (0054,0410) is not present and whose SOP Class is one of the following: CT ("1.2.840.10008.5.1.4.1.1.2") or MR ("1.2.840.10008.5.1.4.1.1.4") or Enhanced CT ("1.2.840.10008.5.1.4.1.1.2.1") or Enhanced MR Image ("1.2.840.10008.5.1.4.1.1.4.1") or Enhanced Color MR Image ("1.2.840.10008.5.1.4.1.1.4.3") or MR Spectroscopy ("1.2.840.10008.5.1.4.1.1.4.2") Storage SOP Classes. May be present for other SOP Classes if Patient Orientation Code Sequence (0054,0410) is not present. See Section C.7.3.1.1.2 for Defined Terms and further explanation.
Smallest Pixel Value in Series	(0028,0108)	3	The minimum value of all images in this Series.
Largest Pixel Value in Series	(0028,0109)	3	The maximum value of all images in this Series.

Attribute Name	Tag	Type	Attribute Description
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.
>Include Table 10-9 "Request Attributes Macro Attributes"			*No Baseline CID is defined.*
Include Table 10-16 "Performed Procedure Step Summary Macro Attributes"			*No Baseline CID is defined.*
Anatomical Orientation Type	(0010,2210)	1C	The anatomical orientation type used in Instances generated by this equipment. Enumerated Values: **BIPED** **QUADRUPED** Required if the Patient is an animal and the anatomical Frame of Reference is not bipedal. May be present otherwise. See Section C.7.6.1.1.1 and Section C.7.6.2.1.1. Note If this Attribute is not present, the default human standard anatomical position is used to define the patient orientation of projection images and the Patient-Based Coordinate System of cross-sectional images.

Note

1. If any Performed Procedure Step SOP Class is supported as an SCU by a Storage SCU, the SCU is strongly encouraged to support the Attribute Referenced Performed Procedure Step Sequence (0008,1111). This Attribute references the Performed Procedure Step SOP Instance, and extraction of this Attribute from a Composite Instance may allow retrieval of the Performed Procedure Step SOP Instance.

2. If the Storage SCU does not conform to any Performed Procedure Step SOP Class, it is still advisable to include the Attributes Performed Procedure Step Start Date (0040,0244), Performed Procedure Step Start Time (0040,0245) and Performed Procedure Step Description (0040,0254) into the Composite Instances.

C.7.3.1.1 General Series Attribute Descriptions

C.7.3.1.1.1 Modality

Defined Terms:

AR Autorefraction
ASMT Content Assessment Results
AU Audio
BDUS Bone Densitometry (ultrasound)
BI Biomagnetic imaging
BMD Bone Densitometry (X-Ray)
CR Computed Radiography
CT Computed Tomography
CTPROTOCOL CT Protocol (Performed)
DG Diaphanography
DOC Document
DX Digital Radiography
ECG Electrocardiography
EEG Electroencephalography
EMG Electromyography
EOG Electrooculography
EPS Cardiac Electrophysiology

ES	Endoscopy
FID	Fiducials
GM	General Microscopy
HC	Hard Copy
HD	Hemodynamic Waveform
IO	Intra-Oral Radiography
IOL	Intraocular Lens Data
IVOCT	Intravascular Optical Coherence Tomography
IVUS	Intravascular Ultrasound
KER	Keratometry
KO	Key Object Selection
LEN	Lensometry
LS	Laser surface scan
MG	Mammography
MR	Magnetic Resonance
M3D	Model for 3D Manufacturing
NM	Nuclear Medicine
OAM	Ophthalmic Axial Measurements
OCT	Optical Coherence Tomography (non-Ophthalmic)
OP	Ophthalmic Photography
OPM	Ophthalmic Mapping
OPT	Ophthalmic Tomography
OPTBSV	Ophthalmic Tomography B-scan Volume Analysis
OPTENF	Ophthalmic Tomography En Face
OPV	Ophthalmic Visual Field
OSS	Optical Surface Scan
OT	Other
PLAN	Plan
POS	Position Sensor
PR	Presentation State
PT	Positron emission tomography (PET)
PX	Panoramic X-Ray
REG	Registration
RESP	Respiratory Waveform
RF	Radio Fluoroscopy
RG	Radiographic imaging (conventional film/screen)
RTDOSE	Radiotherapy Dose
RTIMAGE	Radiotherapy Image
RTINTENT	Radiotherapy Intent
RTPLAN	Radiotherapy Plan
RTRAD	RT Radiation
RTRECORD	RT Treatment Record
RTSEGANN	Radiotherapy Segment Annotation
RTSTRUCT	Radiotherapy Structure Set
RWV	Real World Value Map
SEG	Segmentation
SM	Slide Microscopy
SMR	Stereometric Relationship
SR	SR Document
SRF	Subjective Refraction
STAIN	Automated Slide Stainer
TEXTUREMAP	Texture Map
TG	Thermography
US	Ultrasound
VA	Visual Acuity
XA	X-Ray Angiography
XC	External-camera Photography

Retired Defined Terms:

AS Angioscopy
CD Color flow Doppler
CF Cinefluorography
CP Culposcopy
CS Cystoscopy
DD Duplex Doppler
DF Digital fluoroscopy
DM Digital microscopy
DS Digital Subtraction Angiography
EC Echocardiography
FA Fluorescein angiography
FS Fundoscopy
LP Laparoscopy
MA Magnetic resonance angiography
MS Magnetic resonance spectroscopy
OPR Ophthalmic Refraction
ST Single-photon emission computed tomography (SPECT)
VF Videofluorography

Note

1. The XA modality incorporates the retired modality DS.
2. The RF modality incorporates the retired modalities CF, DF, VF.
3. The modality listed in the Modality Data Element (0008,0060) may not match the name of the IOD in which it appears. For example, a SOP Instance from XA IOD may list the RF modality when an RF implementation produces an XA object.
4. The MR modality incorporates the retired modalities MA and MS.
5. The US modality incorporates the retired modalities EC, CD, and DD.
6. The NM modality incorporates the retired modality ST.

C.7.3.1.1.2 Patient Position

Patient Position (0018,5100) specifies the position of the patient relative to the imaging equipment space. This Attribute is intended for annotation purposes only. It does not provide an exact mathematical relationship of the patient to the imaging equipment.

When multiple subjects are present in the same image, and arranged with different positions, then the Patient Position (0018,5100) in the General Series Module is nominal, does not apply to each subject, but does define the relationship of the nominal Patient-Based Coordinate System to the machine.

Note

In conjunction with the Patient Position (0018,5100) in each Item of the Group of Patients Identification Sequence (0010,0027), Patient Position (0018,5100) in the General Series Module may be helpful to compute patient-relative spatial information for each subject from the Attributes of the Image Plane Module.

When facing the front of the imaging equipment, Head First is defined as the patient's head being positioned toward the front of the imaging equipment (i.e., head entering the front of the equipment). Feet First is defined as the patient's feet being positioned toward the front of the imaging equipment (i.e., feet entering the front of the equipment). Left First is defined as the patient's left side being positioned towards the front of the imaging equipment (i.e., patient's left side entering the front of the equipment). Right First is defined as the patient's right being positioned towards the front of the imaging equipment (i.e., patient's right side entering the front of the equipment). Prone is defined as the patient's face being positioned in a downward (gravity) direction. Supine is defined as the patient's face being in an upward direction. Decubitus Right is defined as the patient's right side being in a downward direction. Decubitus Left is defined as the patient's left side being in a downward direction.

Defined Terms:

HFP Head First-Prone

HFS Head First-Supine
HFDR Head First-Decubitus Right
HFDL Head First-Decubitus Left
FFDR Feet First-Decubitus Right
FFDL Feet First-Decubitus Left
FFP Feet First-Prone
FFS Feet First-Supine
LFP Left First-Prone
LFS Left First-Supine
RFP Right First-Prone
RFS Right First-Supine
AFDR Anterior First-Decubitus Right
AFDL Anterior First-Decubitus Left
PFDR Posterior First-Decubitus Right
PFDL Posterior First-Decubitus Left

Note

1. For quadrupeds, separate concepts for ventral and dorsal are not introduced, rather it is expected that anterior and posterior will be considered synonymous as they are when applied to the trunk.

2. There are no decubitus variants of left or right first, since for imaging equipment that is aligned horizontally with respect to gravity the patient cannot be both decubitus and have the left or right side towards the front of the imaging equipment.

3. There are no prone or supine variants of anterior or posterior first, since for imaging equipment that is aligned horizontally with respect to gravity the patient cannot be prone or supine and have the anterior or posterior side towards the front of the imaging equipment.

The Figure C.7.3.1.1.2-1 illustrates some of these Defined Terms for imaging equipment with a table, such as in X-Ray Angiography. The orientation of the patient related to gravity is always recumbent.

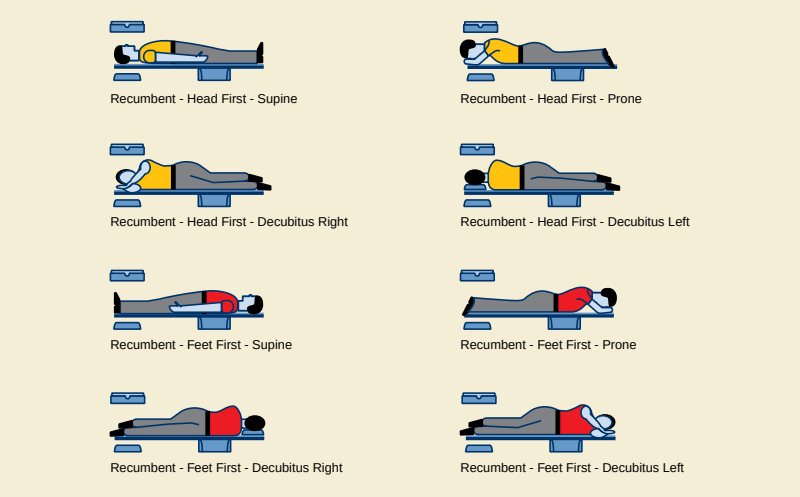


Figure C.7.3.1.1.2-1. Representation of the Eight Different Patient Positions on the X-Ray Table

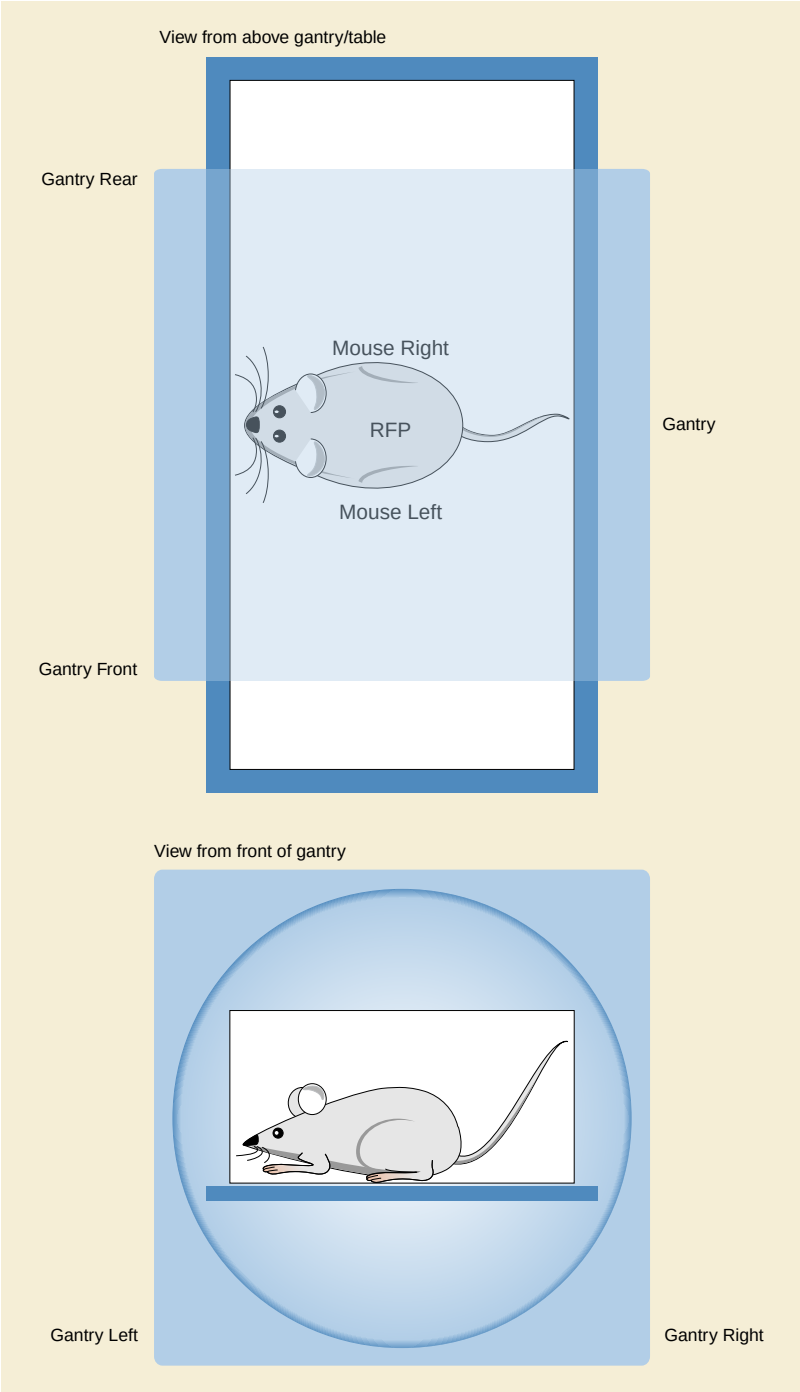


Figure C.7.3.1.1.2-2. Example of Right First-Prone (RFP) Patient Position Relative to the Gantry and Table for a Small Animal

C.7.3.2 Clinical Trial Series Module

Table C.7-5b contains Attributes that identify a Series in the context of a clinical trial or research.

Table C.7-5b. Clinical Trial Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Coordinating Center Name	(0012,0060)	2	The name of the institution that is responsible for coordinating the medical imaging data for the clinical trial or research. See Section C.7.3.2.1.1.
Clinical Trial Series ID	(0012,0071)	3	An identifier of the Series in the context of a clinical trial or research. See Section C.7.3.2.1.2.
Clinical Trial Series Description	(0012,0072)	3	A description of the Series in the context of a clinical trial or research. See Section C.7.3.2.1.2.

C.7.3.2.1 Clinical Trial Series Attribute Descriptions

C.7.3.2.1.1 Clinical Trial Coordinating Center Name

The Clinical Trial Coordinating Center Name (0012,0060) identifies the institution responsible for coordinating the collection of images and associated data for subjects enrolled in the clinical trial or research.

C.7.3.2.1.2 Clinical Trial Series Identifier and Description

The Clinical Trial Series ID (0012,0071) and Clinical Trial Series Description (0012,0072) Attributes can be used to identify and describe a Series within the context of a clinical trial or research without requiring the replacement of the values in Series Number (0020,0011) and Series Description (0008,103E) Attributes in the General Series Module, whose manufacturer or user provided values may be relevant and important to retain.

C.7.3.3 Enhanced Series Module

Table C.7-5c Table specifies the Attributes that identify and describe general information about the Series within a Study.

Note

This table contains a subset of the Attributes of General Series Module (Table C.7-5a) but the Type designation is changed into Type 1. Including this Module in an IOD overwrites the Type designation of the General Series Module.

Table C.7-5c. Enhanced Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Series Number	(0020,0011)	1	A number that identifies this Series. Note 1. The value of this Attribute should be unique for all Series in a Study created on the same equipment. 2. Because Series can be created on more than one equipment, it can not be guaranteed that the value of Series Number (0020,0011) is unique in a Study.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.7.4 Common Frame of Reference Information Entity Modules

C.7.4.1 Frame of Reference Module

Table C.7-6 specifies the Attributes necessary to uniquely identify a Frame of Reference that ensures the spatial relationship of Images within a Series. It also allows Images across multiple Series to share the same Frame Of Reference. This Frame Of Reference (or coordinate system) shall be constant for all Images related to a specific Frame Of Reference.

When a Frame of Reference is identified, it is not important how the imaging target (patient, specimen, or phantom) is positioned relative to the imaging equipment or where the origin of the Frame Of Reference is located. It is important that the position of the imaging target and the origin are constant in relationship to a specific Frame Of Reference.

Note

Since the criteria used to group images into a Series is application specific, it is possible for imaging applications to define multiple Series within a Study that share the same imaging space. Previous versions of the DICOM Standard specified that all images within the Series must be spatially related. However, insufficient information was available to determine if multiple Series within a Study were spatially related.

Table C.7-6. Frame of Reference Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame of Reference UID	(0020,0052)	1	Uniquely identifies the Frame of Reference for a Series. See Section C.7.4.1.1.1 for further explanation.
Position Reference Indicator	(0020,1040)	2	Part of the imaging target used as a reference. See Section C.7.4.1.1.2 for further explanation.

C.7.4.1.1 Frame of Reference Attribute Descriptions

C.7.4.1.1.1 Frame of Reference UID

The Frame of Reference UID (0020,0052) shall be used to uniquely identify a Frame of Reference for a Series. Each Series shall have a single Frame of Reference UID. However, multiple Series within a Study may share a Frame of Reference UID. All images in a Series that share the same Frame of Reference UID shall be spatially related to each other.

Note

1. Previous versions of this Standard defined a Data Element "Location", which has been retired. Frame of Reference UID provides a completely unambiguous identification of the image location reference used to indicate position.

2. A common Frame of Reference UID may be used to spatially relate localizer images with a set of transverse images. However, in some cases (e.g., multiple localizer images being related to a single set of transverse images) a common Frame of Reference UID may not be sufficient. The Referenced Image Sequence (0008,1140) provides an unambiguous method for relating localizer images.

C.7.4.1.1.2 Position Reference Indicator

The Position Reference Indicator (0020,1040) specifies the part of the imaging target that was used as a reference point associated with a specific Frame of Reference UID. The Position Reference Indicator may or may not coincide with the origin of the fixed Frame of Reference related to the Frame of Reference UID.

For a Patient-related Frame of Reference, this is an anatomical reference point such as the iliac crest, orbital-medial, sternal notch, symphysis pubis, xiphoid, lower costal margin, or external auditory meatus, or a fiducial marker placed on the patient. The Patient-Based Coordinate System is described in Section C.7.6.2.1.1.

For a slide-related Frame of Reference, this is the slide corner as specified in Section C.8.12.2.1 and shall be identified in this Attribute with the value "SLIDE_CORNER". The slide-based coordinate system is described in Section C.8.12.2.1.

For an Ophthalmic Coordinate System, the Frame of Reference is based upon the corneal vertex. The corneal vertex is determined by the measuring instrument and shall be identified in this Attribute with the value CORNEAL_VERTEX_R (for the right eye) or CORNEAL_VERTEX_L (for the left eye). The Ophthalmic Coordinate System is described in Section C.8.30.3.1.4.

The Position Reference Indicator shall be used only for annotation purposes and is not intended to be used as a mathematical spatial reference.

Note

The Position Reference Indicator may be encoded as zero length when it has no meaning, for example, when the Frame of Reference Module is required to relate mammographic images of the breast acquired without releasing breast compression, but where there is no meaningful anatomical reference point as such.

C.7.4.2 Synchronization Module

Table C.7-7 specifies the Attributes necessary to uniquely identify a Frame of Reference that establishes the temporal relationship of SOP Instances. A synchronized environment may be established based on a shared time of day clock, and/or on a shared trigger event or synchronization waveform channel.

Note

Within a synchronized environment, different devices may use the shared data differently. An electrical pulse, for example, may be treated as a trigger event by one device (e.g., an X-Ray imaging system), but may be recorded as a synchronization waveform by another device (e.g., a hemodynamics system).

Table C.7-7. Synchronization Module Attributes

Attribute Name	Tag	Type	Attribute Description
Synchronization Frame of Reference UID	(0020,0200)	1	UID of common synchronization environment. See Section C.7.4.2.1.1.
Synchronization Trigger	(0018,106A)	1	Data acquisition synchronization with external equipment Enumerated Values: **SOURCE** this equipment provides synchronization channel or trigger to other equipment **EXTERNAL** this equipment receives synchronization channel or trigger from other equipment **PASSTHRU** this equipment receives synchronization channel or trigger and forwards it **NO TRIGGER** data acquisition not synchronized by common channel or trigger
Trigger Source or Type	(0018,1061)	3	Specifies equipment ID of trigger source and/or type of trigger
Synchronization Channel	(0018,106C)	1C	Identifier of waveform channel that records the synchronization channel or trigger, see Section C.7.4.2.1.3. Required if synchronization channel or trigger is encoded in a waveform in this SOP Instance
Acquisition Time Synchronized	(0018,1800)	1	Acquisition DateTime (0008,002A) synchronized with external time reference. Enumerated Values: **Y** **N** See Section C.7.4.2.1.4
Time Source	(0018,1801)	3	ID of equipment or system providing time reference

Attribute Name	Tag	Type	Attribute Description
Time Distribution Protocol	(0018,1802)	3	Method of time distribution used to synchronize this equipment. Enumerated Values: **NTP** Network Time Protocol **IRIG** Inter Range Instrumentation Group **GPS** Global Positioning System **SNTP** Simple Network Time Protocol **PTP** IEEE 1588 Precision Time Protocol
NTP Source Address	(0018,1803)	3	IP Address of NTP, SNTP, or PTP time source. IPv4 addresses shall be in dotted decimal (e.g., 192.168.1.1). The IPv6 addresses shall be in colon separated hexadecimal (e.g., 12:34:56:78:9a:bc:de:f0). Note Identity of this value in two Instances acquired contemporaneously implies a common time base. The NTP Source Address might not persist over time.

C.7.4.2.1 Synchronization Attribute Descriptions

C.7.4.2.1.1 Synchronization Frame of Reference UID

A set of equipment may share a common acquisition synchronization environment, which is identified by a Synchronization Frame of Reference UID. All SOP Instances that share the same Synchronization Frame of Reference UID shall be temporally related to each other. If a Synchronization Frame of Reference UID is present, all SOP Instances in the Series must share the same Frame of Reference.

The UTC Synchronization UID, 1.2.840.10008.15.1.1, may be used when the equipment is synchronized to the international standard UTC. In this case the quality of synchronization may be determined by means of the Time Distribution Protocol (0018,1802) and NTP Source Address (0018,1803).

Note

1. The Synchronization Frame of Reference UID defines an equipment synchronization environment, and does not need to be changed for each unrelated acquisition. SOP Instances may therefore share a Synchronization Frame of Reference UID, but be clinically unrelated (e.g., apply to different Patients).
2. When a synchronization environment is recalibrated, a new UID must be issued.
3. The method of distributing the Synchronization Frame of Reference UID to multiple devices is not specified.

C.7.4.2.1.2 Time Source and Time Distribution Protocol

Time may originate with a primary source (e.g., a national standards bureau) and be distributed through a chain of secondary distribution systems until reaching the imaging equipment. Time Distribution Protocol (0018,1802) specifies the immediate (last link) method used by the equipment to receive time from the immediately prior Time Source (0018,1801). It does not specify the ultimate time reference from which the Time Source may derive its synchronization.

Note

The time value distributed through the specified Time Distribution Protocol may need to be corrected to align with UTC. For example, GPS does not compensate for leap seconds.

C.7.4.2.1.3 Synchronization Channel

Synchronization Channel (0018,106C) is specified as a pair of values (M,C), where the first value is the ordinal of the Sequence Item of Waveform Sequence (5400,0100) (i.e., the Multiplex Group), and the second value is the ordinal of the Sequence Item of the Channel Definition Sequence (003A,0200) Attribute (i.e., the Waveform Channel Number) within the multiplex group.

C.7.4.2.1.4 Acquisition Time Synchronized

The Acquisition Time Synchronized (0018,1800) Attribute specifies whether Acquisition DateTime (0008,002A) of the Waveform Identification Module or the General Image Module represents an accurate synchronized timestamp for the acquisition of the waveform and/or image data. For triggered multi-frame images, the Acquisition DateTime applies to the trigger for the first image frame (see Attribute Image Trigger Delay (0018.1067) in the Cine Module).

Note

The degree of precision of the Acquisition DateTime and its accuracy relative to the external clock are not specified, but need to be appropriate for the clinical application.

For IODs that include the SR Document Content Module, the Acquisition Time Synchronized (0018,1800) Attribute specifies whether Observation DateTime (0040,A032) of Items in Content Sequence (0040,A730) of the SR Document Content Module represents an accurate synchronized timestamp for the Item.

For IODs that include the RT Radiation Record Common Module, the Acquisition Time Synchronized (0018,1800) Attribute specifies whether the following Attributes represent a synchronized timestamp.

- Recorded RT Control Point DateTime (300A,073A)
- Interlock DateTime (300A,0741)

C.7.5 Common Equipment IE Modules

The following Equipment IE Module is common to all Composite IODs that reference the Equipment IE.

C.7.5.1 General Equipment Module

Table C.7-8 specifies the Attributes that identify and describe the piece of equipment that produced a Series of Composite Instances.

Table C.7-8. General Equipment Module Attributes

Attribute Name	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	2	Manufacturer of the equipment that produced the Composite Instances.
Institution Name	(0008,0080)	3	Institution where the equipment that produced the Composite Instances is located.
Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment that produced the Composite Instances is located.
Station Name	(0008,1010)	3	User defined name identifying the machine that produced the Composite Instances.
Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment that produced the Composite Instances is located.
Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Note This might be obtained from a corresponding HL7v2 message containing PV1:10 Hospital Service. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*
Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that produced the Composite Instances.

Attribute Name	Tag	Type	Attribute Description
Manufacturer's Device Class UID	(0018,100B)	3	Manufacturer's Unique Identifier (UID) for the class of the device. A class is a manufacturer-specific grouping concept with no DICOM-defined scope or criteria. A class is independent from a marketing-defined make, model or version. A class allows grouping of devices with a similar set of capabilities. This Attribute may be multi-valued if this device is a member of more than one class.
Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that produced the Composite Instances. Note This identifier corresponds to the device that actually created the images, such as a CR plate reader or a CT console, and may not be sufficient to identify all of the equipment in the imaging chain, such as the generator or gantry or plate.
Software Versions	(0018,1020)	3	Manufacturer's designation of software version of the equipment that produced the Composite Instances. See Section C.7.5.1.1.3.
Gantry ID	(0018,1008)	3	Identifier of the gantry or positioner.
UDI Sequence	(0018,100A)	3	Unique Device Identifier (UDI) of the entire equipment. For example, the entire CT Scanner. Note 1. Multiple Items may be present if the entire equipment has UDIs issued by different Issuing Authorities. 2. Multiple Items may be present if multiple pieces of equipment were involved in the creation of this Instance, e.g., the DR plate and the DR reader. 3. This is not intended to contain the UDIs of the components of the equipment, such as the X-Ray tube of the CT scanner. Such information is stored elsewhere and accessible using the UDI of the entire equipment and a date. One or more Items are permitted in this Sequence.
>Include Table 10.29-1 “UDI Macro Attributes”			
Device UID	(0018,1002)	3	Unique identifier of the equipment that produced the Composite Instances. Note 1. If present in an SR object, the value is expected to be the same as the (121012, DCM, "Device Observer UID") in TID 1004 “Device Observer Identifying Attributes”. 2. There is no requirement that the Device UID (0018,1002) be the same as the Instance Creator UID (0008,0014) in the SOP Common Module, though they may be.
Spatial Resolution	(0018,1050)	3	The inherent limiting resolution in mm of the acquisition equipment for high contrast objects for the data gathering and reconstruction technique chosen. If variable across the images of the Series, the value at the image center.

Attribute Name	Tag	Type	Attribute Description
Date of Last Calibration	(0018,1200)	3	Date when the image acquisition device calibration was last changed in any way. Multiple entries may be used for additional calibrations at other times. See Section C.7.5.1.1.1 for further explanation.
Time of Last Calibration	(0018,1201)	3	Time when the image acquisition device calibration was last changed in any way. Multiple entries may be used. See Section C.7.5.1.1.1 for further explanation.
Pixel Padding Value	(0028,0120)	1C	Single pixel value or one limit (inclusive) of a range of pixel values used in an image to pad to rectangular format or to signal background that may be suppressed. See Section C.7.5.1.1.2 for further explanation. Required if Pixel Padding Range Limit (0028,0121) is present and either Pixel Data (7FE0,0010) or Pixel Data Provider URL (0028,7FE0) is present. May be present otherwise only if Pixel Data (7FE0,0010) or Pixel Data Provider URL (0028,7FE0) is present. Note 1. The Value Representation of this Attribute is determined by the value of Pixel Representation (0028,0103). 2. This Attribute is not used in Presentation State Instances; there is no means in a Presentation State to "override" any Pixel Padding Value specified in the referenced images. 3. This Attribute does apply to RT Dose and Segmentation Instances, since they include Pixel Data. 4. This Attribute does not apply when Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are used instead of Pixel Data (7FE0,0010); Float Pixel Padding Value (0028,0122) or Double Float Pixel Padding Value (0028,0123), respectively, are used instead, and defined at the Image, not the Equipment, level.

C.7.5.1.1 General Equipment Attribute Descriptions

Note

The Attributes Manufacturer (0008,0070), Manufacturer's Model Name (0008,1090) and Device Serial Number (0018,1000) are intended to be a primary identification of the system that produces the data (e.g., modality or workstation application providing the content of the SOP Instance) and not the identification of the component that encodes the SOP Instance (e.g., a commonly used DICOM encoding toolkit).

C.7.5.1.1.1 Date of Last Calibration, Time of Last Calibration

Date of Last Calibration (0018,1200) and Time of Last Calibration (0018,1201) are used to convey the date and time of calibration. The Attribute Date of Last Calibration (0018,1200) may be supported alone, however, Time of Last Calibration (0018,1201) Attribute has no meaning unless Attribute Date of Last Calibration (0018,1200) is also supported. The order for each Attribute shall be from the oldest date/time to the most recent date/time. When the Attributes are both supported they shall be provided as pairs.

C.7.5.1.1.2 Pixel Padding Value and Pixel Padding Range Limit

Pixel Padding Value (0028,0120) is used to pad grayscale images (those with a Photometric Interpretation of MONOCHROME1 or MONOCHROME2) to rectangular format. The native format of some images is not rectangular. It is common for devices with this format to pad the images to the rectangular format required by the DICOM Standard with a specific pixel value that is not contained in the native image. Further, when resampling, such as after spatial registration, padding may need to be used to fill previously non-existent pixels.

Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) are also used to identify pixels to be excluded from the normal grayscale rendering pipeline for other reasons, such as suppression of background air. Pixel Padding Range Limit (0028,0121) is defined in the Image Pixel Module.

Note

1. The "native image" is that which is being padded to the required rectangular format, e.g., the area within the circular reconstruction perimeter of a CT image, or the subset of the rectangular area that contains useful image information.

2. The pixel padding value is explicitly described in order to prevent display applications from taking it into account when determining the dynamic range of an image, since the Pixel Padding Value will be outside the range between the minimum and maximum values of the pixels in the native image

3. No pixels in the native image will have a value equal to Pixel Padding Value.

Pixel Padding Value (0028,0120) specifies either a single value of this padding value, or when combined with Pixel Padding Range Limit (0028,0121), a range of values (inclusive) that are padding.

The values of Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall be valid values within the constraints defined by Bits Allocated (0028,0100), Bits Stored (0028,0101), and High Bit (0028,0102).

The padding value shall correspond to a value in the original stored pixel data, before the Modality LUT Transformation or any other transformations are applied.

Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall not be present when padding is performed but the pixel value used for padding does occur in the native image.

If Photometric Interpretation (0028,0004) is MONOCHROME2, Pixel Padding Value (0028,0120) shall be less than (closer to or equal to the minimum possible pixel value) or equal to Pixel Padding Range Limit (0028,0121). If Photometric Interpretation (0028,0004) is MONOCHROME1, Pixel Padding Value (0028,0120) shall be greater than (closer to or equal to the maximum possible pixel value) or equal to Pixel Padding Range Limit (0028,0121).

Note

1. When the relationship between pixel value and X-Ray Intensity is unknown, it is recommended that the following values be used to pad with black when the image is unsigned:

   - 0 if Photometric Interpretation (0028,0004) is MONOCHROME2.
   - $2^{\text{Bits Stored}}$ - 1 if Photometric Interpretation (0028,0004) is MONOCHROME1.

   and when the image is signed:

   - $-2^{\text{Bits Stored-1}}$ if Photometric Interpretation (0028,0004) is MONOCHROME2.
   - $2^{\text{Bits Stored-1}}$ - 1 if Photometric Interpretation (0028,0004) is MONOCHROME1.

2. For projection radiography, when the relationship between pixel value and X-Ray Intensity is known (for example as defined by Pixel Intensity Relationship (0028,1040) and Pixel Intensity Relationship Sign (0028,1041)), it is recommended that a pixel value equivalent to, or rendered similarly to, air (least X-Ray absorbance) be used for padding. However, if such a value may occur in the native image, the Pixel Padding Value (0028,0120) Attribute itself should not be present.

   E.g., for an XRF image obtained with an image intensifier, if air is black then a padded perimeter, if any, should also appear black. Typically though, if unpadded, this area would be collimated with a circular collimator, in which case the pixels would appear natively as white (greatest X-Ray absorbance) and a circular shutter would be necessary to neutralize them as black. Whether collimated areas are detected and treated as padded, or neutralized with shutters is at the discretion of the application. See also the Display Shutter Module Section C.7.6.11.

3. The conditional requirement for the Pixel Padding Value Range Limit (0028,0121) in the Image Pixel Module means that it shall not be present unless Pixel Padding Value (0028,0120) is also present.

4. The range of values to be suppressed between Pixel Padding Value (0028,0120) and Pixel Padding Value Range Limit (0028,0121) is specified as being inclusive, that is the values themselves as well as all values between are suppressed.

5. When Pixel Padding Value Range Limit (0028,0121) is present, but not supported by a rendering application, the constraint that Pixel Padding Value (0028,0120) is closest to the "blackest" value, which is typically the most frequently occurring background pixel, will most often result in an acceptable display, permitting "backward compatibility" in the majority of cases.

When modifying equipment changes the pixel padding value in the image, it shall change the values of Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121), if present. If modifying equipment changes the pixel padding values in the image to values present in the native image, the Attribute Pixel Padding Value (0028,0120) and Pixel Padding Range Limit (0028,0121) shall be removed.

Note

1. For example, if a CT image containing signed values from -1024 to 3191 and a Pixel Padding Value of -2000 and a Rescale Intercept of 0 is converted to an unsigned image with a Rescale Intercept of -1024 by adding 1024 to all pixels and clipping all more negative pixels to 0, then the padding pixels will be indistinguishable from some of the modified native image pixels, and hence Pixel Padding Value (0028,0120) needs to be removed.

2. If the modification involves lossy compression, which may result in changes to the pixel values, then the application of Pixel Padding Value and Pixel Padding Range Limit may result in a different appearance, and hence these Attributes may need different values also.

C.7.5.1.1.3 Software Versions

Software Versions (0018,1020) is a multi-valued Attribute. For equipment that is composed of several components, it may be used to identify the name and version for each of those components. This may also include the identifier and version of libraries or configuration files that significantly affect the production of the SOP Instance.

C.7.5.2 Enhanced General Equipment Module

Table C.7-8b specifies the Attributes that identify and describe the piece of equipment that produced a Series of Composite Instances.

Note

1. This table contains a subset of the Attributes of General Equipment Module (Table C.7-8) but the Type Designation is changed into Type 1. Including this Module in an IOD overwrites the Type Designation of the General Equipment Module.

2. The Attributes are intended to be a primary identification of the system that produces the data (e.g., modality or workstation application providing the content of the SOP Instance) and not the identification of the component that encodes the SOP Instance (e.g., a commonly used DICOM encoding toolkit).

Table C.7-8b. Enhanced General Equipment Module Attributes

Attribute Name	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	1	Manufacturer of the equipment that produced the Composite Instances.
Manufacturer's Model Name	(0008,1090)	1	Manufacturer's model name of the equipment that produced the Composite Instances.
Device Serial Number	(0018,1000)	1	Manufacturer's serial number of the equipment that produced the Composite Instances.
Software Versions	(0018,1020)	1	Manufacturer's designation of software version of the equipment that produced the Composite Instances. See Section C.7.5.1.1.3.

C.7.6 Common Image IE Modules

The following Image IE Modules are common to all Composite Image IODs that reference the Image IE.

C.7.6.1 General Image Module

Table C.7-9 specifies the Attributes that identify and describe an image within a particular Series.

Table C.7-9. General Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	2	A number that identifies this image. Note This Attribute was named Image Number in earlier versions of this Standard.
Patient Orientation	(0020,0020)	2C	Patient direction of the rows and columns of the image. Required if image does not require Image Orientation (Patient) (0020,0037) and Image Position (Patient) (0020,0032) or if image does not require Image Orientation (Slide) (0048,0102). May be present otherwise. See Section C.7.6.1.1.1 for further explanation. Note IODs may have Attributes other than Patient Orientation, Image Orientation, or Image Position (Patient) to describe orientation in which case this Attribute will be zero length.
Content Date	(0008,0023)	2C	The date the image pixel data creation started. Required if image is part of a Series in which the images are temporally related. May be present otherwise. Note This Attribute was formerly known as Image Date.
Content Time	(0008,0033)	2C	The time the image pixel data creation started. Required if image is part of a Series in which the images are temporally related. May be present otherwise.
Image Type	(0008,0008)	3	Image identification characteristics. See Section C.7.6.1.1.2 for Defined Terms and further explanation.
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image.
Acquisition Date	(0008,0022)	3	The date the acquisition of data that resulted in this image started
Acquisition Time	(0008,0032)	3	The time the acquisition of data that resulted in this image started
Acquisition DateTime	(0008,002A)	3	The date and time that the acquisition of data that resulted in this image started. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
Images in Acquisition	(0020,1002)	3	Number of images that resulted from this acquisition of data
Image Comments	(0020,4000)	3	User-defined comments about the image

Attribute Name	Tag	Type	Attribute Description
Quality Control Image	(0028,0300)	3	Indicates whether or not this image is a quality control or phantom image. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not be a quality control or phantom image. The phantom device in the image can be described using the Device Module. See Section C.7.6.12
Burned In Annotation	(0028,0301)	3	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain burned in annotation.
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the Patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	3	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	3	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2.
Lossy Image Compression Method	(0028,2114)	3	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b “Image Pixel Macro Attributes”			*See Section C.7.6.1.1.6 for further explanation.*

Attribute Name	Tag	Type	Attribute Description
Presentation LUT Shape	(2050,0020)	3	When present, specifies an identity transformation for the Presentation LUT such that the output of all grayscale transformations, if any, are defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME2 or any color photometric interpretation. **INVERSE** output after inversion is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME1. When this Attribute is used with a color photometric interpretation then the luminance component is in P-Values.
Irradiation Event UID	(0008,3010)	3	Unique identification of the irradiation event(s) associated with the acquisition of this image. See Section C.7.6.1.1.7.
Real World Value Mapping Sequence	(0040,9096)	3	The mapping of stored values to associated Real World values. One or more Items are permitted in this Sequence.
>Include Table C.7.6.16-12b "Real World Value Mapping Item Macro Attributes"			
Image Laterality	(0020,0062)	3	Laterality of (possibly paired) body part (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230) and/or Laterality (0020,0060), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series.
~~*Include* Table 10-7 "General Anatomy Optional Macro Attributes"~~			~~*Anatomic Region Sequence B*CID 4031 "Common Anatomic Regions" *for humans.s*~~ ~~*Anatomic Region Sequence B*CID 7483 "Common Anatomic Regions for Animals" *for animals.*~~
Include Table 10-7 "General Anatomy Optional Macro Attributes"			*Anatomic Region Sequence B*CID 4031 "Common Anatomic Regions" *for humans.* *Anatomic Region Sequence B*CID 7483 "Common Anatomic Regions for Animals" *for animals.*

Note

Previous editions of this Standard specified use of the Referenced Waveform Sequence (0008,113A), but that use has been superseded by Referenced Instance Sequence (0008,114A). See PS3.3-2004.

C.7.6.1.1 General Image Attribute Descriptions

C.7.6.1.1.1 Patient Orientation

Patient Orientation (0020,0020) relative to the image plane shall be specified by two values that designate the anatomical direction of the positive row axis (left to right) and the positive column axis (top to bottom). The first entry is the direction of the rows, given by the direction of the last pixel in the first row from the first pixel in that row. The second entry is the direction of the columns, given by the direction of the last pixel in the first column from the first pixel in that column. Shall be consistent with Image Orientation (Patient) (0020,0037), if both Attributes are present and Patient Orientation (0020,0020) is not zero length.

If Anatomical Orientation Type (0010,2210) is absent or has a value of BIPED, anatomical direction shall be designated by abbreviations using the capital letters:

- A (anterior)
- P (posterior)
- R (right)
- L (left)
- H (head)
- F (foot)

If Anatomical Orientation Type (0010,2210) has a value of QUADRUPED, anatomical direction shall be designated by the abbreviations using capital letters:

- LE (Le or Left)
- RT (Rt or Right)
- D (Dorsal)
- V (Ventral)
- CR (Cr or Cranial)
- CD (Cd or Caudal)
- R (Rostral)
- M (Medial)
- L (Lateral)
- PR (Pr or Proximal)
- DI (Di or Distal)
- PA (Pa or Palmar)
- PL (Pl or Plantar)

Note

1. These abbreviations are capitalized versions of those defined in Smallwood et al for describing radiographic projections. Because of the Code String (CS) Value Representation of Patient Orientation (0020,0020), lowercase letters cannot be used.
2. It is unfortunate that the conventional veterinary abbreviations (e.g., R for rostral and Rt for right) differ from those chosen for humans for DICOM usage (e.g., R for right), but confusion with in the respective human and animal domains will be reduced. Hanging protocols may need to account for the difference by checking for the correct species.

3. Smallwood et al define an O (Oblique) abbreviation, which is useful for describing radiographic projections, but do not specify its use for directional terms, and hence it is not included here for describing the row and column directions.

4. The terms "anterior" and "posterior" are commonly used in vertebrate zoology to describe the cranial and caudal directions respectively, the veterinary terms are used in preference here, also in order to avoid confusion with the contradictory human use of anterior and posterior to mean ventral and dorsal.

5. For animals other than quadrupeds, for example, birds and fish, it is anticipated that the same nomenclature can be logically extended to describe, for example, wings and fins.

Each value of the orientation Attribute shall contain at least one of these abbreviations. If refinements in the orientation descriptions are to be specified, then they shall be designated by one or two additional abbreviations in each value. Within each value, the abbreviations shall be ordered with the principal orientation designated in the first abbreviations.

Note

1. For bipeds, since each abbreviation is a single character, no delimiter is required within a single value and none is used. For quadrupeds, though lowercase letters cannot be used, delimiters are not necessary within a single value to eliminate ambiguity, since the abbreviations used are sufficiently distinct, and can be parsed from left to right with a single character of lookahead.

2. E.g., a medio-lateral oblique projection of the left breast of a human might be encoded with Patient Orientation values of "A\FR" rather than "A\F", since the plane is obliquely inclined such that the columns are directed both downwards and medially, which for a left breast is towards the right, though the downwards direction is the principal column orientation.

3. E.g., a right dorsal-left ventral oblique view of a quadruped's abdomen might be encoded with Patient Orientation values of "LE\V\CD", rather than "LE\CD", since the plane is obliquely inclined such that the rows are directed both to the left and ventrally, though the left direction is the principal row orientation. The abbreviations "LE\V", "LE" and "CD", correspond to the designations in Smallwood et al of "LeV", "Le" and "Cd", respectively

C.7.6.1.1.2 Image Type

Image Type (0008,0008) identifies important image identification characteristics. These characteristics are:

a. Pixel Data Characteristics

   1. is the image an ORIGINAL Image; an image whose pixel values are based on original or source data

   2. is the image a DERIVED Image; an image whose pixel values have been derived in some manner from the pixel value of one or more other images

b. Patient Examination Characteristics

   1. is the image a PRIMARY Image; an image created as a direct result of the patient examination

   2. is the image a SECONDARY Image; an image created after the initial patient examination

c. Modality Specific Characteristics

d. Implementation specific identifiers; other implementation specific identifiers shall be documented in an implementation's conformance statement.

The Image Type Attribute is multi-valued and shall be provided in the following manner:

a. Value 1 shall identify the Pixel Data Characteristics

   Enumerated Values:
   ORIGINAL identifies an Original Image
   DERIVED identifies a Derived Image

b. Value 2 shall identify the Patient Examination Characteristics

Enumerated Values:
PRIMARY identifies a Primary Image
SECONDARY identifies a Secondary Image

c. Value 3 shall identify any Image IOD specific specialization (optional)

d. Other Values that are implementation specific (optional)

Any of the optional values (value 3 and beyond) may be encoded either with a value or zero-length, independent of other optional values, unless otherwise specified by a specialization of this Attribute in an IOD.

If the pixel data of the derived Image is different from the pixel data of the source images and this difference is expected to affect professional interpretation of the image, the Derived Image shall have a UID different than all the source images.

C.7.6.1.1.3 Derivation Description

See Section C.12.4.1.1.

C.7.6.1.1.4 Source Image Sequence

Source Image Sequence (0008,2112) was formerly used in this Module but has been move to the General Reference Module. See Section C.12.4.1.2 “Source Image Sequence”.

C.7.6.1.1.5 Lossy Image Compression

The Attribute Lossy Image Compression (0028,2110) conveys that the Image has undergone lossy compression. It provides a means to record that the Image has been compressed (at a point in its lifetime) with a lossy algorithm and changes have been introduced into the pixel data. Once the value has been set to "01", it shall not be reset.

Note

If an image is compressed with a lossy algorithm, the Attribute Lossy Image Compression (0028,2110) is set to "01". Subsequently, if the image is decompressed and transferred in uncompressed format, this Attribute value remains "01".

The value of Lossy Image Compression (0028,2110) in SOP Instances containing multiple frames in which one or more of the frames have undergone lossy compression shall be "01".

Note

It is recommended that the applicable frames be noted in the Attribute Derivation Description (0008,2111).

If an image is originally obtained as a lossy compressed image from the sensor, then Lossy Image Compression (0028,2110) is set to "01" and Value 1 of the Attribute Image Type (0008,0008) shall be set to ORIGINAL.

If an image is a compressed version of another image, Lossy Image Compression (0028,2110) is set to "01", Value 1 of the Attribute Image Type (0008,0008) shall be set to DERIVED, and if the predecessor was a DICOM image, then the Image shall receive a new SOP Instance UID.

Note

1. It is recommended that the approximate compression ratio be provided in the Attribute Derivation Description (0008,2111). Furthermore, it is recommended that Derivation Description (0008,2111) be used to indicate when pixel data changes might affect professional interpretation (see Section C.12.4.1.1).

2. The Attribute Lossy Image Compression (0028,2110) is defined as Type 3 for backward compatibility with existing IODs. It is expected to be required (i.e., defined as Type 1C) for new Image IODs and for existing IODs that undergo a major revision (e.g., a new IOD is specified).

C.7.6.1.1.5.1 Lossy Image Compression Method

Lossy Image Compression Method (0028,2114) may be multi-valued if successive lossy compression steps have been applied; the value order shall correspond to the values of Lossy Image Compression Ratio (0028,2112), if present.

Defined Terms for Lossy Image Compression Method (0028,2114):

ISO_10918_1 JPEG Lossy Compression [ISO/IEC 10918-1]
ISO_14495_1 JPEG-LS Near-lossless Compression [ISO/IEC 14495-1]
ISO_15444_1 JPEG 2000 Irreversible Compression [ISO/IEC 15444-1]
ISO_13818_2 MPEG2 Compression [ISO/IEC 13818-2]
ISO_14496_10 MPEG-4 AVC/H.264 Compression [ISO/IEC 14496-10]
ISO_23008_2 HEVC/H.265 Lossy Compression [ISO/IEC 23008-2]

C.7.6.1.1.5.2 Lossy Image Compression Ratio

The value of the "compression ratio" is encoded as a numeric value that represents the numerator of an implicit ratio in which the denominator is always one, consistent with the traditional representation in the literature.

Note

For example, a compression ratio of 30:1 would be described with a value of 30.

The value may be an estimate (e.g., the nominal value that is supplied to the compressor), or it may be a measured value (e.g., computed by dividing the uncompressed pixel data size by the size of the compressed bit stream).

Lossy Image Compression Ratio (0028,2112) may be multi-valued if successive lossy compression steps have been applied; if so, the value order shall correspond to the multiple values of Lossy Image Compression Method (0028,2114), if present.

Note

For historical reasons, the lossy compression ratio should also be described in Derivation Description (0008,2111).

C.7.6.1.1.6 Icon Image Sequence

An Icon Image may be used as a key representative of an Image. It is defined as a Sequence that contains a single Item encapsulating the Data Set made of the Data Elements of the Icon Image. The Data Elements are defined by the Image Pixel Macro (see Section C.7.6.3). Unless otherwise specified in the Module or Macro table where the Icon Image Sequence (0088,0200) is used, the following restrictions shall apply on the Image Pixel Macro usage:

a. Only monochrome and palette color images shall be used. Samples per Pixel (0028,0002) shall have a Value of 1, Photometric Interpretation (0028,0004) shall have a Value of either MONOCHROME 1, MONOCHROME 2 or PALETTE COLOR, Planar Configuration (0028,0006) shall not be present.

   Note

   True color icon images are not supported. This is due to the fact that the reduced size of the Icon Image makes the quality of a palette color image (with 256 colors) sufficient in most cases.

b. There is no explicit limitation on the size of an Icon Image specified by Rows (0028,0010) and Columns (0028,0011).

c. Pixel samples shall have a Value of either 1 or 8 for Bits Allocated (0028,0100) and Bits Stored (0028,0101). High Bit (0028,0102) shall have a Value of one less than the Value used in Bit Stored.

d. Pixel Representation (0028,0103) shall specify an unsigned integer representation (Value 0000H).

e. Pixel Aspect Ratio (0028,0034) shall have a Value of 1:1.

f. If a Palette Color lookup Table is used, Bits Allocated (0028,0100) shall have a Value of 8.

C.7.6.1.1.7 Irradiation Event UID

An irradiation event is the loading of X-Ray equipment caused by a single continuous actuation of the equipment's irradiation switch, from the start of the loading time of the first pulse until the loading time trailing edge of the final pulse. Any on-off switching of the irradiation source during the event shall not be treated as separate events, rather the event includes the time between start and stop of irradiation as triggered by the user. E.g., a pulsed fluoro X-Ray acquisition shall be treated as a single irradiation event.

C.7.6.2 Image Plane Module

Table C.7-10 specifies the Attributes that define the transmitted pixel array of a two dimensional image plane.

Note

In previous versions of this Standard, image position and image orientation were specified relative to a specific equipment coordinate system. This equipment coordinate system was not fully defined and a number of ambiguities existed. The Equipment-Based Coordinate System has been retired and replaced by the Patient-Based Coordinate System defined in this Module.

Table C.7-10. Image Plane Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0028,0030)	1	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation.
Image Orientation (Patient)	(0020,0037)	1	The direction cosines of the first row and the first column with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
Image Position (Patient)	(0020,0032)	1	The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the image, in mm. See Section C.7.6.2.1.1 for further explanation.
Slice Thickness	(0018,0050)	2	Nominal slice thickness, in mm.
Slice Location	(0020,1041)	3	Relative position of the image plane expressed in mm. See Section C.7.6.2.1.2 for further explanation.

C.7.6.2.1 Image Plane Attribute Descriptions

C.7.6.2.1.1 Image Position and Image Orientation

Image Position (0020,0032) specifies the x, y, and z coordinates of the upper left hand corner of the image; it is the center of the first voxel transmitted. Image Orientation (0020,0037) specifies the direction cosines of the first row and the first column with respect to the patient. These Attributes shall be provide as a pair. Row value for the x, y, and z axes respectively followed by the Column value for the x, y, and z axes respectively.

The direction of the axes is defined fully by the patient's orientation.

If Anatomical Orientation Type (0010,2210) is absent or has a value of BIPED, the x-axis is increasing to the left hand side of the patient. The y-axis is increasing to the posterior side of the patient. The z-axis is increasing toward the head of the patient.

If Anatomical Orientation Type (0010,2210) has a value of QUADRUPED, the

- x-axis is increasing to the left (as opposed to right) side of the patient
- the y-axis is increasing towards
  - the dorsal (as opposed to ventral) side of the patient for the neck, trunk and tail,
  - the dorsal (as opposed to ventral) side of the patient for the head,
  - the dorsal (as opposed to plantar or palmar) side of the distal limbs,
  - the cranial (as opposed caudal) side of the proximal limbs, and
- the z-axis is increasing towards
  - the cranial (as opposed to caudal) end of the patient for the neck, trunk and tail,
  - the rostral (as opposed to caudal) end of the patient for the head, and

- the proximal (as opposed to distal) end of the limbs

  Note

  1. The axes for quadrupeds are those defined and illustrated in Smallwood et al for proper anatomic directional terms as they apply to various parts of the body.
  2. It should be anticipated that when quadrupeds are imaged on human equipment, and particularly when they are position in a manner different from the traditional human prone and supine head or feet first longitudinal position, then the equipment may well not indicate the correct orientation, though it will remain an orthogonal Cartesian right-handed system that could be corrected subsequently.

The Patient-Based Coordinate System is a right handed system, i.e., the vector cross product of a unit vector along the positive x-axis and a unit vector along the positive y-axis is equal to a unit vector along the positive z-axis.

Note

If a patient is positioned parallel to the ground, in dorsal recumbency (i.e., for humans, face-up on the table), with the caudo-cranial (i.e., for humans, feet-to-head) direction the same as the front-to-back direction of the imaging equipment, the direction of the axes of this Patient-Based Coordinate System and the Equipment-Based Coordinate System in previous versions of this Standard will coincide.

The Image Plane Attributes, in conjunction with the Pixel Spacing Attribute, describe the position and orientation of the image slices relative to the Patient-Based Coordinate System. In each image frame Image Position (Patient) (0020,0032) specifies the origin of the image with respect to the Patient-Based Coordinate System. RCS and Image Orientation (Patient) (0020,0037) values specify the orientation of the image frame rows and columns. The mapping of pixel location (i,j) to the RCS is calculated as follows:

$$\begin{bmatrix} P_x \\ P_y \\ P_z \\ 1 \end{bmatrix} = \begin{bmatrix} X_x \Delta_i & Y_x \Delta_j & 0 & S_x \\ X_y \Delta_i & Y_y \Delta_j & 0 & S_y \\ X_z \Delta_i & Y_z \Delta_j & 0 & S_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} i \\ j \\ 0 \\ 1 \end{bmatrix} = M \begin{bmatrix} i \\ j \\ 0 \\ 1 \end{bmatrix} \qquad \text{(C.7.6.2.1-1)}$$

Where:

P_{xyz} The coordinates of the voxel (i,j) in the frame's image plane in units of mm.

S_{xyz} The three values of Image Position (Patient) (0020,0032). It is the location in mm from the origin of the RCS.

X_{xyz} The values from the row (X) direction cosine of Image Orientation (Patient) (0020,0037).

Y_{xyz} The values from the column (Y) direction cosine of Image Orientation (Patient) (0020,0037).

i Column index to the image plane. The first column is index zero.

Δ_i Column pixel resolution of Pixel Spacing (0028,0030) in units of mm.

j Row index to the image plane. The first row index is zero.

Δ_j Row pixel resolution of Pixel Spacing (0028,0030) in units of mm.

Additional constraints apply:

1. The row and column direction cosine vectors shall be orthogonal, i.e., their dot product shall be zero.
2. The row and column direction cosine vectors shall be normal, i.e., the dot product of each direction cosine vector with itself shall be unity.

C.7.6.2.1.2 Slice Location

Slice Location (0020,1041) is defined as the relative position of the image plane expressed in mm. This information is relative to an unspecified implementation specific reference point.

C.7.6.3 Image Pixel Module

Table C.7-11a describes the Image Pixel Module.

Table C.7-11a. Image Pixel Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.7-11c "Image Pixel Description Macro Attributes"			*Required if the IOD is not being transferred in a STOW-RS Request and is not encoded as metadata and compressed bulk pixel data. May be present otherwise.* *See Section 10.5 "Store Transaction" in PS3.18.* Note When the IOD is encoded as metadata in a STOW-RS Request and the bulk pixel data is compressed, the STOW-RS origin server is required to be able to derive appropriate values for the Image Pixel Macro Attributes from the compressed bit stream.
Pixel Data	(7FE0,0010)	1C	A data stream of the pixel samples that comprise the Image. See Section C.7.6.3.1.4 for further explanation. Required if Pixel Data Provider URL (0028,7FE0) is not present.
Pixel Data Provider URL	(0028,7FE0)	1C	A URL of a provider service that supplies the pixel data of the Image. Required if the image is to be transferred in one of the following presentation contexts identified by Transfer Syntax UID: • 1.2.840.10008.1.2.4.94 (DICOM JPIP Referenced Transfer Syntax) • 1.2.840.10008.1.2.4.95 (DICOM JPIP Referenced Deflate Transfer Syntax) Note The VR of this Data Element has changed from UT to UR.
Pixel Padding Range Limit	(0028,0121)	1C	Pixel value that represents one limit (inclusive) of a range of padding values used together with Pixel Padding Value (0028,0120) as defined in the General Equipment Module. See Section C.7.5.1.1.2 for further explanation. Required if pixel padding is to be defined as a range rather than a single value. Note 1. The Value Representation of this Attribute is determined by the value of Pixel Representation (0028,0103). 2. Pixel Padding Value (0028,0120) is also required when this Attribute is present.

Attribute Name	Tag	Type	Attribute Description
Extended Offset Table	(7FE0,0001)	3	Byte offsets of the Frames in the Sequence of Items in Encapsulated Pixel Data encoded in Pixel Data (7FE0,0010). See Section C.7.6.3.1.8. May only be present when: • Pixel Data (7FE0,0010) is present, and the Transfer Syntax uses Encapsulated Pixel Data, and • the Transfer Syntax encodes Frames in separate Fragments, and • the Basic Offset Table in the first Item is not present (its Item has zero length), and • each Frame is entirely contained within one Fragment. Note Unlike a Basic Offset Table, an Extended Offset Table is not permitted to be empty.
Extended Offset Table Lengths	(7FE0,0002)	1C	Byte lengths of the Frames in the Sequence of Items in Encapsulated Pixel Data encoded in Pixel Data (7FE0,0010). See Section C.7.6.3.1.8. Required if Extended Offset Table (7FE0,0001) is present and every frame is encoded as a single fragment. Note The length information is not sent when there are multiple fragments per frame, since it is necessary to assemble the frame from fragments with delimiters rather than assuming a single contiguous span of bytes.

Table C.7-11b specifies the common Attributes that describe and encode the pixel data of the image.

Table C.7-11b. Image Pixel Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.7-11c "Image Pixel Description Macro Attributes"			
Pixel Data	(7FE0,0010)	1	A data stream of the pixel samples that comprise the Image. See Section C.7.6.3.1.4 for further explanation.

Table C.7-11c specifies the common Attributes that describe the pixel data of the image.

Table C.7-11c. Image Pixel Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.7.6.3.1.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Rows	(0028,0010)	1	Number of rows in the image. Shall be an exact multiple of the vertical downsampling factor if any of the samples (planes) are encoded downsampled in the vertical direction for pixel data encoded in a Native (uncompressed) format. E.g., required to be an even value for a Photometric Interpretation (0028,0004) of YBR_FULL_422.
Columns	(0028,0011)	1	Number of columns in the image. Shall be an exact multiple of the horizontal downsampling factor if any of the samples (planes) are encoded downsampled in the horizontal direction for pixel data encoded in a Native (uncompressed) format. E.g., required to be an even value for a Photometric Interpretation (0028,0004) of YBR_FULL_422.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Bits Allocated (0028,0100) shall be either 1, or a multiple of 8. See PS3.5 for further explanation.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See PS3.5 for further explanation.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101). See PS3.5 for further explanation.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. Enumerated Values: **0000H** unsigned integer. **0001H** 2's complement
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.7.6.3.1.3 for further explanation.
Pixel Aspect Ratio	(0028,0034)	1C	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. Required if the aspect ratio values do not have a ratio of 1:1 and the physical pixel spacing is not specified by Pixel Spacing (0028,0030), or Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), either for the entire Image or per-frame in a Functional Group Macro. See Section C.7.6.3.1.7.
Smallest Image Pixel Value	(0028,0106)	3	The minimum actual pixel value encountered in this image.
Largest Image Pixel Value	(0028,0107)	3	The maximum actual pixel value encountered in this image.
Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203). Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.5 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if Photometric Interpretation (0028,0004) has a value of PALETTE COLOR or Pixel Presentation (0008,9205) at the image level equals COLOR or MIXED. See Section C.7.6.3.1.6 for further explanation.
ICC Profile	(0028,2000)	3	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15.1.1. When present, defines the color space of color Pixel Data (7FE0,0010) values, and the output of Palette Color Lookup Table Data (0028,1201-1203). Note The profile applies only to Pixel Data (7FE0,0010) at the same level of the Data Set and not to any icons nested within Sequences, which may or may not have their own ICC profile specified.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.7.6.3.1 Image Pixel Attribute Descriptions

C.7.6.3.1.1 Samples Per Pixel

Samples per Pixel (0028,0002) is the number of separate planes in this image. One and three image planes are defined. Other numbers of image planes are allowed, but their meaning is not defined by this Standard.

For monochrome (gray scale) and palette color images, the number of planes is 1. For RGB and other three vector color models, the value of this Attribute is 3.

Note

The use of a value of 4 was previously described, but the Photometric Interpretations that used it have been retired.

All image planes shall have the same number of Rows (0028,0010), Columns (0028,0011), Bits Allocated (0028,0100), Bits Stored (0028,0101), High Bit (0028,0102), Pixel Representation (0028,0103), and Pixel Aspect Ratio (0028,0034).

Note

Downsampled chrominance planes of a color Photometric Interpretation are a special case, e.g., for a Photometric Interpretation (0028,0004) of YBR_FULL_422. In such cases, Samples per Pixel (0028,0002) describes the nominal number of channels (i.e., 3), and does not reflect that two chrominance samples are shared between four luminance samples. For YBR_FULL_422, Rows (0028,0010) and Columns (0028,0011) describe the size of the luminance plane, not the downsampled chrominance planes.

The data in each pixel may be represented as a "Composite Pixel Code". If Samples Per Pixel is one, the Composite Pixel Code is just the "n" bit pixel sample, where "n" = Bits Allocated. If Samples Per Pixel is greater than one, Composite Pixel Code is a "k" bit concatenation of samples, where "k" = Bits Allocated multiplied by Samples Per Pixel, and with the sample representing the vector

color designated first in the Photometric Interpretation name comprising the most significant bits of the Composite Pixel Code, followed in order by the samples representing the next vector colors, with the sample representing the vector color designated last in the Photometric Interpretation name comprising the least significant bits of the Composite Pixel Code. For example, for Photometric Interpretation = "RGB", the most significant "Bits Allocated" bits contain the Red sample, the next "Bits Allocated" bits contain the Green sample, and the least significant "Bits Allocated" bits contain the Blue sample.

C.7.6.3.1.2 Photometric Interpretation

The value of Photometric Interpretation (0028,0004) specifies the intended interpretation of the image pixel data.

See PS3.5 for additional restrictions imposed by compressed Transfer Syntaxes.

See Section 8.2.13 in PS3.5 for constraints that apply when using DICOM Real-Time Video.

The following values are defined. Other values are permitted if supported by the Transfer Syntax but the meaning is not defined by this Standard.

Defined Terms:

MONOCHROME1 Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as white after any VOI gray scale transformations have been performed. See PS3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5.

MONOCHROME2 Pixel data represent a single monochrome image plane. The minimum sample value is intended to be displayed as black after any VOI gray scale transformations have been performed. See PS3.4. This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5.

PALETTE COLOR Pixel data describe a color image with a single sample per pixel (single image plane). The pixel value is used as an index into each of the Red, Blue, and Green Palette Color Lookup Tables (0028,1101-1103&1201-1203). This value may be used only when Samples per Pixel (0028,0002) has a value of 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5. When the Photometric Interpretation is Palette Color; Red, Blue, and Green Palette Color Lookup Tables shall be present.

RGB Pixel data represent a color image described by red, green, and blue image planes. The minimum sample value for each color plane represents minimum intensity of the color. This value may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) may be 0 or 1. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5.

HSV *Retired.*

ARGB *Retired.*

CMYK *Retired.*

YBR_FULL Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR). This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5. Planar Configuration (0028,0006) may be 0 or 1.

This Photometric Interpretation is primarily used with RLE compressed bit streams, for which the Planar Configuration (0028,0006) may be 0 or 1; see Section 8.2.2 in PS3.5 and Section G.2 in PS3.5. When used in the US Image Module, the Planar Configuration (0028,0006) is required to be 1; see Section C.8.5.6.1.16 “Planar Configuration”.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to half full scale.

Note

In the case where Bits Allocated (0028,0100) has value of 8 half full scale is 128.

In the case where Bits Allocated (0028,0100) has a value of 8 then the following equations convert between RGB and YCBCR Photometric Interpretation.

Y = + .2990R + .5870G + .1140B

CB= - .1687R - .3313G + .5000B + 128

CR= + .5000R - .4187G - .0813B + 128

Note

The above is based on CCIR Recommendation 601-2 dated 1990.

YBR_FULL_422 The same as YBR_FULL except that the CB and CR values are sampled horizontally at half the Y rate and as a result there are half as many CB and CR values as Y values.

Planar Configuration (0028,0006) shall be 0. May be used for pixel data in a Native (uncompressed) or Encapsulated (compressed) format; see Section 8.2 in PS3.5.

Note

1. This Photometric Interpretation is primarily used with JPEG compressed bit streams, but is also occasionally used for pixel data in a Native (uncompressed) format.

2. Though the chrominance channels are downsampled, there are still nominally three channels, hence Samples per Pixel (0028,0002) has a value of 3, not 2. I.e., for pixel data in a Native (uncompressed) format, the Value Length of Pixel Data (7FE0,0010) is not:

   Rows (0028,0010) * Columns (0028,0011) * Number of Frames (0028,0008) * Samples per Pixel (0028,0002) * (⌊(Bits Allocated (0028,0100)-1)/8⌋+1)

   padded to an even length, as it would otherwise be, but rather is:

   Rows (0028,0010) * Columns (0028,0011) * Number of Frames (0028,0008) * 2 * (⌊(Bits Allocated (0028,0100)-1)/8⌋+1)

   padded to an even length.

3. When used to describe JPEG compressed bit streams, the chrominance sub-sampling in the JPEG bit stream may differ from this description. E.g., though many JPEG codecs produce only horizontally sub-sampled chrominance components (4:2:2), some sub-sample vertically as well (4:2:0). Though inaccurate, the use of YBR_FULL_422 to describe both has proven harmless. For a discussion of the sub-sampling notation, see [Poynton 2008].

Two Y values shall be stored followed by one CB and one CR value. The CB and CR values shall be sampled at the location of the first of the two Y values. For each Row of Pixels, the first CB and CR samples shall be at the location of the first Y sample. The next CB and CR samples shall be at the location of the third Y sample etc.

Note

This subsampling sited on the even luminance pixels is often referred to as cosited sampling. The cositing applies when describing pixel data in a Native (uncompressed) form. When used to describe compressed bit streams, the siting depends on the compression scheme. E.g., for JPEG according to JFIF [ISO/IEC 10918-5], the siting is midway between luminance samples, whereas for MPEG2 [ISO/IEC 13818-2], the sampling is cosited with the even luminance pixels. See also [Poynton 2008].

YBR_PARTIAL_422 Retired. See PS3.3 2017b.

YBR_PARTIAL_420 Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. The CB and CR values are sampled horizontally and vertically at half the Y rate and as a result there are four times less CB and CR values than Y values.

Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5.

Note

This Photometric Interpretation is primarily used with MPEG compressed bit streams. For a discussion of the sub-sampling notation and siting, see [Poynton 2008].

Luminance and chrominance values are represented as follows:

1. black corresponds to Y = 16;
2. Y is restricted to 220 levels (i.e., the maximum value is 235);
3. CB and CR each has a minimum value of 16;
4. CB and CR are restricted to 225 levels (i.e., the maximum value is 240);
5. lack of color is represented by CB and CR equal to 128.

In the case where Bits Allocated (0028,0100) has value of 8 then the following equations convert between RGB and YBR_PARTIAL_420 Photometric Interpretation

Y = + .2568R + .5041G + .0979B + 16

CB= - .1482R - .2910G + .4392B + 128

CR= + .4392R - .3678G - .0714B + 128

Note

The above is based on CCIR Recommendation 601-2 dated 1990.

The CB and CR values shall be sampled at the location of the first of the two Y values. For the first Row of Pixels (etc.), the first CB and CR samples shall be at the location of the first Y sample. The next CB and CR samples shall be at the location of the third Y sample etc. The next Rows of Pixels containing CB and CR samples (at the same locations than for the first Row) will be the third etc.

YBR_ICT

Irreversible Color Transformation:

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5.

Note

This Photometric Interpretation is primarily used with JPEG 2000 compressed bit streams.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to zero.

Regardless of the value of Bits Allocated (0028,0100), the following equations convert between RGB and YCBCR Photometric Interpretation.

Y = + .29900R + .58700G + .11400B

CB= - .16875R - .33126G + .50000B

CR= + .50000R - .41869G - .08131B

Note

1. The above is based on [ISO/IEC 15444-1] (JPEG 2000).
2. In a JPEG 2000 bit stream, DC level shifting (used if the untransformed components are unsigned) is applied before forward color transformation, and the transformed components may be signed (unlike in JPEG ISO/IEC 10918-1).
3. In JPEG 2000, spatial down-sampling of the chrominance components, if performed, is signaled in the JPEG 2000 bit stream.

YBR_RCT Reversible Color Transformation:

Pixel data represent a color image described by one luminance (Y) and two chrominance planes (CB and CR).

This photometric interpretation may be used only when Samples per Pixel (0028,0002) has a value of 3. Planar Configuration (0028,0006) shall be 0. Shall only be used for pixel data in an Encapsulated (compressed) format; see Section 8.2 in PS3.5.

Note

This Photometric Interpretation is primarily used with JPEG 2000 compressed bit streams.

Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to zero.

Regardless of the value of Bits Allocated (0028,0100), the following equations convert between RGB and YBR_RCT Photometric Interpretation.

$Y = \lfloor (R + 2G + B) / 4 \rfloor$ (Note: $\lfloor \ldots \rfloor$ mean floor)

CB= B - G

CR= R - G

The following equations convert between YBR_RCT and RGB Photometric Interpretation.

$G = Y - \lfloor (CR + CB) / 4 \rfloor$

R = CR+ G

B = CB+ G

Note

1. The above is based on [ISO/IEC 15444-1] (JPEG 2000).
2. In a JPEG 2000 bit stream, DC level shifting (used if the untransformed components are unsigned) is applied before forward color transformation, and the transformed components may be signed (unlike in JPEG ISO/IEC 10918-1).
3. This photometric interpretation is a reversible approximation to the YUV transformation used in PAL and SECAM.

C.7.6.3.1.3 Planar Configuration

Planar Configuration (0028,0006) indicates whether the color pixel data are encoded color-by-plane or color-by-pixel. This Attribute shall be present if Samples per Pixel (0028,0002) has a value greater than 1. It shall not be present otherwise.

Enumerated Values:

0 The sample values for the first pixel are followed by the sample values for the second pixel, etc. For RGB images, this means the order of the pixel values encoded shall be R1, G1, B1, R2, G2, B2, …, etc.

1 Each color plane shall be encoded contiguously. For RGB images, this means the order of the pixel values encoded is R1, R2, R3, …, G1, G2, G3, …, B1, B2, B3, etc.

Note

Planar Configuration (0028,0006) is not meaningful when a compression Transfer Syntax is used that involves reorganization of sample components in the compressed bit stream. In such cases, since the Attribute is required to be present, then an appropriate value to use may be specified in the description of the Transfer Syntax in PS3.5, though in all likelihood the value of the Attribute will be ignored by the receiving implementation.

C.7.6.3.1.4 Pixel Data

Pixel Data (7FE0,0010) for this image. The order of pixels encoded for each image plane is left to right, top to bottom, i.e., the upper left pixel (labeled 1,1) is encoded first followed by the remainder of row 1, followed by the first pixel of row 2 (labeled 2,1) then the remainder of row 2 and so on.

For multi-plane images see Planar Configuration (0028,0006) in this Section.

C.7.6.3.1.5 Palette Color Lookup Table Descriptor

The three values of Palette Color Lookup Table Descriptor (0028,1101-1104) describe the format of the Lookup Table Data in the corresponding Data Element (0028,1201-1204) or (0028,1221-1223). In this section, the term "input value" is either the Palette Color Lookup Table input value described in the Enhanced Palette Color Lookup Table Sequence (0028,140B) or if that Attribute is absent, the stored pixel value.

The first Palette Color Lookup Table Descriptor value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0. The first value shall be identical for each of the Red, Green, Blue and Alpha Palette Color Lookup Table Descriptors.

The second Palette Color Lookup Table Descriptor value is the first input value mapped. This input value is mapped to the first entry in the Lookup Table Data. All input values less than the first value mapped are also mapped to the first entry in the Lookup Table Data if the Photometric Interpretation is PALETTE COLOR.

Note

In the case of the Supplemental Palette Color LUT, the stored pixel values less than the second descriptor value are grayscale values.

An input value one greater than the first value mapped is mapped to the second entry in the Lookup Table Data. Subsequent input values are mapped to the subsequent entries in the Lookup Table Data up to an input value equal to number of entries + first value mapped - 1, which is mapped to the last entry in the Lookup Table Data. Input values greater than or equal to number of entries + first value mapped are also mapped to the last entry in the Lookup Table Data. The second value shall be identical for each of the Red, Green, Blue and Alpha Palette Color Lookup Table Descriptors.

The third Palette Color Lookup Table Descriptor value specifies the number of bits for each entry in the Lookup Table Data. It shall take the value of 8 or 16. The LUT Data shall be stored in a format equivalent to 8 bits allocated when the number of bits for each entry is 8, and 16 bits allocated when the number of bits for each entry is 16, where in both cases the high bit is equal to bits allocated-1. The third value shall be identical for each of the Red, Green and Blue Palette Color Lookup Table Descriptors.

Note

Some implementations have encoded 8 bit entries with 16 bits allocated, padding the high bits; this can be detected by comparing the number of entries specified in the LUT Descriptor with the actual value length of the LUT Data entry. The value length in bytes should equal the number of entries if bits allocated is 8, and be twice as long if bits allocated is 16.

When the Red, Green, or Blue Palette Color Lookup Table Descriptor (0028,1101-1103) are used as part of the Palette Color Lookup Table Module or the Supplemental Palette Color Lookup Table Module in an Image or Presentation State IOD, the third value shall be equal to 16. When the Alpha Palette Color Lookup Table Descriptor (0028,1104) is used, the third value shall be equal to 8.

When the Red, Green, or Blue Palette Color Lookup Table Descriptor (0028,1101-1103) are used as part of the Palette Color Lookup Table Module in a Color Palette IOD, the 3rd value of Palette Color Lookup Table Descriptor (0028,1101-1103) (i.e, the number of bits for each entry in the Lookup Table Data) shall be 8.

Note

1. A value of 16 indicates the Lookup Table Data will range from (0,0,0) minimum intensity to (65535,65535,65535) maximum intensity.
2. Since the Palette Color Lookup Table Descriptor (0028,1101-1104) Attributes are multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified, even though the first and third values are always by definition interpreted as unsigned. The explicit VR actually used is dictated by the VR needed to represent the second value, which will be consistent with Pixel Representation (0028,0103).

C.7.6.3.1.6 Palette Color Lookup Table Data

Palette Color Lookup Table Data (0028,1201-1204) contain the lookup table data corresponding to the Lookup Table Descriptor (0028,1101-1104).

Palette color values must always be scaled across the full range of available intensities. This is indicated by the fact that there are no bits stored and high bit values for palette color data.

Note

For example, if there are 16 bits per entry specified and only 8 bits of value are truly used then the 8 bit intensities from 0 to 255 must be scaled to the corresponding 16 bit intensities from 0 to 65535. To do this for 8 bit values, simply replicate the value in both the most and least significant bytes.

These lookup tables shall be used only when there is a single sample per pixel (single image plane) in the image.

C.7.6.3.1.7 Pixel Aspect Ratio

The pixel aspect ratio is the ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. To illustrate, consider the example pixel size shown in Figure C.7.6.3.1.7-1

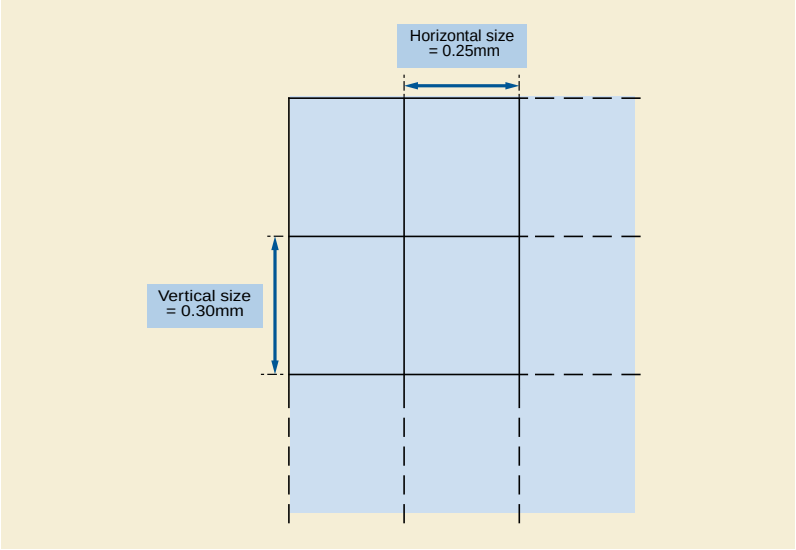


Figure C.7.6.3.1.7-1. Example of Pixel Size and Aspect Ratio

Pixel Aspect Ratio = Vertical Size \ Horizontal Size = 0.30 mm \0.25 mm. Thus the Pixel Aspect Ratio could be represented as the multi-valued integer string "6\5", "60\50", or any equivalent integer ratio.

C.7.6.3.1.8 Extended Offset Table

The Extended Offset Table (7FE0,0001) Value shall contain byte offsets to the first byte of the Item Tag of the first fragment for every frame in the Pixel Data Sequence.

The byte offsets are measured from the first byte of the first Item Tag following the empty (zero length) Basic Offset Table item, i.e., the Item Tag of the first fragment of the first frame.

C.7.6.4 Contrast/Bolus Module

Table C.7-12 specifies the Attributes that describe the contrast /bolus used in the acquisition of the Image.

Table C.7-12. Contrast/Bolus Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Agent	(0018,0010)	2	Contrast or bolus agent
Contrast/Bolus Agent Sequence	(0018,0012)	3	Sequence that identifies the contrast agent. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 12 “Radiographic Contrast Agent”.*
Contrast/Bolus Route	(0018,1040)	3	Administration route of contrast agent
Contrast/Bolus Administration Route Sequence	(0018,0014)	3	Sequence that identifies the route of administration of contrast agent. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 11 “Route of Administration”.*
>Additional Drug Sequence	(0018,002A)	3	Sequence that identifies any additional drug that is administered with the contrast agent bolus. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Contrast/Bolus Volume	(0018,1041)	3	Volume injected in milliliters of diluted contrast agent
Contrast/Bolus Start Time	(0018,1042)	3	Time of start of injection
Contrast/Bolus Stop Time	(0018,1043)	3	Time of end of contrast injection
Contrast/Bolus Total Dose	(0018,1044)	3	Total amount in milliliters of the undiluted contrast agent
Contrast Flow Rate	(0018,1046)	3	Rate(s) of injection(s) in milliliters/sec
Contrast Flow Duration	(0018,1047)	3	Duration(s) of injection(s) in seconds. Each Contrast Flow Duration value shall correspond to a value of Contrast Flow Rate (0018,1046).
Contrast/Bolus Ingredient	(0018,1048)	3	Active ingredient of agent. Defined Terms: **IODINE** **GADOLINIUM** **CARBON DIOXIDE** **BARIUM**
Contrast/Bolus Ingredient Concentration	(0018,1049)	3	Milligrams of active ingredient per milliliter of (diluted) agent

Note

1. Flow duration is an alternate method of specifying stop time

2. Flow rate allows for stepped injections by being capable of multiple values (1,N) instances.
3. For a 100 ml injection of 76% Diatrizoate and meglumine/sodium, diluted 1:1,
   - the Contrast/Bolus Agent would be "76% Diatrizoate" as text
   - the Contrast/Bolus Volume would be 100 ml,
   - the Contrast/Bolus Total Dose would be 50 ml,
   - the Contrast/Bolus Ingredient would be "IODINE",
   - the Contrast/Bolus Ingredient Concentration would be 370mg/ml.

C.7.6.4b Enhanced Contrast/Bolus Module

Table C.7-12b specifies the Attributes that describe the contrast/bolus used in the acquisition of the Image.

Table C.7-12b. Enhanced Contrast/Bolus Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Agent Sequence	(0018,0012)	1	Sequence that identifies one or more contrast agents administered prior to or during the acquisition. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 12 “Radiographic Contrast Agent”.*
>Contrast/Bolus Agent Number	(0018,9337)	1	Identifying number, unique within this SOP Instance, of the agent administered. Used to reference this particular agent from the Contrast/Bolus Functional Group Macro. The number shall be 1 for the first Item and increase by 1 for each subsequent Item.
>Contrast/Bolus Administration Route Sequence	(0018,0014)	1	Sequence that identifies the route of administration of contrast agent. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 11 “Route of Administration”.*
>Contrast/Bolus Ingredient Code Sequence	(0018,9338)	2	Active ingredient of agent. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 13 “Radiographic Contrast Agent Ingredient”.*
>Contrast/Bolus Volume	(0018,1041)	2	Total volume administered in milliliters of diluted contrast agent.
>Contrast/Bolus Ingredient Concentration	(0018,1049)	2	Milligrams of active ingredient per milliliter of agent.
>Contrast/Bolus Ingredient Percent by Volume	(0052,0001)	3	Percentage by volume of active ingredient in the total volume.
>Contrast/Bolus Ingredient Opaque	(0018,9425)	3	Absorption of the ingredient greater than the absorption of water (tissue). Enumerated Values: **YES** **NO** See Section C.7.6.4b.1.

Attribute Name	Tag	Type	Attribute Description
>Contrast/Bolus T1 Relaxivity	(0018,0013)	3	T1 Relaxivity of the MR Contrast/Bolus used specified in $s^{-1}*mmol^{-1}$ specified at body temperature in human blood plasma.
>Contrast Administration Profile Sequence	(0018,9340)	3	Sequence that describes one or more phases of contrast administered. One or more Items are permitted in this Sequence.
>>Contrast/Bolus Volume	(0018,1041)	2	Volume administered during this phase in milliliters of diluted contrast agent.
>>Contrast/Bolus Start Time	(0018,1042)	3	Time of start of administration.
>>Contrast/Bolus Stop Time	(0018,1043)	3	Time of end of administration.
>>Contrast Flow Rate	(0018,1046)	3	Rate of administration in milliliters/sec. Only a single value shall be present.
>>Contrast Flow Duration	(0018,1047)	3	Duration of injection in seconds. Only a single value shall be present.

C.7.6.4b.1 Enhanced Contrast/Bolus Module Attributes

C.7.6.4b.1.1 Contrast/Bolus Ingredient Opaque for X-Ray Equipment

Contrast/Bolus Ingredient Opaque (0018,9425) Attribute specifies the type of relative X-Ray absorption of the contrast/bolus ingredient, compared to the X-Ray absorption of water.

Enumerated Values:

YES The contrast/bolus ingredient absorbs more X-Ray photons than water
NO The contrast/bolus ingredient absorbs less X-Ray photons than water

Note

The Contrast/Bolus Ingredient Opaque (0018,9425) Attribute determines the sign of the gradient of X-Ray beam intensity from inside to outside the injected vessel, thus allowing optimal settings of the image processing applications (e.g., vessel edge detection, etc.), see Figure C.7.6.4b-1.

The relative gray level of the injected vessel with respect to the gray level of the water of Pixel Data (7FE0,0010) is determined by the Contrast/Bolus Ingredient Opaque (0018,9425) and by the Pixel Intensity Relationship Sign (0028,1041). For example, if the contrast/bolus ingredient is more radio graphically dense than water (i.e., YES), and the Pixel Intensity Relationship Sign (0028,1041) is -1, then the contrast/bolus ingredient is represented by higher values of Pixel Data than water.

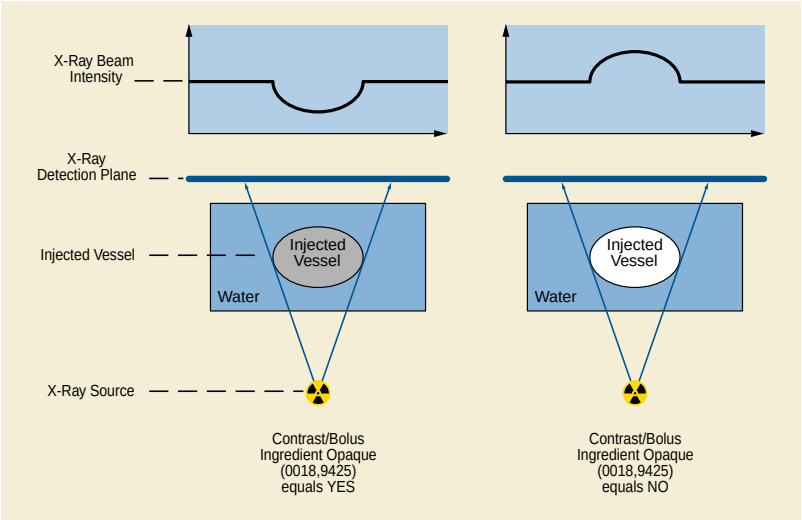


Figure C.7.6.4b-1. X-Ray beam intensity vs. Contrast/Bolus Ingredient Opaque

C.7.6.5 Cine Module

Table C.7-13 specifies the Attributes of a Multi-frame Cine Image.

Table C.7-13. Cine Module Attributes

Attribute Name	Tag	Type	Attribute Description
Preferred Playback Sequencing	(0018,1244)	3	Describes the preferred playback sequencing for a multi-frame image. Enumerated Values: **0** Looping (1,2…n,1,2,…n,1,2,….n,…) **1** Sweeping (1,2,…n,n-1,…2,1,2,…n,…)
Frame Time	(0018,1063)	1C	Nominal time (in msec) per individual frame. See Section C.7.6.5.1.1 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Frame Time.
Frame Time Vector	(0018,1065)	1C	An array that contains the real time increments (in msec) between frames for a Multi-frame image. See Section C.7.6.5.1.2 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Frame Time Vector. Note Frame Time Vector arrays may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
Start Trim	(0008,2142)	3	The frame number of the first frame of the Multi-frame image to be displayed.
Stop Trim	(0008,2143)	3	The Frame Number of the last frame of a Multi-frame image to be displayed.
Recommended Display Frame Rate	(0008,2144)	3	Recommended rate at which the frames of a Multi-frame image should be displayed in frames/second.
Cine Rate	(0018,0040)	3	Number of frames per second.
Frame Delay	(0018,1066)	3	Time (in msec) from Content Time (0008,0033) to the start of the first frame in a Multi-frame image.

Attribute Name	Tag	Type	Attribute Description
Image Trigger Delay	(0018,1067)	3	Delay time in milliseconds from trigger (e.g., X-Ray on pulse) to the first frame of a Multi-frame image.
Effective Duration	(0018,0072)	3	Total time in seconds that data was actually taken for the entire Multi-frame image.
Actual Frame Duration	(0018,1242)	3	Elapsed time of data acquisition in msec per each frame.
Multiplexed Audio Channels Description Code Sequence	(003A,0300)	2C	Description of any multiplexed audio channels. See Section C.7.6.5.1.3. Zero or more Items may be included in this Sequence. Required if the Transfer Syntax used to encode the multi-frame image contains multiplexed (interleaved) audio channels, such as is possible with MPEG2 Systems (see [ISO/IEC 13818-1]).
>Channel Identification Code	(003A,0301)	1	A reference to the audio channel as identified within Transfer Syntax encoded bit stream (1 for the main channel, 2 for the second channel and 3 to 9 to the complementary channels).
>Channel Mode	(003A,0302)	1	A coded descriptor qualifying the mode of the channel: Enumerated Values: **MONO** 1 signal **STEREO** 2 simultaneously acquired (left and right) signals
>Channel Source Sequence	(003A,0208)	1	A coded descriptor of the audio channel source. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 3000 “Audio Channel Source”.*

C.7.6.5.1 Cine Attribute Descriptions

C.7.6.5.1.1 Frame Time

Frame Time (0018,1063) is the nominal time (in milliseconds) between individual frames of a Multi-frame image. If the Frame Increment Pointer points to this Attribute, Frame Time shall be used in the following manner to calculate 'the relative time' for each frame:

Frame 'Relative Time' (n) = Frame Delay + Frame Time * (n-1)

where: n = number of frame within the Multi-frame image and the first frame number is one

Note

When there is only one frame present, Frame Time (0018,1063) may have either a value of 0, or a nominal value that would apply if there were multiple frames.

C.7.6.5.1.2 Frame Time Vector

Frame Time Vector (0018,1065) is an array that contains the time increments (in milliseconds) between the nth frame and the previous frame for a Multi-frame image. The first frame always has a time increment of 0. If the Frame Increment Pointer points to this Attribute, the Frame Time Vector shall be used in the following manner to calculate 'relative time' *T(n)* for frame *n*:

$$T(n) = \sum_{i=1}^{n} \Delta t_i$$

where Δt_i is the ith Frame Time Vector component.

C.7.6.5.1.3 Multiplexed Audio

During a video acquisition, audio may be used for voice commentary of what is being observed, as well as to record sound-based physiological information such as Doppler audio.

Some Transfer Syntaxes allow for the multiplexing of interleaved audio with video data, and the Attributes of the Cine Module support this encoding paradigm. They are not intended to describe audio acquired simultaneously when it is encoded in other SOP Instances or within Attributes other than Pixel Data (7FE0,0010) of the same SOP Instance.

Synchronization between audio and video is assumed to be encoded at the Transfer Syntax level (i.e., within the encoded bit stream).

Note

If no audio was recorded, the Multiplexed Audio Channels Description Code Sequence (003A,0300) will be present and contain no Items.

C.7.6.6 Multi-frame Module

Table C.7-14 specifies the Attributes of a Multi-frame pixel data Image.

Table C.7-14. Multi-frame Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Frames	(0028,0008)	1	Number of frames in a Multi-frame Image. See Section C.7.6.6.1.1 for further explanation.
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tag of the Attribute that is used as the frame increment in Multi-frame pixel data. See Section C.7.6.6.1.2 for further explanation.
Stereo Pairs Present	(0022,0028)	3	The multi-frame pixel data consists of left and right stereoscopic pairs. See Section C.7.6.6.1.3 for further explanation. Enumerated Values: **YES** **NO**

C.7.6.6.1 Multi-frame Attribute Descriptions

C.7.6.6.1.1 Number of Frames and Frame Increment Pointer

A Multi-frame Image is defined as a Image whose pixel data consists of a sequential set of individual Image Pixel frames. A Multi-frame Image is transmitted as a single contiguous stream of pixels. Frame headers do not exist within the data stream.

Each individual frame shall be defined (and thus can be identified) by the Attributes in the Image Pixel Module (see Section C.7.6.3). All Image IE Attributes shall be related to the first frame in the Multi-frame image.

The total number of frames contained within a Multi-frame Image is conveyed in the Number of Frames (0028,0008). Number of Frames (0028,0008) shall have a value greater than zero.

C.7.6.6.1.2 Frame Increment Pointer

The frames within a Multi-frame Image shall be conveyed as a logical sequence. The information that determines the sequential order of the frames shall be identified by the Data Element Tag or Tags conveyed by the Frame Increment Pointer (0028,0009). Each specific Image IOD that supports the Multi-frame Module specializes the Frame Increment Pointer (0028,0009) to identify the Attributes that may be used as sequences.

Even if only a single frame is present, Frame Increment Pointer (0028,0009) is still required to be present and have at least one value, each of which shall point to an Attribute that is also present in the Data Set and has a value.

Note

For example, in single-frame Instance of an IOD that is required to or may contain the Cine Module, it may be appropriate for Frame Time (0018,1063) to be present with a value of 0, and be the only target of Frame Increment Pointer (0028,0009).

When the IOD permits the use of Multi-frame Functional Groups as a Standard or Standard Extended SOP Class, Frame Increment Pointer may contain the single value of Per-frame Functional Groups Sequence (5200,9230) to indicate that the Functional Groups contain the descriptors of the frames.

Note

For example, the Multi-frame Grayscale Word SC Image IOD requires the Multi-frame Module but also permits the Multi-frame Functional Groups, for example, to describe the plane position of each frame.

C.7.6.6.1.3 Stereoscopic Pairs Present

Stereo Pairs Present (0022,0028) shall have the value of YES when frames within a Multi-frame Image are encoded as left and right stereoscopic pairs.

When Stereoscopic Pairs are present, and the pixel data is uncompressed, or compressed with a Transfer Syntax that does not explicitly convey the semantics of stereo pairs, the first and subsequent odd frames (frames numbered from 1) are the left frame of each pair, and the second and subsequent even frames are the right frame of each pair.

If the pixel data is compressed with a Transfer Syntax that does explicitly convey the semantics of stereo pairs, then the identification of the left and right frames in the compressed pixel data will be as defined in the compressed bit stream.

Note

1. For example, the MPEG-4 AVC/H.264 Supplemental Enhancement Information (SEI) frame packing arrangement (FPA) field defines various methods of encoding stereo pairs. See PS3.5 Section 8.2.8 “MPEG-4 AVC/H.264 High Profile / Level 4.2 Video Compression”. Videos encoded with this Transfer Syntax are used for what is colloquially referred to as "3D Television" applications. PS3.5 Section 8.2.9 “MPEG-4 AVC/H.264 Stereo High Profile / Level 4.2 Video Compression” defines a method of encoding stereo pairs without frame packing and with 2D backwards compatibility.

2. The presence of Stereo Pairs Present (0022,0028) is independent of the use of Instances of the Stereometric Relationship IOD. In particular, no further description of the method of acquisition of the stereoscopic pairs is required, such as might be present in Attributes of the Stereo Pairs Sequence (0022,0020) of the Stereometric Relationship IOD. The definition of the references to left and right pairs in that IOD prohibit the encoding of the left and right pairs in the same Instance, as distinct for the usage here.

3. Not all multi-frame IODs are sufficiently generic in their description to permit the presence of stereoscopic pairs. E.g., the Video Endoscopic Image IOD, Video Microscopic IOD and Video Photographic IODs are, since they do not specify any conflicting constraints on the meaning of the frames.

C.7.6.7 Bi-plane Sequence Module (Retired)

C.7.6.8 Bi-plane Image Module (Retired)

C.7.6.9 Frame Pointers Module

Table C.7-15 specifies the Attributes of a Frame Pointer Module.

Table C.7-15. Frame Pointers Module Attributes

Attribute Name	Tag	Type	Attribute Description
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g., icon) of the Multi-frame Image
Frame Numbers Of Interest (FOI)	(0028,6020)	3	Frame number(s) selected as frames of interest. A frame number may appear more than once.

Attribute Name	Tag	Type	Attribute Description
Frame Of Interest Description	(0028,6022)	3	Description of each one of the Frame(s) of Interest selected in (0028,6020). If multiple Frames of Interest are selected and this Attribute is used, it shall contain the same number of values as are in Frame Numbers of Interest (0028,6020).
Frame of Interest Type	(0028,6023)	3	A Defined Term for each one of the Frame(s) of Interest (0028,6020) that identifies the significance of the frame. If multiple Frames of Interest are selected and this Attribute is used, it shall contain the same number of values as are in Frame Numbers of Interest (0028,6020). Defined Terms: **HIGHMI** a frame acquired at the time of the high power pulse that destroys acoustic contrast **RWAVE** the frame closest to the R-Wave **TRIGGER** a trigger frame, for example a set delay from the R Wave **ENDSYSTOLE** the frame closest to end of systole, at the end of the T-wave

Note

1. Frame numbers begin at 1.
2. Frame of Interest Description is intended to indicate such frames as Systolic, Diastolic, Stenotic Artery, or trigger label.

C.7.6.10 Mask Module

Table C.7-16 specifies the Attributes that describe mask operations for a Multi-frame image.

Table C.7-16. Mask Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1	Defines a Sequence that describes mask subtraction operations for a Multi-frame Image. One or more Items shall be included in this Sequence.
>Mask Operation	(0028,6101)	1	Defined Term identifying the type of mask operation to be performed. See Section C.7.6.10.1 for further explanation.
>Subtraction Item ID	(0028,9416)	1C	Identification of the Subtraction Item used to associate a certain Mask Sub-Pixel Shift (0028,6114) in the Frame Pixel Shift Functional Group. See Section C.7.6.16.2.14.1. Required if SOP Class UID (0008,0016) equals "1.2.840.10008.5.1.4.1.1.12.1.1" or "1.2.840.10008.5.1.4.1.1.12.2.1". May be present otherwise.
>Applicable Frame Range	(0028,6102)	1C	Each pair of numbers in this multi-valued Attribute specify a beginning and ending frame number inclusive of a range where this particular mask operation is valid. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. If this Attribute is missing in this particular Sequence Item, then the mask operation is applicable throughout the entire Multi-frame Image, subject to certain limits as described in Section C.7.6.10.1.1. Required if Mask Operation (0028,6101) equals REV_TID. May be present otherwise.
>Mask Frame Numbers	(0028,6110)	1C	Specifies the frame numbers of the pixel data used to generate this mask. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. Required if Mask Operation (0028,6101) is AVG_SUB.

Attribute Name	Tag	Type	Attribute Description
>Contrast Frame Averaging	(0028,6112)	3	Specifies the number of contrast frames to average together before performing the mask operation. If the Attribute is missing, no averaging is performed.
>Mask Sub-pixel Shift	(0028,6114)	3	A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the contrast frame. See Section C.7.6.10.1.2. Note When the Frame Pixel Shift Functional Group is present the values of the Mask Pixel Shift Attribute of that Functional Group prevails over the values specified in this Module.
>TID Offset	(0028,6120)	2C	If Mask Operation is TID, specifies the offset to be subtracted from the current frame number in order to locate the mask frame in TID mode. If Mask Operation is REV_TID, specifies the initial offset to be subtracted from the first contrast frame number. See Section C.7.6.10.1.1. If zero length, TID Offset defaults to 1. Required if Mask Operation (0028,6101) is TID or REV_TID.
>Mask Operation Explanation	(0028,6190)	3	Free form explanation of this particular mask operation.
>Mask Selection Mode	(0028,9454)	3	Specifies the method of selection of the mask operations of this Item. Enumerated Values: **SYSTEM** **USER**
Recommended Viewing Mode	(0028,1090)	2	Specifies the recommended viewing protocol(s). Defined Terms: **SUB** For subtraction with mask images. **NAT** Native viewing of image as encoded. Note If an implementation does not recognize the Defined Term for Recommended Viewing Mode (0028,1090), reverting to native display mode is recommended.

Note

Frame numbers begin at 1.

C.7.6.10.1 Mask Subtraction Attribute Descriptions

C.7.6.10.1.1 Mask Operation

Mask Operation (0028,6101) specifies a type of mask operation to be performed.

Defined Terms:

NONE (No Subtraction) No mask subtraction operation is specified;

AVG_SUB (Average Subtraction) The frames specified by the Mask Frame Numbers (0028,6110) are averaged together, shifted by the amount specified in the Mask Sub-pixel Shift (0028,6114), then subtracted from the contrast frames in the range specified in the Applicable Frame Range (0028,6102). Contrast Frame Averaging (0028,6112) number of frames starting with the current frame are averaged together before the subtraction. If the Applicable Frame Range is not present in this Sequence Item, the Applicable Frame Range is assumed to end at the last frame number of the image minus Contrast Frame Averaging (0028,6112) plus one;

TID (Time Interval Differencing) The mask for each frame within the Applicable Frame Range (0028,6102) is selected by subtracting TID Offset (0028,6120) from the respective frame number. If the Applicable Frame Range is not present in this Sequence Item, the Applicable Frame Range is assumed to be a range where TID offset subtracted from any frame number with the range results in a valid frame number within the Multi-frame image.

Note

A positive value for TID Offset (0028,6120) means that the mask frame numbers are lower than the subtracted frame numbers. A negative TID Offset means that the mask frame numbers are higher than the subtracted frame numbers.

REV_TID (Reversed Time Interval Differencing) The number of the mask frame for each contrast frame within the Applicable Frame Range (0028,6102) is calculated by subtracting TID Offset (0028,6120) from the first frame within the Applicable Frame Range, TID Offset (0028,6120) +2 from the second frame within the Applicable Frame Range, TID Offset (0028,6120) +4 from the third frame and so on. The Applicable Frame Range (0028,6102) shall be present.

When multiple pairs of frame numbers are specified in the Applicable Frame Range Attribute, the beginning frame numbers (i.e., the first frame number in each pair) shall be in increasing order.

Algorithm to calculate the Mask Frame Number:

MFN = (FCFN - TID Offset) - (CFN - FCFN)

Where:

MFN = Mask Frame Number

CFN = Contrast Frame Number

FCFN = First Contrast Frame Number, the first frame number of the first pair in the Applicable Frame Range

Note

A positive value for TID Offset (0028,6120) means that the mask frame numbers are lower than the subtracted frame numbers. A negative TID Offset means that the mask frame numbers are higher than the subtracted frame numbers.

Note

Example of TID Offset, see Figure C.7.6.10-1:

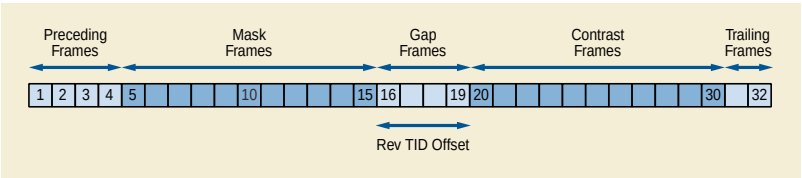


Figure C.7.6.10-1. Example of TID Offset

Number of Frames: 32

Applicable Frame Range: 20 to 30

TID Offset: 5

For Calculating the TID Offset for Mask Operation REV_TID see Table C.7.6.10-1.

Table C.7.6.10-1. Example Mask Frame Numbers for Mask Operation REV_TID

Contrast Frame Number (CFN) (Absolute value)	Mask Frame Number (MFN) (Absolute value)
20	15

Contrast Frame Number (CFN) (Absolute value)	Mask Frame Number (MFN) (Absolute value)
21	14
22	13
…	…
28	7
29	6
30	5

In this example the acquisition of the mask frames starts with frame 5 and ends with frame 15. The acquisition of the contrast frames starts with frame 20 and ends with frame 30 (Applicable Frame Range). The number 5 for TID Offset indicates a gap between "end of mask frames" and "begin of contrast frames" of 4 frames, e.g., injection phase and/or time needed to drive C-arm in reverse. Additionally, in this example, the first 4 frames and the last two frames are not used for this Reversed Time Interval Differencing loop.

C.7.6.10.1.2 Mask Sub-pixel Shift

A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the contrast frame. The row offset results in a shift of the pixels along the column axis. The column offset results in a shift of the pixels along the row axis. A positive row offset is a shift toward the pixels of the lower row of the pixel plane. A positive column offset is a shift toward the pixels of the left hand side column of the pixel plane.

C.7.6.11 Display Shutter Module

The Display shutter is a geometric mask consisting of one or more combined shapes that may be applied on the image for presentation purposes in order to neutralize the display of any of the pixels located outside of the shutter shape. Geometry of the shutter is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represents a row spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different shutter shapes may be used and superimposed.

The manner in which the display area is neutralized (black-out, gray, or other means) is defined by the Attribute Shutter Presentation Value (0018,1622), or undefined if this Attribute is absent or empty.

Table C.7-17. Display Shutter Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.7-17a “Display Shutter Macro Attributes”			

Table C.7-17a. Display Shutter Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Shutter Shape	(0018,1600)	1	Shape(s) of the shutter defined for display. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL** This multi-valued Attribute shall contain at most one of each Enumerated Value. When multiple values are present, and the shutter is applied to a displayed image, then all of the shapes shall be combined and applied simultaneously, that is, the least amount of image remaining shall be visible (unoccluded). See Figure C.7-4b.
Shutter Left Vertical Edge	(0018,1602)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the left edge of the rectangular shutter with respect to pixels in the image given as column.

Attribute Name	Tag	Type	Attribute Description
Shutter Right Vertical Edge	(0018,1604)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the right edge of the rectangular shutter with respect to pixels in the image given as column.
Shutter Upper Horizontal Edge	(0018,1606)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the upper edge of the rectangular shutter with respect to pixels in the image given as row.
Shutter Lower Horizontal Edge	(0018,1608)	1C	Required if Shutter Shape (0018,1600) is RECTANGULAR. Location of the lower edge of the rectangular shutter with respect to pixels in the image given as row.
Center of Circular Shutter	(0018,1610)	1C	Required if Shutter Shape (0018,1600) is CIRCULAR. Location of the center of the circular shutter with respect to pixels in the image given as row and column.
Radius of Circular Shutter	(0018,1612)	1C	Required if Shutter Shape (0018,1600) is CIRCULAR. Radius of the circular shutter with respect to pixels in the image given as a number of pixels along the row direction.
Vertices of the Polygonal Shutter	(0018,1620)	1C	Required if Shutter Shape (0018,1600) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex\column of the origin vertex Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon shutter. Polygon shutters are implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices.
Shutter Presentation Value	(0018,1622)	3	A single gray unsigned value used to replace those parts of the image occluded by the shutter, when rendered on a monochrome display. The units are specified in P-Values, from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
Shutter Presentation Color CIELab Value	(0018,1624)	3	A color triplet value used to replace those parts of the image occluded by the shutter, when rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

Figure C.7-1, Figure C.7-2, Figure C.7-3, Figure C.7-4 and Figure C.7-4b illustrate the values of coordinate Attributes for 1:1 aspect and 2:1 aspect ratio images with rectangular and circular display shutters applied.

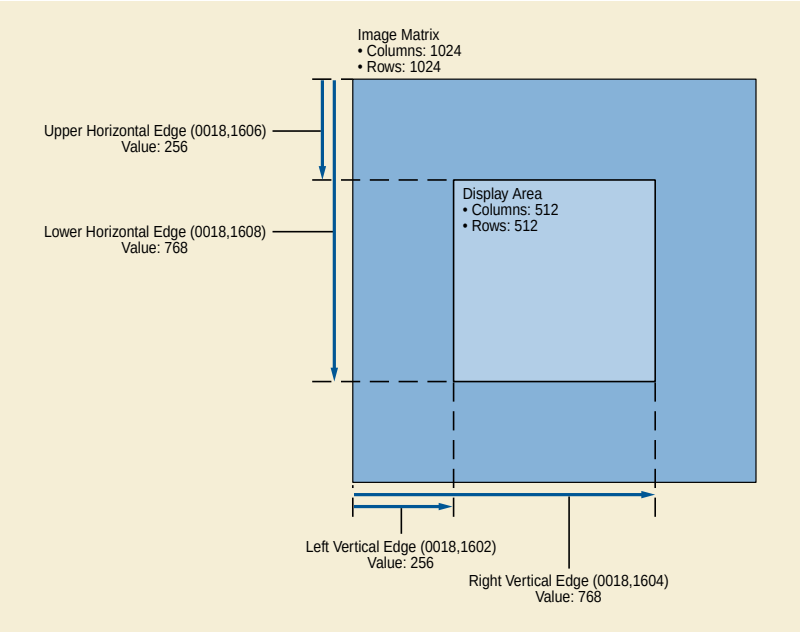


Figure C.7-1. Rectangular Display Shutter (1:1 aspect ratio image)

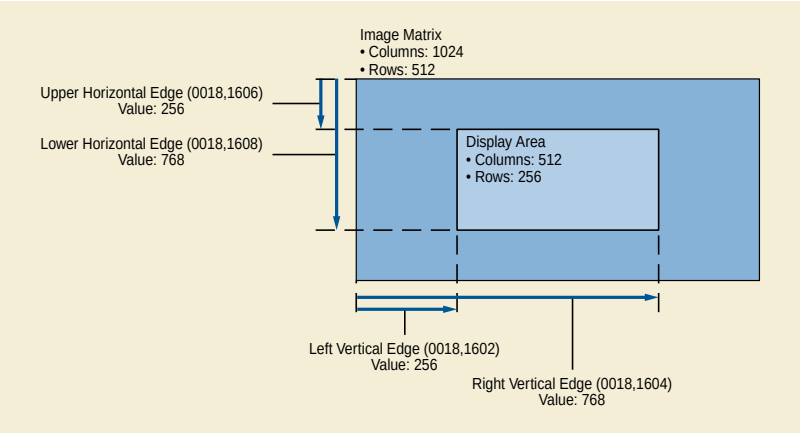


Figure C.7-2. Rectangular Display Shutter (2:1 aspect ratio images as they would appear before interpolation for display)

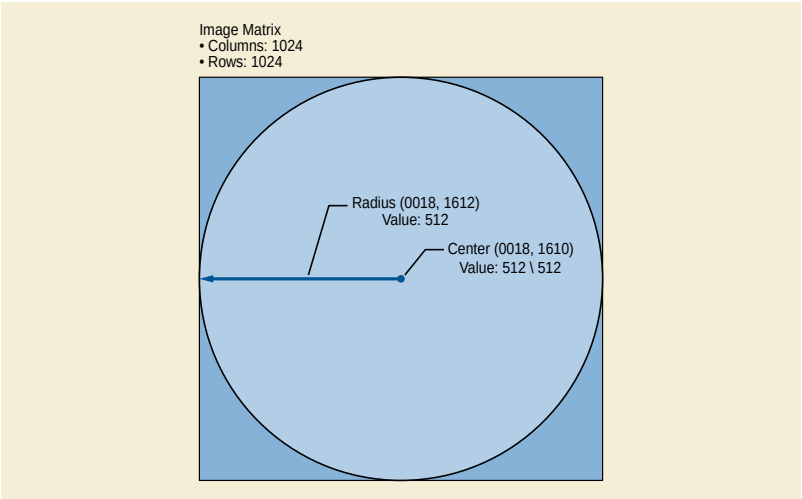


Figure C.7-3. Circular Display Shutter (1:1 aspect ratio image)

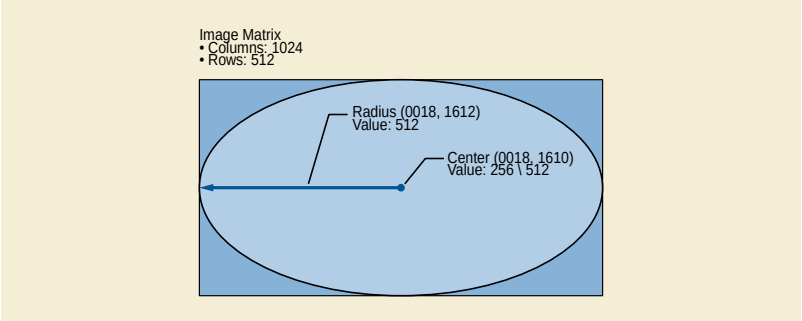


Figure C.7-4. Circular Display Shutter (2:1 aspect ratio images as they would appear before interpolation for display)

Figure C.7-4b illustrates the combined application of rectangular and circular display shutters to show the least amount of visible image.

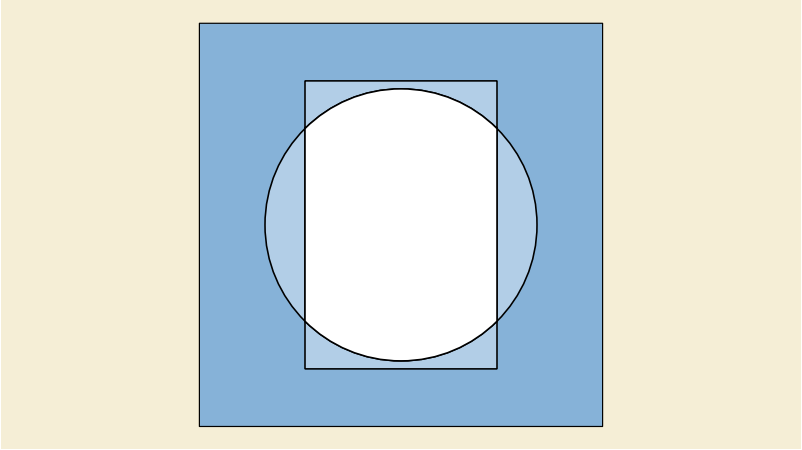


Figure C.7-4b. Combined Rectangular and Circular Display Shutter

C.7.6.12 Device Module

Table C.7-18 describes the Attributes of devices or calibration objects (e.g., catheters, markers, baskets) that are associated with a Study and/or image.

Table C.7-18. Device Module Attributes

Attribute Name	Tag	Type	Attribute Description
Device Sequence	(0050,0010)	1	A Sequence of Items describing devices used that may be visible in the image. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4051 "General Devices".*
>Manufacturer	(0008,0070)	3	Manufacturer of the device
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the device
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the device
>Device ID	(0018,1003)	3	User-supplied identifier for the device
>Device Length	(0050,0014)	3	Length in mm of device. See Section C.7.6.12.1.1.
>Device Diameter	(0050,0016)	3	Unit diameter of device. See Section C.7.6.12.1.1.
>Device Diameter Units	(0050,0017)	2C	Required if Device Diameter (0050,0016) is present. Defined Terms: **FR** French **GA** Gauge **IN** Inch **MM** Millimeter
>Device Volume	(0050,0018)	3	Volume of device in ml. See Section C.7.6.12.1.1.
>Inter-Marker Distance	(0050,0019)	3	Distance in mm between markers on calibrated device. See Section C.7.6.12.1.1.
>Device Description	(0050,0020)	3	Further description in free form text describing the device.

C.7.6.12.1 Device Attribute Descriptions

C.7.6.12.1.1 Device Type and Size

Depending on the type of device specified by Code Value (0008,0100) in an Item of Device Sequence (0050,0010), various device size Attributes (e.g., Device Length (0050,0014), Device Diameter (0050,0016), Device Volume (0050,0018), Inter Marker Distance (0050,0019)) may be required to fully characterize the device.

C.7.6.13 Intervention Module

Table C.7-19 describes the Attributes of therapies (e.g., interventions during an angiographic procedure) that are associated with a Study and/or image.

Table C.7-19. Intervention Module Attributes

Attribute Name	Tag	Type	Attribute Description
Intervention Sequence	(0018,0036)	3	Sequence describing interventional therapies or procedures. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 9 "Image Guided Therapeutic Procedures".*

Attribute Name	Tag	Type	Attribute Description
>Intervention Status	(0018,0038)	2	Temporal relation of SOP Instance to intervention Enumerated Values: **PRE** **INTERMEDIATE** **POST** **NONE**
>Intervention Drug Code Sequence	(0018,0029)	3	Sequence that identifies the interventional drug. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 10 "Interventional Drug".*
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the interventional drug.
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug.
>Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the Administration Route. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 11 "Route of Administration".*
>Intervention Description	(0018,003A)	3	Further description in free form text describing the therapy or other intervention.

Note

Therapy Description (0018,0039) was included in this Module in earlier editions, but its use has been retired. See PS3.3-2003.

C.7.6.14 Acquisition Context Module

Table C.7.6.14-1 specifies Attributes for description of the conditions present during data acquisition.

This Module shall not contain descriptions of conditions that replace those that are already described in specific Modules or Attributes that are also contained within the IOD that contains this Module.

Note

1. Each Item of the Acquisition Context Sequence (0040,0555) contains one Item of the Concept Name Code Sequence (0040,A043) and one of the mutually-exclusive Observation-value Attributes: Concept Code Sequence (0040,A168), the pair of Numeric Value (0040,A30A) and Measurement Units Code Sequence (0040,08EA), Date (0040,A121), Time (0040,A122), Person Name (0040,A123) or Text Value (0040,A160).

2. If this SOP Instance is a Multi-frame SOP Instance, each Item of the Acquisition Context Sequence (0040,0555) may be configured to describe one frame, all frames, or any specifically enumerated subset set of frames of the Multi-frame SOP Instance. Previously, Referenced Frame Numbers (0040,A136) was used to enumerate which frames were described, but its length was limited, so it has been replaced by Referenced Frame Number (0008,1160).

Table C.7.6.14-1. Acquisition Context Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Context Sequence	(0040,0555)	2	A Sequence of Items that describes the conditions present during the acquisition of the data of the SOP Instance. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Value Type	(0040,A040)	3	The type of the value encoded in this Item. Defined Terms: **TEXT** **NUMERIC** **CODE** **DATE** **TIME** **PNAME** See Section 10.2.
>Observation DateTime	(0040,A032)	3	The date and time on which this Item was completed. For the purpose of recording measurements or logging events, completion time is defined as the ending time of data acquisition of the measurement, or the ending time of occurrence of the event.
>Concept Name Code Sequence	(0040,A043)	1	A concept that constrains the meaning of (i.e., defines the role of) the Observation Value. The "Name" component of a Name/Value pair. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>Referenced Frame Number	(0008,1160)	1C	References one or more frames in a Multi-frame SOP Instance. The first frame shall be denoted as frame number one. Required if this SOP Instance is a Multi-frame SOP Instance and the values in this Sequence Item do not apply to all frames.
>Numeric Value	(0040,A30A)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a set of one or more numeric values. Required if the value that Concept Name Code Sequence (0040,A043) requires (implies) is a set of one or more integers or real numbers. Shall not be present otherwise.
>Floating Point Value	(0040,A161)	1C	The floating point representation of Numeric Value (0040,A30A). The same number of values as Numeric Value (0040,A30A) shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent the value as a string. May be present otherwise.
>Rational Numerator Value	(0040,A162)	1C	The integer numerator of a rational representation of Numeric Value (0040,A30A). Encoded as a signed integer value. The same number of values as Numeric Value (0040,A30A) shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent a rational value as a string. May be present otherwise.
>Rational Denominator Value	(0040,A163)	1C	The integer denominator of a rational representation of Numeric Value (0040,A30A). Encoded as a non-zero unsigned integer value. The same number of values as Numeric Value (0040,A30A) shall be present. Required if Rational Numerator Value (0040,A162) is present.
>Measurement Units Code Sequence	(0040,08EA)	1C	Units of measurement. Only a single Item shall be included in this Sequence. Required if Numeric Value (0040,A30A) is present. Shall not be present otherwise.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 82 "Units of Measurement".*

Attribute Name	Tag	Type	Attribute Description
>Date	(0040,A121)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a date. Note The purpose or role of the date value could be specified in Concept Name Code Sequence (0040,A043). Required if the value that Concept Name Code Sequence (0040,A043) requires (implies) is a date. Shall not be present otherwise.
>Time	(0040,A122)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a time. Note The purpose or role of the time value could be specified in Concept Name Code Sequence (0040,A043). Required if the value that Concept Name Code Sequence (0040,A043) requires (implies) is a time. Shall not be present otherwise.
>Person Name	(0040,A123)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a Person Name. Note The role of the person could be specified in Concept Name Code Sequence (0040,A043). Required if the value that Concept Name Code Sequence (0040,A043) requires (implies) is a person name. Shall not be present otherwise.
>Text Value	(0040,A160)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a Text Observation Value. Required if Date (0040,A121), Time (0040,A122), and Person Name (0040,A123) do not fully describe the concept specified by Concept Name Code Sequence (0040,A043). Shall not be present otherwise.
>Concept Code Sequence	(0040,A168)	1C	This is the Value component of a Name/Value pair when the Concept implied by Concept Name Code Sequence (0040,A043) is a Coded Value. Only a single Item shall be included in this Sequence. Required if Date (0040,A121), Time (0040,A122), Person Name (0040,A123), Text Value (0040,A160), and the pair of Numeric Value (0040,A30A) and Measurement Units Code Sequence (0040,08EA) are not present.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Acquisition Context Description	(0040,0556)	3	Free-text description of the image-acquisition context.

C.7.6.15 Bitmap Display Shutter Module

The Bitmap Display Shutter is a bitmap that defines an arbitrary shape that may be applied on the image for presentation purposes in order to neutralize the display of any of the pixels defined in the bitmap.

The manner in which the display area is neutralized (black-out, gray, or other means) is defined by the Attribute Shutter Presentation Value (0018,1622).

The bitmap is specified as a reference to an instance of the Overlay Plane Module Section C.9.2. The referenced Overlay is specialized such that:

- Overlay Type (60xx,0040) shall be "G",
- Overlay Bits Allocated (60xx,0100) shall be 1,
- Overlay Bit Position (60xx,0102) shall be 0 and
- Overlay Origin (60xx,0050) shall be 1\1.

Overlay Rows (60xx,0010) and Overlay Columns (60xx,0011) shall be the same as Rows (0028,0010) and Columns (0028,0011) in the image respectively.

A value of 1 in Overlay Data (60xx,3000) shall indicate a pixel to which the shutter is applied, i.e., replaced with Shutter Presentation Value (0018,1622).

The Overlay specified in this Attribute shall not be activated (used as a conventional overlay) by the Overlay Activation Module Section C.11.7.

Table C.7.6.15-1. Bitmap Display Shutter Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shutter Shape	(0018,1600)	1	Shape of the shutter defined for display. Enumerated Values: **BITMAP** This Attribute shall contain one Value.
Shutter Overlay Group	(0018,1623)	1	Specifies the Group (60xx) of an Overlay stored within the Presentation State IOD that contains the bitmap data, as defined in the Overlay Plane Module Section C.9.2.
Shutter Presentation Value	(0018,1622)	1	A single gray unsigned value used to replace those parts of the image occluded by the shutter, when rendered on a monochrome display. The units are specified in P-Values, from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
Shutter Presentation Color CIELab Value	(0018,1624)	3	A color triplet value used to replace those parts of the image occluded by the shutter, when rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

C.7.6.16 Multi-frame Functional Groups Module

Table C.7.6.16-1 specifies the Attributes of the Multi-frame Functional Groups Module. This Module is included in SOP Instances even if there is only one frame in the Instance.

Table C.7.6.16-1. Multi-frame Functional Groups Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shared Functional Groups Sequence	(5200,9229)	1	Sequence that contains the Functional Group Macros that are shared for all frames in this SOP Instance and Concatenation. Note The contents of this Sequence are the same in all SOP Instances that comprise a Concatenation. Only a single Item shall be included in this Sequence. See Section C.7.6.16.1.1 for further explanation.
>Include one or more Functional Group Macros that are shared by all frames. The selected Functional Group Macros shall not be present in the Per-frame Functional Groups Sequence (5200,9230).			For each IOD that includes this Module, a table is defined in which the permitted Functional Group Macros and their usage is specified. The Item may be empty if the requirements for inclusion of the Functional Groups are not satisfied.
Per-frame Functional Groups Sequence	(5200,9230)	1C	Sequence that contains the Functional Group Sequence Attributes corresponding to each frame of the Multi-frame Image. The first Item corresponds with the first frame, and so on. One or more Items shall be included in this Sequence. The number of Items shall be the same as the number of frames in the Multi-frame image. See Section C.7.6.16.1.2 for further explanation. Required if for any frame, there are Per-Frame Functional Groups that are not empty.
>Include one or more Functional Group Macros.			For each IOD that includes this Module, a table is defined in which the permitted Functional Group Macros and their usage is specified. An Item may be empty if the requirements for inclusion of the Functional Groups for the corresponding frame are not satisfied.
Instance Number	(0020,0013)	1	A number that identifies this Instance. The value shall be the same for all SOP Instances of a Concatenation, and different for each separate Concatenation and for each SOP Instance not within a Concatenation in a Series.
Content Date	(0008,0023)	1	The date the data creation was started. Note For Instance, this is the date the pixel data is created, not the date the data is acquired.
Content Time	(0008,0033)	1	The time the data creation was started. Note For Instance, this is the time the pixel data is created, not the time the data is acquired.
Number of Frames	(0028,0008)	1	Number of frames in a multi-frame image. See Section C.7.6.6.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Stereo Pairs Present	(0022,0028)	3	The multi-frame pixel data consists of left and right stereoscopic pairs. See Section C.7.6.6.1.3 for further explanation. Enumerated Values: **YES** **NO**
Concatenation Frame Offset Number	(0020,9228)	1C	Offset of the first frame in a multi-frame image of a concatenation. Logical frame numbers in a concatenation can be used across all its SOP Instances. This offset can be applied to the implicit frame number to find the logical frame number in a concatenation. The offset is numbered from zero; i.e., the instance of a concatenation that begins with the first frame of the concatenation has a Concatenation Frame Offset Number (0020,9228) of zero. Required if Concatenation UID (0020,9161) is present.
Representative Frame Number	(0028,6010)	3	The frame number selected for use as a pictorial representation (e.g., icon) of the multi-frame Image.
Concatenation UID	(0020,9161)	1C	Identifier of all SOP Instances that belong to the same concatenation. Required if a group of multi-frame image SOP Instances within a Series are part of a Concatenation.
SOP Instance UID of Concatenation Source	(0020,0242)	1C	The SOP Instance UID of the single composite SOP Instance of which the Concatenation is a part. All SOP Instances of a concatenation shall use the same value for this Attribute, see Section C.7.6.16.1.3. Note May be used to reference the entire Instance rather than individual Instances of the concatenation, which may be transient (e.g., from a presentation state). Required if Concatenation UID (0020,9161) is present.
In-concatenation Number	(0020,9162)	1C	Identifier for one SOP Instance belonging to a concatenation. See Section C.7.6.16.2.2.4 for further specification. The first Instance in a concatenation (that with the lowest Concatenation Frame Offset Number (0020,9228) value) shall have an In-concatenation Number (0020,9162) value of 1, and subsequent Instances shall have values monotonically increasing by 1. Required if Concatenation UID (0020,9161) is present.
In-concatenation Total Number	(0020,9163)	3	The number of SOP Instances sharing the same Concatenation UID. If present, shall have a value greater than one, unless an IOD overrides this constraint to enumerate a value of 1 to prevent the use of Concatenations (e.g., see Section C.8.17.7 and Section C.8.17.16).

C.7.6.16.1 Multi-frame Functional Groups Module Attribute Description

C.7.6.16.1.1 Functional Group

A Functional Group is a set of Attributes that are logically related and may vary together. Functional Groups are defined by editorial convention in Macros. Those Functional Groups that apply to all frames are included in the Shared Functional Groups Sequence (5200,9229). Functional Groups whose Attribute values may vary from frame to frame are included in the Per-frame Functional Groups Sequence (5200,9230).

A single Functional Group shall not be included in both the Shared Functional Groups Sequence (5200,9229) and the Per-frame Functional Groups Sequence (5200,9230).

Note

1. In the case of a SOP Instance containing a single frame, some Functional Groups may be contained in the Shared Functional Groups Sequence (5200,9229) and others in the one Item of the Per-frame Functional Groups Sequence (5200,9230).

2. Even if there are no Functional Groups in the Per-frame Functional Groups Sequence (5200,9230) an empty Item is encoded for every frame, which an IOD is permitted to specify for a Type 1 Sequence, as described in PS3.5, unless all Items for all frames are empty, in which case the Per-frame Functional Groups Sequence (5200,9230) may be entirely omitted.

It may happen that the Data Set for the Item of a Functional Group Sequence Attribute does not contain any Attributes (e.g., a condition for a single Type 1C Attribute in the Sequence is not met). In this case, the Item is included but is empty.

Note

PS3.5 describes that an empty Item is permitted for a Type 1 or Type 2 Sequence depending on what the IOD in PS3.3 defines for the Data Set that is defined for that Sequence Item.

It may happen that a Functional Group Sequence Attribute is not required for a particular frame (e.g., an optional Functional Group). In this case the Functional Group Sequence Attribute is not included in the Per-frame Functional Groups Sequence (5200,9230) Item for that frame.

Note

The absence of the Sequence Attribute corresponding to a particular Functional Group indicates that the Functional Group is not used for a particular frame.

Private Functional Groups may be defined. The Attributes of such a group may be Standard or Private Attributes. A Private Functional Group may not replicate the Attributes of a Standard Functional Group.

A Private Functional Group can be added to either the Shared Functional Groups Sequence (5200,9229) or the Per-frame Functional Groups Sequence (5200,9230).

C.7.6.16.1.2 Per-frame Functional Groups Sequence

The Per-frame Functional Groups Sequence Attribute (5200,9230) consists of a Sequence of Items. Each Item describes the frame of the same rank in the multi-frame pixel data. The first Item describes frame 1, the second Item describes frame 2, etc. Frames are implicitly numbered starting from 1. See Figure C.7.6.16-1.

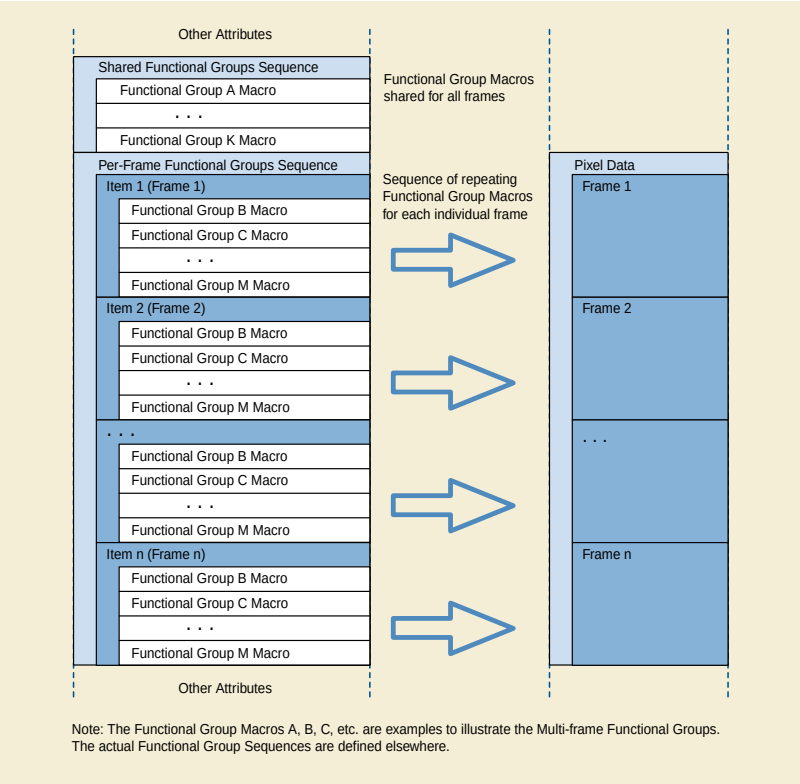


Figure C.7.6.16-1. A Graphical Presentation of the Multi-frame Functional Groups Structure

C.7.6.16.1.3 SOP Instance UID of Concatenation Source

The SOP Instance UID of Concatenation Source (0020,0242) Attribute contains the SOP Instance UID of the original, not concatenated, SOP Instance and does not change when a concatenation is created. It is independent of Concatenation UID (0020,9161) because a SOP Instance can be divided into concatenations only during exchange and there can be more than one concatenation with different Concatenation UIDs of an original SOP Instance; See Figure C.7.6.16-1a.

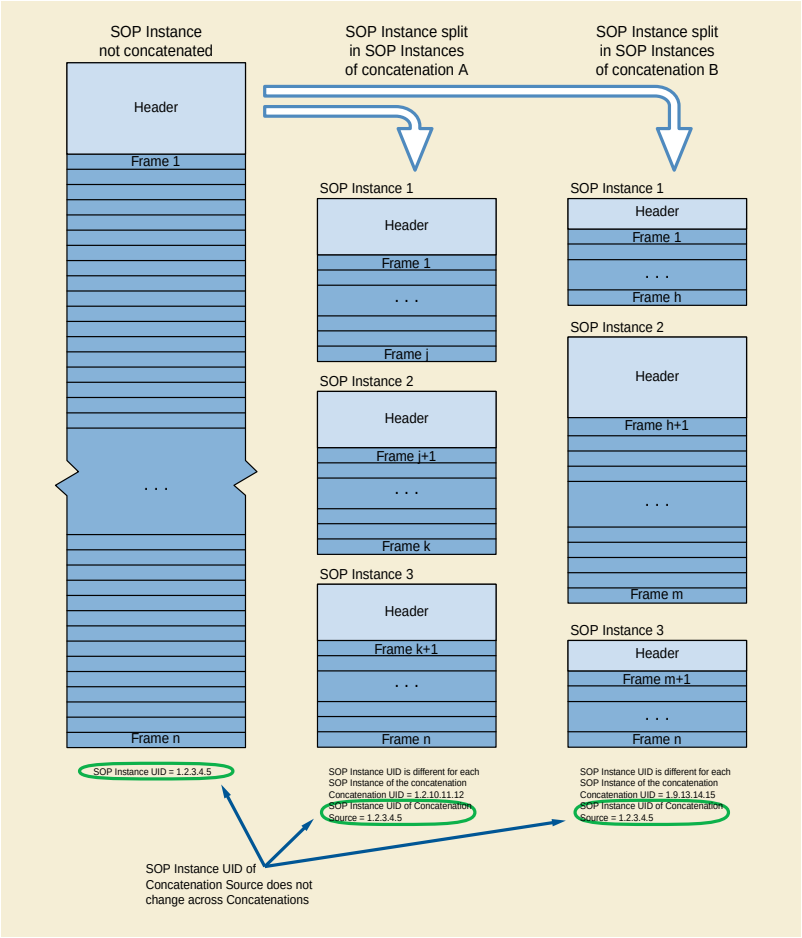


Figure C.7.6.16-1a. SOP Instance UID of Concatenation Source

C.7.6.16.2 Common Functional Group Macros

The following sections contain Functional Group Macros common to more than one IOD specification.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean "for all frames".

C.7.6.16.2.1 Pixel Measures Macro

Table C.7.6.16-2 specifies the Attributes of the Pixel Measures Functional Group Macro.

Table C.7.6.16-2. Pixel Measures Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Measures Sequence	(0028,9110)	1	Identifies the physical characteristics of the pixels of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Pixel Spacing	(0028,0030)	1C	Physical distance in the imaging target (patient, specimen, or phantom) between the centers of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Note In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the pixel spacing is that in a plane normal to the central ray of the diverging X-Ray beam as it passes through the data collection center. Required if: • Volumetric Properties (0008,9206) is other than DISTORTED or SAMPLED, or • SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or • SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or • SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8"). May be present otherwise.
>Slice Thickness	(0018,0050)	1C	Nominal reconstructed slice thickness (for tomographic imaging) or depth of field (for optical non-tomographic imaging), in mm. See Section C.7.6.16.2.3.1 for further explanation. Note Depth of field may be an extended depth of field created by focus stacking (see Section C.8.12.4). Required if: • Volumetric Properties (0008,9206) is VOLUME or SAMPLED, or • SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or • SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or • SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8"). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Spacing Between Slices	(0018,0088)	1C	Spacing between adjacent slices, in mm. The spacing is measured from the center-to-center of each slice, and if present shall not be negative. Required if Dimension Organization Type (0020,9311) is TILED_FULL and Total Pixel Matrix Focal Planes (0048,0303) is greater than 1. May be present otherwise. Note In the case of Whole Slide Images, Spacing Between Slices (0018,0088) describes the spacing of focal planes separately encoded, and is distinct from Distance Between Focal Planes (0048,0014), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).

C.7.6.16.2.2 Frame Content Macro

Table C.7.6.16-3 specifies the Attributes of the Frame Content Functional Group Macro.

This Functional Group Macro may only be part of the Per-frame Functional Groups Sequence (5200,9230) Attribute.

Table C.7.6.16-3. Frame Content Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Content Sequence	(0020,9111)	1	Identifies general characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Acquisition Number	(0020,9156)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this frame.
>Frame Reference DateTime	(0018,9151)	1C	The point in time that is most representative of when data was acquired for this frame. See Section C.7.6.16.2.2.1 and Section C.7.6.16.2.2.2 for further explanation. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800). Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and the SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" or "1.2.840.10008.5.1.4.1.1.4.4" or "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted) or 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image Storage). May be present otherwise.
>Frame Acquisition DateTime	(0018,9074)	1C	The date and time that the acquisition of data that resulted in this frame started. See Section C.7.6.16.2.2.1 for further explanation. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and the SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" or "1.2.840.10008.5.1.4.1.1.4.4" or "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted) or 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image Storage). May be present otherwise.
>Frame Acquisition Duration	(0018,9220)	1C	The actual amount of time [in milliseconds] that was used to acquire data for this frame. See Section C.7.6.16.2.2.1 and Section C.7.6.16.2.2.3 for further explanation. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and the SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" or "1.2.840.10008.5.1.4.1.1.4.4" or "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted) or 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image Storage). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Cardiac Cycle Position	(0018,9236)	3	Description of the position in the cardiac cycle that is most representative of this frame. Defined Terms: **END_SYSTOLE** **END_DIASTOLE** **UNDETERMINED**
>Respiratory Cycle Position	(0018,9214)	3	Description of the position in the respiratory cycle that is most representative of this frame. Defined Terms: **START _RESPIR** **END_RESPIR** **UNDETERMINED**
>Dimension Index Values	(0020,9157)	1C	Contains the values of the indices defined in the Dimension Index Sequence (0020,9222) for this multi-frame header frame. The number of values is equal to the number of Items of the Dimension Index Sequence and shall be applied in the same order. See Section C.7.6.17.1 for a description. Note In Section C.7.6.17.1, the index values are defined to start from 1 and monotonically increase by 1, within the scope of the Dimension Organization UID (0020,9164). Required if the value of Dimension Index Sequence (0020,9222) exists. Note For some IODs, such as the VL Whole Slide Microscopy Image IOD, the entire Frame Content Sequence (0020,9111) may be omitted, but if it is present and Dimensions are explicitly defined, then the index values need to be supplied here.
>Temporal Position Index	(0020,9128)	1C	Ordinal number (starting from 1) of the frame in the set of frames with different temporal positions. Required if the value of SOP Class UID (0008,0016) equals "1.2.840.10008.5.1.4.1.1.130" or Functional MR Sequence (0018,9621) is present. May be present otherwise. See Section C.7.6.16.2.2.6 and Section C.7.6.16.2.2.8.
>Stack ID	(0020,9056)	1C	Identification of a group of frames, with different positions and/or orientations that belong together, within a dimension organization. See Section C.7.6.16.2.2.4 for further explanation. Required if the value of SOP Class UID (0008,0016) equals "1.2.840.10008.5.1.4.1.1.130" or Functional MR Sequence (0018,9621) is present. May be present otherwise. See Section C.7.6.16.2.2.7 and Section C.7.6.16.2.2.8.
>In-Stack Position Number	(0020,9057)	1C	The ordinal number of a frame in a group of frames, with the same Stack ID (0020,9056). Required if Stack ID (0020,9056) or Functional MR Sequence (0018,9621) is present. See Section C.7.6.16.2.2.4 and Section C.7.6.16.2.2.8 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Frame Comments	(0020,9158)	3	User-defined comments about the frame.
>Frame Label	(0020,9453)	3	Label corresponding to a specific dimension index value. Selected from a set of dimension values defined by the application. This Attribute may be referenced by the Dimension Index Pointer (0020,9165) Attribute in the Multi-frame Dimension Module. See Section C.7.6.16.2.2.5 for further explanation.

C.7.6.16.2.2.1 Timing Parameter Relationships

Figure C.7.6.16-2 shows the relationships among the various timing parameters used.

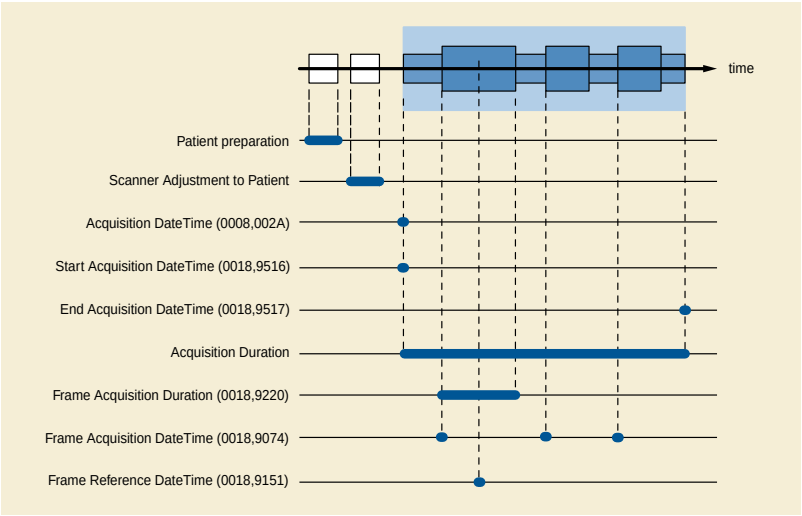


Figure C.7.6.16-2. Relationship of Timing Related Attributes

C.7.6.16.2.2.2 Frame Reference DateTime

The Frame Reference DateTime (0018,9151) is used to indicate the point in time that is most representative for that specific frame.

Note

1. For example, in the case of MR it might be the time of acquisition of the data for the $k_y = 0$ line in k-space (the central Fourier segment).
2. For cardiac gated acquisitions the choice of the Frame Reference DateTime (0018,9151) is influenced by the Nominal Cardiac Trigger Delay Time (0020,9153). For respiratory gated acquisitions the choice of the Frame Reference DateTime (0018,9151) is influenced by the Nominal Respiratory Trigger Delay Time (0020,9255).

C.7.6.16.2.2.3 Frame Acquisition Duration

The Frame Acquisition Duration (0018,9220) is used to indicate the duration of the acquisition related to this frame.

For SOP Instances or Concatenations of the Enhanced PET Image Storage SOP Class (1.2.840.10008.5.1.4.1.1.130) the Frame Acquisition Duration (0018,9220) is the sum of the portion of each cycle during which data contributing to this frame has actually been acquired for all of the cardiac or respiratory cycles of a gated acquisition (i.e., if Cardiac Synchronization Technique (0018,9037) equals other than NONE, and/or if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE).

C.7.6.16.2.2.4 Concatenations and Stacks

Due to implementation specific reasons (such as maximum object size) the information of a multi-frame image may be split into more than one SOP Instance. These SOP Instances form together a Concatenation. This is a group of SOP Instances within a Series that is uniquely identified by Concatenation UID (0020,9161).

The Dimension Index Sequence (0020,9222) for each SOP Instance with the same Concatenation UID (0020,9161) shall contain exactly the same Attributes and values.

In a Concatenation the Dimension Index Sequence (0020,9222) Items of the Shared Functional Groups (5200,9229) shall be identical and have the same values for all individual SOP Instances. The Items of the Per-frame Functional Groups (5200,9230) shall be identical for all individual SOP Instances but the values may change per frame. For all other Attributes of all the Modules of the IOD, the same Attributes shall be present and the values shall be identical, with the exception of the following Attributes:

- Number of Frames (0028,0008)
- Concatenation Frame Offset Number (0020,9228)
- In-concatenation Number (0020,9162)
- SOP Instance UID (0008,0018)
- Instance Creation Time (0008,0013)

Note

The intent of Concatenations is to split what might have been encoded in a single SOP Instance into smaller fragments for more convenient storage or transmission. All the multiple SOP Instances of a Concatenation should be able to be assembled into a valid single SOP Instance. Hence it is not permitted to change such Attributes as Photometric Interpretation (0028,0004), Rows (0028,0010), Columns (0028,0011), etc.

Stacks describe application-specific groups of frames that have a geometric relationship. Stacks have a Stack ID (0020,9056) that contains a descriptive name that identifies the stack. A Stack ID (0020,9056) may be re-used in another SOP Instance even outside a concatenation. The value of Stack ID (0020,9056) is unique within the scope of a particular Dimension Organization UID (0020,9164) if present, otherwise it is unique within the scope of a particular Concatenation UID (0020,9161). See Figure C.7.6.16-3 for an example.

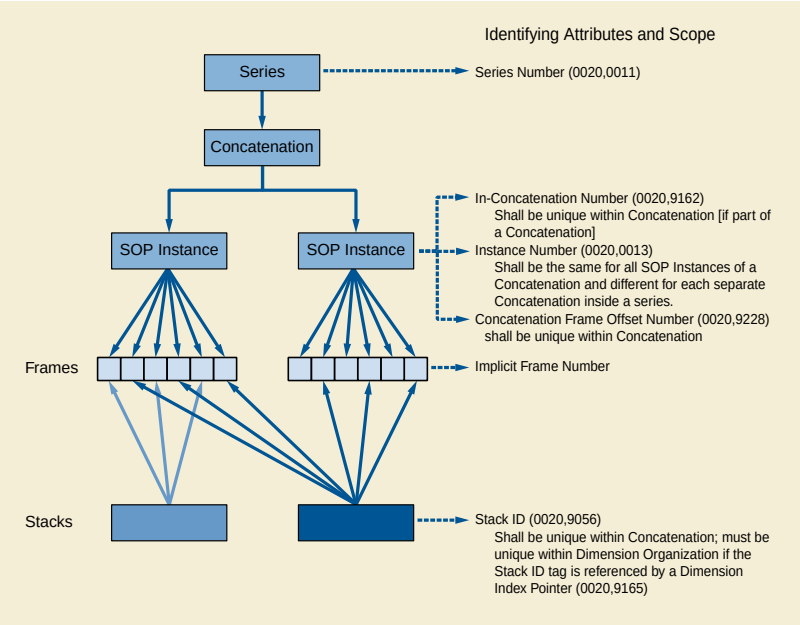


Figure C.7.6.16-3. Identifying Attributes for Concatenation, SOP Instances, Frames and Stacks

Each frame in a stack has an In-Stack Position Number (0020,9057) that is the ordinal number (starting from 1) of the frame within the set of frames with the same Stack ID (0020,9056), see Figure C.7.6.16-4 for an example.

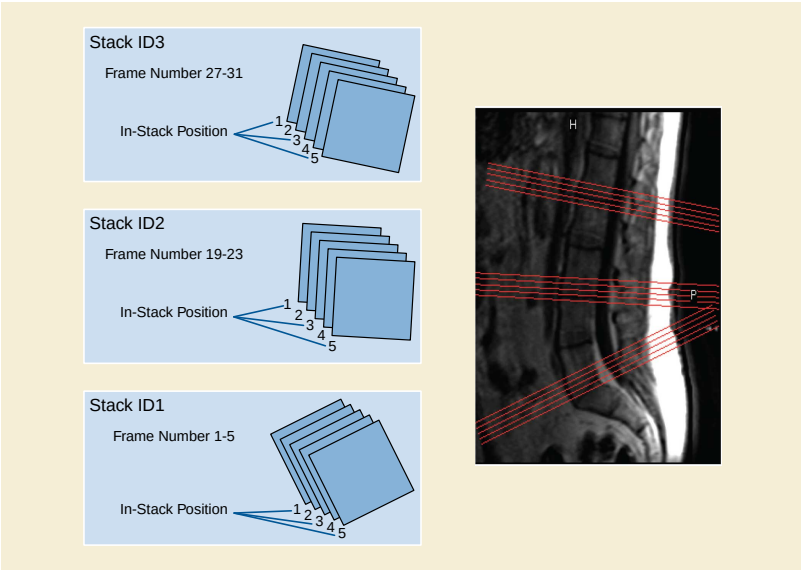


Figure C.7.6.16-4. Example of multiple stacks

In order to allow interoperable operations on stacks, 2 different frames with the same Stack ID (0020,9056) can only have the same In-Stack Position Number (0020,9057) if they have the same values for the following Attributes:

1. Dimension Organization UID (0020,9164) to qualify the Stack ID
2. Image Position (Patient) (0020,0032)
3. Image Orientation (Patient) (0020,0037)
4. Rows (0028,0010) * first value of Pixel Spacing (0028,0030) (= field of view in the row direction)
5. Columns (0028,0011) * second value of Pixel Spacing (0028,0030) (= field of view in the column direction)
6. Slice Thickness (0018,0050)

C.7.6.16.2.2.5 Frame Label

The Frame Label (0020,9453) Attribute can be used to label frames that need to be handled as a group in application. The Dimension Index Pointer (0020,9165) from the Multi-frame Dimension Module may point to this Attribute if it is the base of a dimension.

C.7.6.16.2.2.6 Temporal Position Index and Stack ID in PET images

For PET Dynamic images, i.e., images in which Image Type (0008,0008) Value 3 is DYNAMIC, Temporal Position Index is used to distinguish between the multiple acquisitions of the same anatomical area. Similarly, the frames that result from one acquisition over the anatomic area shall be contained in one stack. Thus, for Dynamic images, Temporal Position Index (0020,9128), Stack ID (0020,9056), and In-Stack Position Number (0020,9057) shall be used as three of the dimensions of the image, in that order.

Figure C.7.6.16-4b describes the usage for a PET dynamic image.

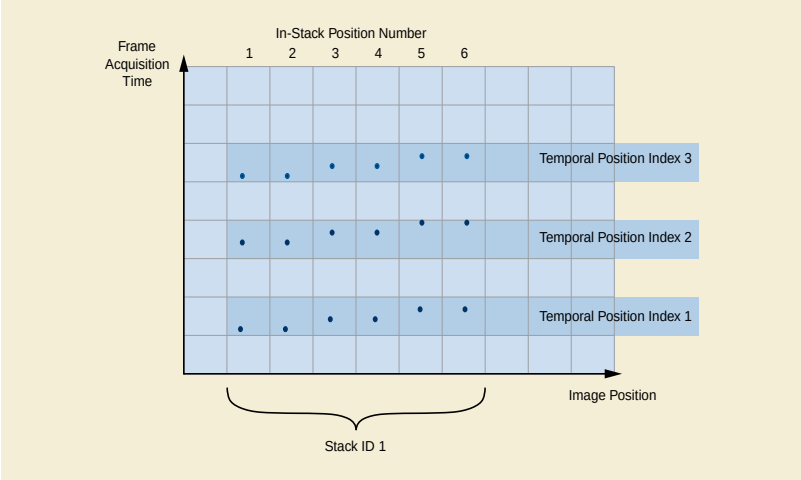


Figure C.7.6.16-4b. PET dynamic frame organization

C.7.6.16.2.2.7 Stack ID usage in PET static, whole body and gated images

For static and whole body PET images, a single Stack ID (0020,9056) is used to group all of the transverse slices over the entire imaged volume together. That is, a single Stack ID (0020,9056) is used no matter how many acquisition bed positions are involved. In-Stack Position Number (0020,9057) is then used as the spatial dimension index. When rectangular sagittal, coronal or oblique images are created from these, a single Stack ID (0020,9056) is again used.

Similarly, in cardiac or respiratory gated images, the entire volume is again identified by a single Stack ID (0020,9056), and In-Stack Position Number (0020,9057) is the spatial dimension index. The time dimension is indicated by one of the timing Attributes, such as trigger delay time or respiratory phase.

C.7.6.16.2.2.8 Usage of Temporal Position Index, Stack ID and In-Stack Position Number in fMRI Volumes

For fMRI volumes the Temporal Position Index is used to distinguish between the multiple volumes acquired in time (phases of a volume) for the same Stack ID. Each frame in the volume has an In-Stack Position Number that is the ordinal number in space of each volume. See Figure C.7.6.16-4c for an example.

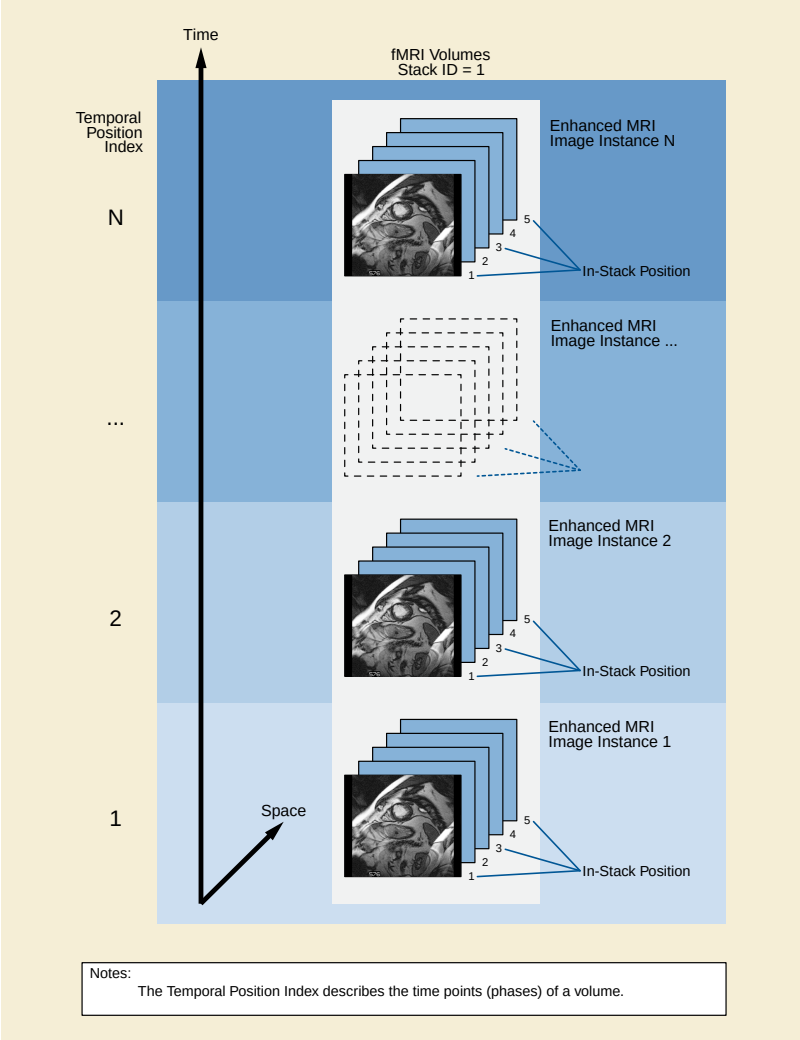


Figure C.7.6.16-4c. Example of Functional MRI volumes

C.7.6.16.2.3 Plane Position (Patient) Macro

Table C.7.6.16-4 specifies the Attributes of the Plane Position (Patient) Functional Group Macro.

Table C.7.6.16-4. Plane Position (Patient) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Position Sequence	(0020,9113)	1	Identifies the position of the plane of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Image Position (Patient)	(0020,0032)	1C	The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the frame, in mm. See Section C.7.6.2.1.1 and Section C.7.6.16.2.3.1 for further explanation. Note In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT_ANGLE the image plane is defined to pass through the data collection center and be normal to the central ray of the diverging X-Ray beam. Required if: • Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Volumetric Properties (0008,9206) of this frame is other than DISTORTED, or • SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or • SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or • SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8"). May be present otherwise.

C.7.6.16.2.3.1 Position and Orientation for SAMPLED Frames

In the case of Volumetric Properties (0008,9206) having a value of SAMPLED, Image Position (0020,0032), Image Orientation (0020,0037) and Slice Thickness (0018,0050) shall represent the volume from which the frame was derived based on the orientation of the sampling performed.

Note

For example in the case of MAX_IP:

The Image Orientation shall be the direction of the ray used for projection of the center of the plane.

The image position shall contain the x, y, and z coordinates of the intersection of the mid-plane of the sampled volume with the ray used to project the upper left hand corner of the frame.

The Slice Thickness shall contain the distance that the ray used for projection of the center of the plane traveled through the volume.

C.7.6.16.2.4 Plane Orientation (Patient) Macro

Table C.7.6.16-5 specifies the Attributes of the Plane Orientation (Patient) Functional Group Macro.

Table C.7.6.16-5. Plane Orientation (Patient) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Orientation Sequence	(0020,9116)	1	Identifies orientation of the plane of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Image Orientation (Patient)	(0020,0037)	1C	The direction cosines of the first row and the first column with respect to the patient. See Section C.7.6.2.1.1 and Section C.7.6.16.2.3.1 for further explanation. Required if: • Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Volumetric Properties (0008,9206) of this frame is other than DISTORTED, or • SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or • SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or • SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8"). May be present otherwise.

C.7.6.16.2.5 Referenced Image Macro

Table C.7.6.16-6 specifies the Attributes of the Referenced Image Functional Group Macro.

Table C.7.6.16-6. Referenced Image Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Image Sequence	(0008,1140)	2	The set of images or other composite SOP Instances used to plan the acquisition, if any, and other significant related images. See Section C.7.6.16.2.5.1 for further explanation. Zero or more Items shall be included in this Sequence.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1C	Describes the purpose for which the reference is made. Only a single Item shall be included in this Sequence. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise. See Section C.7.6.16.2.5.1 for further explanation.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7201 “Referenced Image Purposes of Reference”, or as specified in the IOD invocation of this Functional Group.*

C.7.6.16.2.5.1 Use of Referenced Image Macro

Referenced Image Sequence (0008,1140) shall be used to identify other data objects used to plan the acquisition of this image. Instances referenced for this purpose shall have the same Frame of Reference UID (0020,0052) as this image. For each Item that contains such a reference, the value of Purpose of Reference Code Sequence (0040,A170) shall be (121311, DCM, "Localizer"). Applications can use the Referenced Image Sequence (0008,1140) in combination with data in Plane Position (Patient) and Plane Orientation (Patient) Macros to provide projections of the position of an image with respect to the referenced image.

The Referenced Image Sequence (0008,1140) may also be present when references to other images (or frames within other images) are required for other reasons, as specified by Purpose of Reference Code Sequence (0040,A170).

Note

An Image may contain references to itself (e.g., to other frames within itself).

C.7.6.16.2.6 Derivation Image Macro

Table C.7.6.16-7 specifies the Attributes of the Derivation Image Functional Group Macro.

Table C.7.6.16-7. Derivation Image Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Derivation Image Sequence	(0008,9124)	2	The set of Images or other composite SOP Instances that were used to derive this frame. Zero or more Items shall be included in this Sequence.
>Derivation Description	(0008,2111)	3	A text description of how this frame data was derived. See Section C.12.4.1.1 for further explanation.
>Derivation Code Sequence	(0008,9215)	1C	A coded description of how this frame was derived. See Section C.12.4.1.1 for further explanation. One or more Items shall be included in this Sequence. More than one Item indicates that successive derivation steps have been applied. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7203 “Image Derivation”.*
>Source Image Sequence	(0008,2112)	2	The set of Images or other Composite SOP Instances that were used to derive this frame. Zero or more Items shall be included in this Sequence. See Section C.12.4.1.2 for further explanation.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>>Purpose of Reference Code Sequence	(0040,A170)	1C	Describes the purpose for which the reference is made, that is what role the source image or frame played in the derivation of this image or frame. Only a single Item shall be included in this Sequence. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7202 “Source Image Purposes of Reference”.*

Attribute Name	Tag	Type	Attribute Description
>>Spatial Locations Preserved	(0028,135A)	3	The extent to which the spatial locations of all pixels are preserved during the processing of the source image that resulted in the current image or frame. Enumerated Values: **YES** **NO** **REORIENTED_ONLY** A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees Note 1. This applies not only to images with a known relationship to a 3D space, but also to projection images. For example, a projection radiograph such as a mammogram that is processed by a point image processing operation such as contrast enhancement, or a smoothing or edge enhancing convolution, would have a value of YES for this Attribute. A projection radiograph that had been magnified or warped geometrically would have a value of NO for this Attribute. A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees, such that transformation of pixel locations is possible by comparison of the values of Patient Orientation (0020,0020) would have a value of REORIENTED_ONLY. This Attribute is typically of importance in relating images with Presentation Intent Type (0008,0068) values of FOR PROCESSING and FOR PRESENTATION. 2. When the value of this Attribute is NO, it is not possible to locate on the current image any pixel coordinates that are referenced relative to the source image, such as for example, might be required for rendering CAD findings derived from a referenced FOR PROCESSING image on the current FOR PRESENTATION image.
>>Patient Orientation	(0020,0020)	1C	The Patient Orientation values of the source image. Required if the value of Spatial Locations Preserved (0028,135A) is REORIENTED_ONLY.

C.7.6.16.2.7 Cardiac Synchronization Macro

Table C.7.6.16-8 specifies the Attributes of the Cardiac Synchronization Functional Group Macro.

Table C.7.6.16-8. Cardiac Synchronization Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Cardiac Synchronization Sequence	(0018,9118)	1	Sequence that describes the frame specific cardiac synchronization parameters. Only a single Item shall be included in this Sequence.
>Nominal Percentage of Cardiac Phase	(0020,9241)	1C	The nominal time relative to the preceding R peak divided by the nominal R-R interval multiplied by 100. Required if used as a dimension index, may be present otherwise.
>Nominal Cardiac Trigger Delay Time	(0020,9153)	1	The nominal time in ms from the time of the previous R-peak to the value of Frame Reference DateTime (0018,9151) expressed as a positive value. See Section C.7.6.16.2.7.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Actual Cardiac Trigger Delay Time	(0020,9252)	1C	The actual time in ms from the time of the previous R-peak to the value of Frame Reference DateTime (0018,9151) expressed as a positive value. See Section C.7.6.16.2.7.1 for further explanation. Required if Intervals Acquired (0018,1083) is present and has a value of 1. May be present otherwise.
>Nominal Cardiac Trigger Time Prior to R-peak	(0020,9154)	3	The nominal time in ms from the time of the next R-peak to the value of Frame Reference DateTime (0018,9151) expressed as a negative value. See Section C.7.6.16.2.7.1 for further explanation.
>Actual Cardiac Trigger Time Prior to R-peak	(0020,9155)	3	The actual time in ms from the time of the next R-peak to the value of Frame Reference DateTime (0018,9151) expressed as a negative value. See Section C.7.6.16.2.7.1 for further explanation.
>Intervals Acquired	(0018,1083)	3	Number of R-R intervals acquired.
>Intervals Rejected	(0018,1084)	3	Number of R-R intervals rejected.
>Heart Rate	(0018,1088)	3	Average number of heart beats per minute for the collection period for this frame. This shall include all accepted beats as well as rejected beats. Note During prolonged acquisitions the average heart rate may differ from the reciprocal of the nominal R-R interval.
>R-R Interval Time Nominal	(0020,9251)	1C	Nominal R-peak - R-peak interval time in ms for the cardiac cycle used for the acquisition of this frame. See Section C.7.6.16.2.7.1 for further explanation. Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE or REALTIME. May be present otherwise.
>Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in ms.
>High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in ms.

C.7.6.16.2.7.1 Relationship of Cardiac Timing Attributes

The Nominal Cardiac Trigger Delay Time (0020,9153) is the nominal trigger delay time in ms from the previous R-peak to the value of Frame Reference DateTime (0018,9151). When frames are acquired with prospective gating, that is, the data acquisition actually begins in response to a timed delay from the R-peak, it may be that Actual Cardiac Trigger Delay Time (0020,9252) and the Nominal Cardiac Trigger Delay Time (0020,9153) have the same value.

However, when frames are the result of retrospective gating, that is, the data is continuously acquired and then later compared with a simultaneously acquired ECG waveform and fitted into time slots corresponding to nominal phases of the cardiac cycle, then Nominal Cardiac Trigger Delay Time (0020,9153) and the Actual Cardiac Trigger Delay Time (0020,9252) may have different values. When applicable the same is valid for the Nominal Cardiac Trigger Time Prior to R-peak (0020,9154) and the Actual Cardiac Trigger Time Prior to R-peak (0020,9155) Attributes.

When multiple cardiac cycles are averaged together, then the Low R-R Value (0018,1081), and High R-R Value (0018,1082) are an average of the cardiac cycles that were accepted in the frame.

Note

For cardiac gated acquisitions the choice of the Frame Reference DateTime (0018,9151) is influenced by the Nominal Cardiac Trigger Delay Time (0020,9153). For respiratory gated acquisitions the choice of the Frame Reference DateTime (0018,9151) is influenced by the Nominal Respiratory Trigger Delay Time (0020,9255).

Figure C.7.6.16-5a depicts the usage.

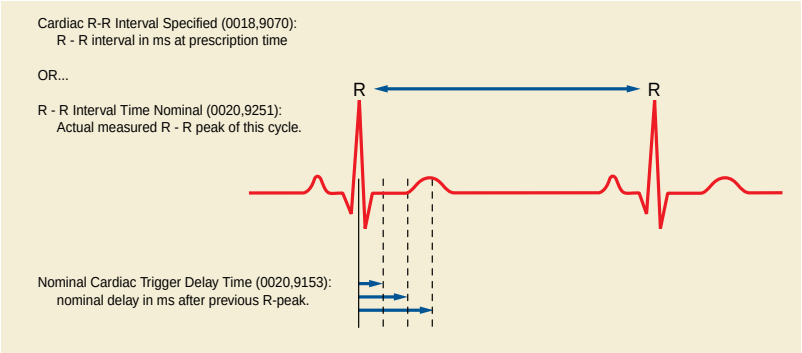


Figure C.7.6.16-5a. Cardiac Timing Tags

Nominal Cardiac Trigger Time Prior to R-peak (0020,9154) and the Actual Cardiac Trigger Time Prior to R-peak (0020,9155) Attributes can be used to store a time of the next R-peak to the value of Frame Reference DateTime (0018,9151) expressed as a negative value. In this case the Actual Cardiac Trigger Delay Time (0020,9252), when present, and the Nominal Cardiac Trigger Delay Time (0020,9153) shall contain a value calculated based on the R-R interval applicable for this frame. See Figure C.7.6.16-5b.

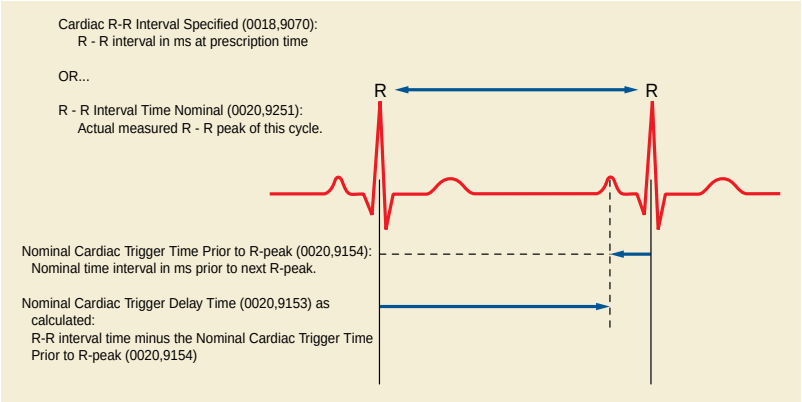


Figure C.7.6.16-5b. Cardiac Timing Relationships

Note

Specifying the time interval prior to the R-peak is relevant for applications such as capturing P- and Q-wave related morphology.

C.7.6.16.2.8 Frame Anatomy Macro

Table C.7.6.16-9 specifies the Attributes of the Frame Anatomy Functional Group Macro.

Table C.7.6.16-9. Frame Anatomy Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Anatomy Sequence	(0020,9071)	1	Identifies anatomic characteristics of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Frame Laterality	(0020,9072)	1	Laterality of (possibly paired) body parts (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right Note This Attribute is mandatory, in order to ensure that frames maybe positioned correctly relative to one another for display. Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present.
~~>*Include* Table 10-5 “General Anatomy Mandatory Macro Attributes”~~			~~*Anatomic Region Sequence D*CID 4030 “CT, MR and PET Anatomy Imaged”.~~ ~~*Anatomic Region Modifier Sequence (0008,2220) D*CID 2 “Anatomic Modifier”.~~ ~~*Primary Anatomic Structure Modifier Sequence (0008,2230) D*CID 2 “Anatomic Modifier”.~~
>*Include* Table 10-5 “General Anatomy Mandatory Macro Attributes”			*Anatomic Region Sequence D*CID 4030 “CT, MR and PET Anatomy Imaged”. *Anatomic Region Modifier Sequence (0008,2220) D*CID 2 “Anatomic Modifier”. *Primary Anatomic Structure Modifier Sequence (0008,2230) D*CID 2 “Anatomic Modifier”.

C.7.6.16.2.9 Pixel Value Transformation Macro

Table C.7.6.16-10 specifies the Attributes of the Pixel Value Transformation Functional Group Macro.

Note

This Macro is equivalent with the Modality LUT transformation in non Multi-frame IODs.

Table C.7.6.16-10. Pixel Value Transformation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Value Transformation Sequence	(0028,9145)	1	Contains the Attributes involved in the transformation of stored pixel values. Only a single Item shall be included in this Sequence.
>Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b.
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052).

Attribute Name	Tag	Type	Attribute Description
>Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. Enumerated Values: **US** Unspecified if Modality (0008,0060) equals MR or PT.

Note

Window Center (0028,1050) and Window Width (0028,1051) are applied after Rescale Slope (0028,1053) and Rescale Intercept (0028,1054) have been applied to Stored Pixel Values, see Section C.11.2.1.2.

C.7.6.16.2.9b Identity Pixel Value Transformation Macro

Table C.7.6.16-10b specifies the Attributes of the Identity Pixel Value Transformation Functional Group Macro.

Note

This Macro constrains the Modality LUT Transformation step in the grayscale rendering pipeline to be an identity transformation.

Table C.7.6.16-10b. Identity Pixel Value Transformation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Value Transformation Sequence	(0028,9145)	1	Contains the Attributes involved in the transformation of stored pixel values. Only a single Item shall be included in this Sequence.
>Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b. Enumerated Values: **0**
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052). Enumerated Values: **1**
>Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. Enumerated Values: **US** Unspecified

C.7.6.16.2.10 Frame VOI LUT Macro

Table C.7.6.16-11 specifies the Attributes of the Frame VOI LUT Functional Group Macro.

Table C.7.6.16-11. Frame VOI LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame VOI LUT Sequence	(0028,9132)	1	Window Center and Width values applied to the frame. Only a single Item is permitted in this Sequence.
>Window Center	(0028,1050)	1	Window Center for display. See Section C.11.2.1.2 for further explanation.
>Window Width	(0028,1051)	1	Window Width for display. See Section C.11.2.1.2 for further explanation.
>Window Center & Width Explanation	(0028,1055)	3	Explanation of the Window Center and Width. Defined Terms for CT: **BRAIN** **SOFT_TISSUE** **LUNG** **BONE**
>VOI LUT Function	(0028,1056)	3	Describes a VOI LUT function to apply to the values of Window Center (0028,1050) and Window Width (0028,1051). See Section C.11.2.1.3 for further explanation. Defined Terms: **LINEAR** **LINEAR_EXACT** **SIGMOID** When this Attribute is not present, the interpretation of the values of Window Center (0028,1050) and Window Width (0028,1051) is linear as in Section C.11.2.1.2.

C.7.6.16.2.10b Frame VOI LUT With LUT Macro

Table C.7.6.16-11b specifies the Attributes of the Frame VOI LUT With LUT Functional Group Macro. This Macro contains one or more sets of linear or sigmoid window values and/or one or more sets of lookup tables.

Table C.7.6.16-11b. Frame VOI LUT with LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame VOI LUT Sequence	(0028,9132)	1	The VOI LUT transformations applied to this frame. Only a single Item is permitted in this Sequence.
>Include Table C.11-2b "VOI LUT Macro Attributes"			

C.7.6.16.2.11 Real World Value Mapping Macro

Table C.7.6.16-12 specifies the Attributes of the Real World Value Mapping Functional Group Macro.

Table C.7.6.16-12. Real World Value Mapping Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Real World Value Mapping Sequence	(0040,9096)	1	The mapping of stored values to associated Real World values. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.7.6.16-12b "Real World Value Mapping Item Macro Attributes"			*Measurement Units Code Sequence DCID 82 "Units of Measurement", or as specified in the Macro invocation.*

Table C.7.6.16-12b. Real World Value Mapping Item Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Real World Value First Value Mapped	(0040,9216)	1C	Specifies the first stored value mapped for the Real Word Value Intercept (0040,9224) and Real World Value Slope (0040,9225) or Real World Value LUT (0040,9212) of this Item. Required if Pixel Data (7FE0,0010) or Real World Value LUT Data (0040,9212) is present or Double Float Real World Value First Value Mapped (0040,9214) is absent. Note This Attribute may be used even when Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are used instead of Pixel Data (7FE0,0010) if an integer of the size of this Attribute is sufficient to define the range. See Section C.7.6.16.2.11.1 for further explanation.
Real World Value Last Value Mapped	(0040,9211)	1C	Specifies the last stored value mapped for the Real Word Value Intercept (0040,9224) and Real World Value Slope (0040,9225) or Real World Value LUT (0040,9212) of this Item. Required if Pixel Data (7FE0,0010) or Real World Value LUT Data (0040,9212) is present or Double Float Real World Value Last Value Mapped (0040,9213) is absent. Note This Attribute may be used even when Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are used instead of Pixel Data (7FE0,0010) if an integer of the size of this Attribute is sufficient to define the range. See Section C.7.6.16.2.11.1 for further explanation.
Double Float Real World Value First Value Mapped	(0040,9214)	1C	Specifies the first stored value mapped for the Real Word Value Intercept (0040,9224) and Real World Value Slope (0040,9225) of this Item. Required if Real World Value First Value Mapped (0040,9216) is absent. Note The same Attribute with a double float precision value is used whether or not Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present, an integer value is not sufficient.
Double Float Real World Value Last Value Mapped	(0040,9213)	1C	Specifies the last stored value mapped for the Real Word Value Intercept (0040,9224) and Real World Value Slope (0040,9225) of this Item. Required if Real World Value Last Value Mapped (0040,9211) is absent. Note The same Attribute with a double float precision value is used whether or not Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present, an integer value is not sufficient.

Attribute Name	Tag	Type	Attribute Description
Real World Value Intercept	(0040,9224)	1C	The Intercept value in relationship between stored values (SV) and the Real World values. See Section C.7.6.16.2.11.1.2 for further explanation. Required if Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present or Real World Value LUT Data (0040,9212) is not present.
Real World Value Slope	(0040,9225)	1C	The Slope value in relationship between stored values (SV) and the real world values. See Section C.7.6.16.2.11.1.2 for further explanation. Required if Float Pixel Data (7FE0,0008) or Double Float Pixel Data (7FE0,0009) are present or Real World Value LUT Data (0040,9212) is not present.
Real World Value LUT Data	(0040,9212)	1C	LUT Data in this Sequence. Required if Real World Value Intercept (0040,9224) is not present.
LUT Explanation	(0028,3003)	1	Free form text explanation of the meaning of the transformation in this Item.
LUT Label	(0040,9210)	1	Label that is used to identify the transformation of this Item.
Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement. Only a single Item shall be included in this Sequence. See Section C.7.6.16.2.11.1 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7181 "Abstract Multi-dimensional Image Model Component Units", or as specified in the Macro invocation.*
Quantity Definition Sequence	(0040,9220)	3	A list of name-value pairs that describe the characteristics of the quantity represented by the Real World Value. One or more Items are permitted in this Sequence.
>Include Table 10.2.1-1 "Content Item with Modifiers Macro Attributes"			*BTID 15400 "Real-World Quantity Definition".* Other TIDs may be defined by the IOD or application that uses this Macro.

C.7.6.16.2.11.1 Real World Value Representation

C.7.6.16.2.11.1.1 Real World Value Mapping Sequence

The Items in the Real World Value Mapping Sequence (0040,9096) may be used to translate stored values into real world values when there is such a relationship. The Real World Value Mapping Sequence (0040,9096) is independent of the Modality LUT (or Pixel Value Transformation Macro), as illustrated in Figure C.7.6.16-6.

Each Item specifies the range of stored values as well as the associated mapping function. Each Item can specify either a linear mapping, using Real World Value Slope (0040,9225) and Real World Value Intercept (0040,9224), or a non-linear mapping using Real World Value LUT Data (0040,9212). More than one Real World Value Mapping Item is allowed.

The range of stored pixel values specified by different Real Value World Mapping Sequence (0040,9096) Items can overlap (as illustrated in the example in Figure C.7.6.16-7).

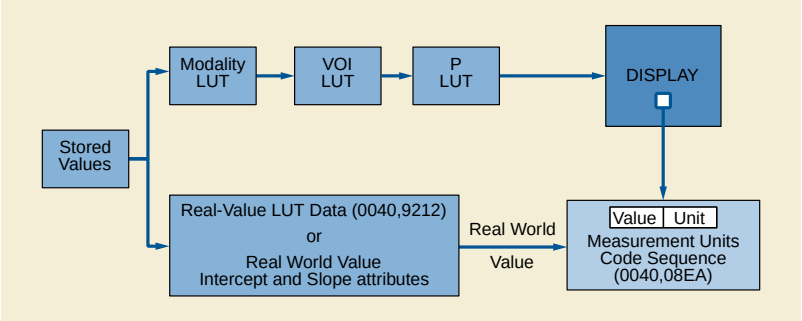


Figure C.7.6.16-6. The Real World Value LUT and the Image Viewing Pipeline

Note

For example, MR images may contain data that is not only the result of the physical/chemical properties of the scanned anatomy, but may also contain information that is representing real world values, such as, temperature [in degrees C], flow [in l/min], speed [in m/sec], relative activity [in %], relative contrast enhancement [in %], diffusion [in sec/mm^2], etc.

In some cases the conversion from Stored Values to Real World Values can be linear (through "slope" and "intercept") or non-linear (through look-up tables).

Both transformation methods can be applied to one range of stored values. Overlapped ranges might be used for different representations such as log versus linear scales or for different representations in units such as cm/sec versus mm/sec. Alternative methods can be identified by the labels assigned to the transformations.

C.7.6.16.2.11.1.2 Real World Values Mapping Sequence Attributes

The Real World Value First Value Mapped (0040,9216) and Real World Value Last Value Mapped (0040,9211) Attributes describe the range of stored pixel values that are mapped by the Sequence Item. Stored pixel values less than the first value mapped, or greater than the last value mapped have no real value attached.

When the Real World Value Intercept (0040,9224) and Real World Value Slope (0040,9225) Attributes are supplied, the stored value (SV) is converted to a real world value (RV) using the equation:

RV = (Real World Value Slope) * SV + Real World Value Intercept

When the Real World Value LUT Data (0040,9212) Attribute is supplied, Real World Values are obtained via a lookup operation. The stored pixel value of the first value mapped is mapped to the first entry in the LUT Data. Subsequent stored pixel values are mapped to the subsequent entries in the LUT Data up to a stored pixel value equal to the last value mapped.

The number of entries in the LUT data is given by:

Number of entries = Real World Value Last Value Mapped- Real World Value First Value Mapped + 1

Note

If the stored pixel values that are encoded as floating point rather than integer values, only the equation and not the lookup operation is defined.

The Value Representation of Real World Value First Value Mapped (0040,9216) and Real World Value Last Value Mapped (0040,9211) (US or SS) is determined by the value of Pixel Representation (0028,0103) in the case of integer pixel data, or is SS in the case of floating point pixel data if these Attributes are present.

Note

In practice, integer values may well be sufficient to define an input range that exceeds the actual stored floating point pixel value range. The reason to permit floating point alternatives to an integer range is that ~~sometimnes~~sometimes the stored floating point values may be very large and exceed what can be specified as an integer value.

The physical units for the real world values obtained from the Sequence Item are given by the Measurement Units Code Sequence (0040,08EA).

The quantity that the real world values represent may be described by the Quantity Definition Sequence (0040,9220), which consists of a list of name-value pairs, in which the coded concept name specifies what aspect of the physical quantity is being described.

Note

1. For example, Relative Regional Blood Flow may be described by units and quantity as follows:

   - Measurement Units Code Sequence (0040,08EA) = ({ratio}, UCUM, "ratio")
   - Quantity Definition Sequence (0040,9220):
     - (246205007, SCT, "Quantity") = (126397, DCM, "Relative Regional Blood Flow")

   Additional information about how the relative blood flow was derived, e.g., the reference region used, can also be encoded as name-value pairs in the Quantity Definition Sequence (0040,9220). See the example in Annex EEEE “Encoding Diffusion Model Parameters for Parametric Maps and ROI Measurements (Informative)” in PS3.17.

2. For example, the Apparent Diffusion Coefficient (ADC) may be described by units and quantity as follows:

   - Measurement Units Code Sequence (0040,08EA) = (mm2/s, UCUM, "mm2/s")
   - Quantity Definition Sequence (0040,9220):
     - (246205007, SCT, "Quantity") = (113041, DCM, "Apparent Diffusion Coefficient")

   Additional information about how the ADC was derived, e.g., the model used, method of fitting and acquisition b-values used, can also be encoded as name-value pairs in the Quantity Definition Sequence (0040,9220). Other diffusion models and quantities are also defined. See the example in Annex EEEE “Encoding Diffusion Model Parameters for Parametric Maps and ROI Measurements (Informative)” in PS3.17.

The Quantity Definition Sequence (0040,9220) describes only the stored pixel values that are mapped using the Real World Values Mapping, and does not describe derived values from multiple pixels to which the Real World Values Mapping applies.

Note

I.e., the mapping is a "point" operation, and as a consequence various modifiers that might be applied to a group of pixels, such as in an ROI, should not be used. E.g., an ROI encoded in a Structured Report using TID 1419 "ROI Measurements" might be the mean or maximum value (e.g., SUVbw mean or SUVbw max), and be encoded with (121401, DCM, "Derivation") = (373098007, SCT, "Mean") or (56851009, SCT, "Maximum"), respectively. These would not be appropriate to use within Quantity Definition Sequence (0040,9220), unless the individual pixel values were themselves derived in such a manner, e.g., when multiple images are averaged together. Thus the Content Items used in an SR to describe an ROI might be a superset of the name-value pairs used in Quantity Definition Sequence (0040,9220).

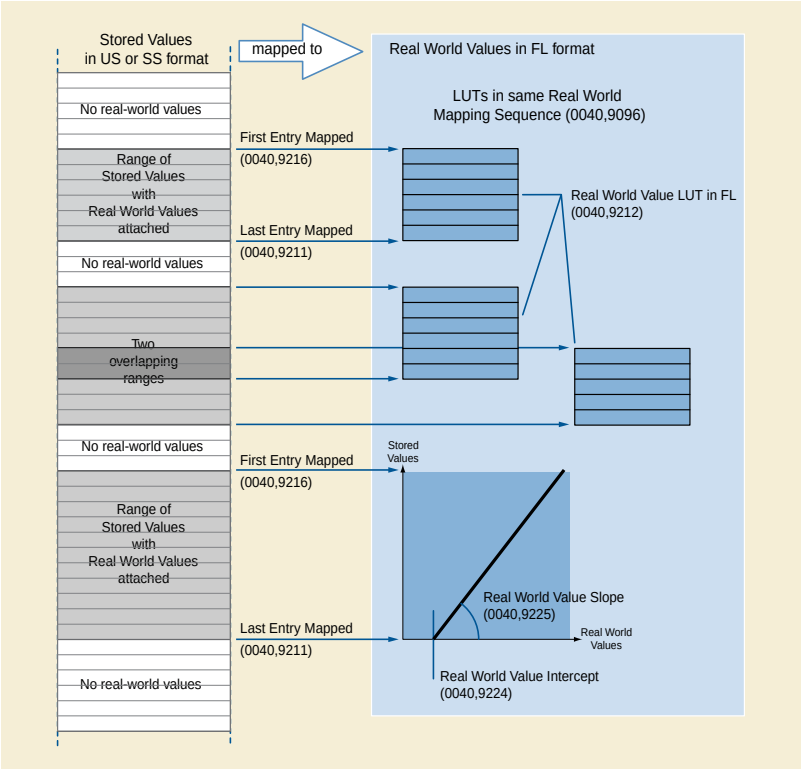


Figure C.7.6.16-7. Example of mapping stored values to real world values

C.7.6.16.2.12 Contrast/Bolus Usage Macro

Table C.7.16-13 specifies the Attributes of the Contrast/Bolus Usage Macro.

Table C.7.16-13. Contrast/Bolus Usage Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Contrast/Bolus Usage Sequence	(0018,9341)	1	Contains the Attributes describing the use of contrast for this frame. One or more Items shall be included in this Sequence.
>Contrast/Bolus Agent Number	(0018,9337)	1	Identifying number corresponding to the agent described in the Enhanced Contrast/Bolus Module.
>Contrast/Bolus Agent Administered	(0018,9342)	1	The administration of the selected agent had begun by the time this frame was acquired. Enumerated Values: **YES** **NO**
>Contrast/Bolus Agent Detected	(0018,9343)	2	The selected agent was detected in the frame. Enumerated Values: **YES** **NO** May only be zero length if the acquisition device is not capable of detecting the presence of this contrast agent in the frame.

Attribute Name	Tag	Type	Attribute Description
>Contrast/Bolus Agent Phase	(0018,9344)	2C	Nominal phase of intravenous contrast administration. Defined Terms: **PRE_CONTRAST** **POST_CONTRAST** **IMMEDIATE** **DYNAMIC** **STEADY_STATE** **DELAYED** **ARTERIAL** **CAPILLARY** **VENOUS** **PORTAL_VENOUS** Required if Contrast/Bolus Administration Route Sequence (0018,0014) for the Contrast/Bolus Agent Number (0018,9337) defined in the Contrast/Bolus Agent Sequence (0018,0012) is (47625008, SCT, "Intravenous route") or (47625008, SCT, "Intravenous route"); may be present otherwise.

C.7.6.16.2.13 Pixel Intensity Relationship LUT Macro

Table C.7.6.16-14 specifies the Attributes of the Pixel Intensity Relationship LUT Functional Group Macro.

Table C.7.6.16-14. Pixel Intensity Relationship LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Intensity Relationship LUT Sequence	(0028,9422)	1	Defines a Sequence of Pixel Intensity Relationship LUTs. One or more Items shall be included in this Sequence. If Pixel Intensity Relationship (0028,1040) value equals LOG, exactly one Item with LUT Function (0028,9474) value TO_LINEAR LUT shall be present; other Items with other values of LUT Function (0028,9474) may be present.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.1.1 and Section C.7.6.16.2.13.1 for further explanation.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
>LUT Function	(0028,9474)	1	The transformation function this LUT applies to the stored pixel values. Defined Terms: **TO_LOG** **TO_LINEAR**

C.7.6.16.2.13.1 Pixel Intensity Relationship LUT

The purpose of this Pixel Intensity Relationship LUT Sequence is to provide information to recalculate the pixel values proportional to the X-Ray beam intensity from the stored pixel values. It is intended to be used by any application that needs transformed pixel values (e.g., scaled back to acquired pixel values) pixel values for further processing and not as replacement of the Modality LUT in the display pipeline, see Figure C.7.6.16-7a.

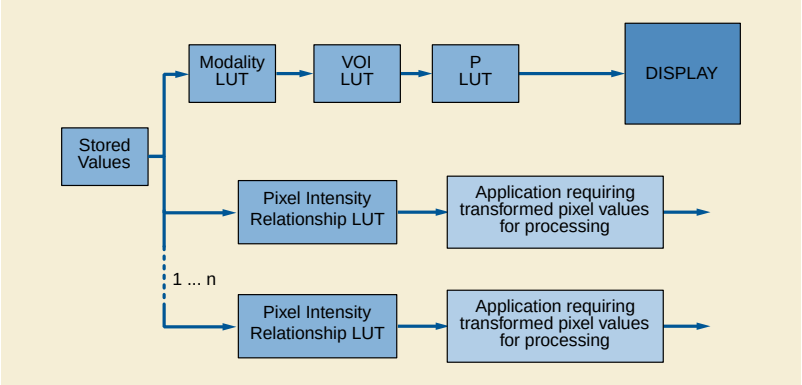


Figure C.7.6.16-7a. Purpose of Pixel Intensity Relationship LUT

C.7.6.16.2.13.2 Pixel Intensity Relationship LUT Data Attribute

The number of bits in LUT Data (0028,3006) may be different from the value of Bit Stored (0028,0101) Attribute.

C.7.6.16.2.14 Frame Pixel Shift Macro

Table C.7.6.16-15 specifies the Attributes of the Frame Pixel Shift Functional Group Macro.

Table C.7.6.16-15. Frame Pixel Shift Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Pixel Shift Sequence	(0028,9415)	1	Sequence containing the pixel shift for a number of masks for this frame. One or more Items shall be included in this Sequence.
>Subtraction Item ID	(0028,9416)	1	Identifier of the Subtraction Item in the Mask Subtraction Sequence (0028,6100) to which this pixel shift is associated. See Section C.7.6.16.2.14.1.
>Mask Sub-pixel Shift	(0028,6114)	1	A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from this contrast frame. Note If no pixel shift has to be applied a pair of zero values should be specified. See Section C.7.6.10.1.2.

C.7.6.16.2.14.1 Subtraction Item ID Description

Subtraction Item ID (0028,9416) specifies the ID of a subtraction operation to which the Mask Sub-pixel Shift (0028,6114) is associated. The Subtraction Item ID is also present in the Mask Subtraction Sequence (0028,6100) to allow this association.

When used as per-frame Macro, the Subtraction Item ID (0028,9416) allows to specify different values of Mask Sub-pixel Shift (0028,6114) individually frame by frame, and relate them to a single Item of the Mask Subtraction Sequence (0028,6100).

Note

There is no restriction in the number of Subtraction Item ID's associated to each contrast frame. The same contrast frame may be present in several Items of the Mask Subtraction Sequence, each Item having a different value of Subtraction Item ID.

When used as shared Macro, the Subtraction Item ID (0028,9416) allows to specify one or more values of Mask Sub-pixel Shift that will be applied to all the frames of the Multi-frame image.

Note

Example of usage of Subtraction Item ID in a per-frame Macro, see Figure C.7.6.16-8:

In this example of Multi-frame Image with 3 frames, one Mask Frame (i.e., Frame 1) is applied to the next two frames of the Multi-frame image (i.e., Frames 2 and 3). Therefore, there is only one Item in the Mask Subtraction Sequence, containing its own Subtraction Item ID value (i.e., 100). The Frame Pixel Shift Macro allows to define a Mask Sub-Pixel Shift different for each contrast frame.

First Frame Subtracted: Subtraction of Frame 1 (Mask) to Frame 2, with Sub-Pixel Shift 1.3\2.4

Second Frame Subtracted: Subtraction of Frame 1 (Mask) to Frame 3, with Sub-Pixel Shift 1.9\3.0

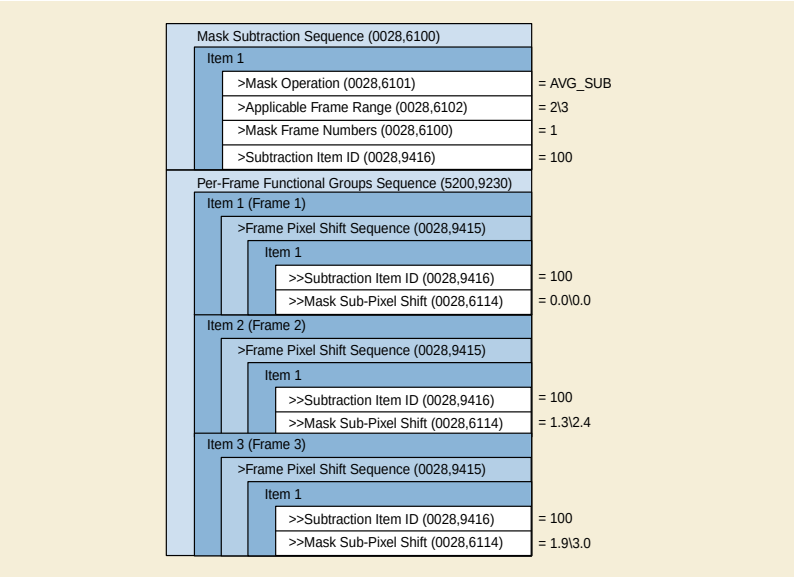


Figure C.7.6.16-8. Example of usage of Subtraction Item ID in a per-frame Macro

C.7.6.16.2.15 Patient Orientation in Frame Macro

Table C.7.6.16-16 specifies the Attributes of the Patient Orientation in Frame Functional Group Macro.

Table C.7.6.16-16. Patient Orientation in Frame Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Orientation in Frame Sequence	(0020,9450)	1	Sequence containing the row and column directions for this frame in the patient. Only a single Item shall be included in this Sequence.
>Patient Orientation	(0020,0020)	1	Patient direction of the rows and columns of this frame. See Section C.7.6.1.1.1 for further explanation.

C.7.6.16.2.16 Frame Display Shutter

Table C.7.6.16-17 specifies the Attributes of the Frame Display Shutter Functional Group Macro.

Table C.7.6.16-17. Frame Display Shutter Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Display Shutter Sequence	(0018,9472)	1	Sequence containing the display shutter parameters for this frame. Only a single Item shall be included in this Sequence.
>Include Table C.7-17a "Display Shutter Macro Attributes"			

C.7.6.16.2.17 Respiratory Synchronization Macro

Table C.7.6.16-18 specifies the Attributes of the Respiratory Synchronization Functional Group Macro.

Table C.7.6.16-18. Respiratory Synchronization Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Respiratory Synchronization Sequence	(0020,9253)	1	Sequence that describes the frame specific respiratory synchronization parameters. Only a single Item shall be included in this Sequence.
>Respiratory Interval Time	(0020,9254)	1C	Measured interval time in ms from maximum respiration peak to the next peak for the respiratory cycle in which this frame occurs. See Section C.7.6.16.2.17.1 for further explanation. Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE or REALTIME and Respiratory Trigger Type (0020,9250) is absent or has a value of TIME or BOTH.
>Nominal Percentage of Respiratory Phase	(0020,9245)	1C	The nominal time relative to the preceding respiratory inspiration maximum divided by the nominal respiratory interval multiplied by 100. Required if used as a dimension index, may be present otherwise.
>Nominal Respiratory Trigger Delay Time	(0020,9255)	1	The nominal time in ms from the beginning of the respiratory interval to the value of Frame Reference DateTime (0018,9151). See Section C.7.6.16.2.17.1 for further explanation.
>Actual Respiratory Trigger Delay Time	(0020,9257)	1C	The actual time in ms from the beginning of the respiratory interval to the value of Frame Reference DateTime (0018,9151). See Section C.7.6.16.2.17.1 for further explanation. Required if Respiratory Trigger Type (0020,9250) is TIME or BOTH.
>Starting Respiratory Amplitude	(0020,9246)	1C	Nominal amplitude of the respiratory signal at which the acquisition of data for this frame begins, in percent of the nominal maximum value (which represents maximum inspiration). Required if Respiratory Trigger Type (0020,9250) is AMPLITUDE or BOTH.
>Starting Respiratory Phase	(0020,9247)	1C	The phase of respiration at which the Starting Respiratory Amplitude (0020,9246) was measured. Enumerated Values: **INSPIRATION** **MAXIMUM** **EXPIRATION** **MINIMUM** Required if Starting Respiratory Amplitude (0020,9246) is present.

Attribute Name	Tag	Type	Attribute Description
>Ending Respiratory Amplitude	(0020,9248)	1C	Nominal amplitude of the respiratory signal at which the acquisition of data for this frame ends, in percent of the nominal maximum value (which represents maximum inspiration). Required if Respiratory Trigger Type (0020,9250) is AMPLITUDE or BOTH.
>Ending Respiratory Phase	(0020,9249)	1C	The phase of respiration at which the Ending Respiratory Amplitude (0020,9248) was measured. Enumerated Values: **INSPIRATION** **MAXIMUM** **EXPIRATION** **MINIMUM** Required if Ending Respiratory Amplitude (0020,9248) is present.

C.7.6.16.2.17.1 Relationship of Respiratory Timing Attributes

For time based respiratory gating, the Nominal Respiratory Trigger Delay Time (0020,9255) is the prescribed trigger delay time in ms from the previous Respiratory-peak to the value of Frame Reference DateTime (0018,9151). When frames are acquired with prospective gating, that is, the data acquisition actually begins in response to a timed delay from the Respiratory trigger, it may be that Actual Respiratory Trigger Delay Time (0020,9257) and the Nominal Respiratory Trigger Delay Time (0020,9255) have the same value.

However, when frames are the result of retrospective gating, that is, the data is continuously acquired and then later compared with a simultaneously acquired respiratory waveform and fitted into bins corresponding to nominal phases of the respiratory cycle, then Nominal Respiratory Trigger Delay Time (0020,9255) and the Actual Respiratory Trigger Delay Time (0020,9257) may have different values.

Figure C.7.6.16-9a and Figure C.7.6.16-9b depict the usage.

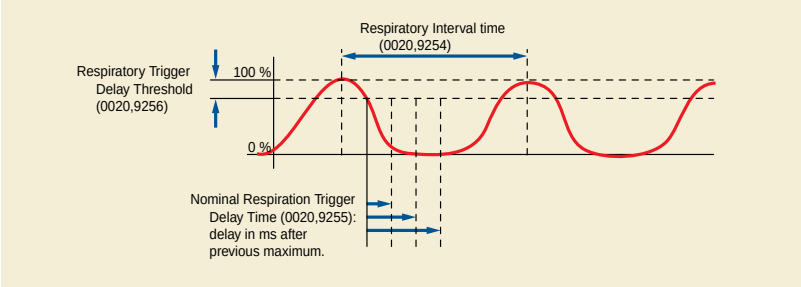


Figure C.7.6.16-9a. Respiratory Timing Tags

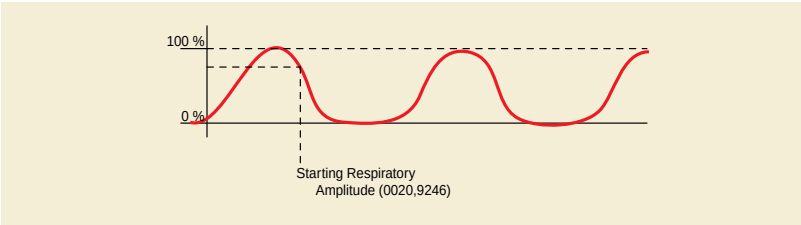


Figure C.7.6.16-9b. Relationship of Respiratory Amplitude Attributes

C.7.6.16.2.18 Irradiation Event Identification Macro

Table C.7.6.16-19 specifies the Attributes containing the Irradiation Event Identification Functional Group Macro.

Table C.7.6.16-19. Irradiation Event Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Irradiation Event Identification Sequence	(0018,9477)	1	Sequence containing the Irradiation Event Identification for this frame. Only a single Item shall be included in this Sequence.
>Irradiation Event UID	(0008,3010)	1	Unique identification of the irradiation event(s) associated with the acquisition of this image.

C.7.6.16.2.19 Radiopharmaceutical Usage Macro

Table C.7.6.16.2-20 specifies the Attributes of the Radiopharmaceutical Usage Functional Group Macro.

Table C.7.6.16.2-20. Radiopharmaceutical Usage Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Radiopharmaceutical Usage Sequence	(0018,9737)	1	One or more Items shall be included in this Sequence.
>Radiopharmaceutical Agent Number	(0018,9729)	1	Identifying number corresponding to the radiopharmaceutical described in the Enhanced PET Isotope Module.

C.7.6.16.2.20 Patient Physiological State Macro

Table C.7.6.16.2-21 specifies the Attributes of the Patient Physiological State Functional Group Macro, which describes the physiological state of the patient.

Table C.7.6.16.2-21. Patient Physiological State Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Physiological State Sequence	(0018,9771)	1	Contains the Attributes describing the physiological state of the patient for this frame. Only a single Item shall be included in this Sequence.
>Patient Physiological State Code Sequence	(0018,9772)	1	The physiological state of the patient. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 3101 “Cardiac Procedural State Values”.*

C.7.6.16.2.21 Plane Position (Volume) Macro

Table C.7.6.16.2.21-1 specifies the Attributes of the Plane Position (Volume) Functional Group Macro.

Table C.7.6.16.2.21-1. Plane Position (Volume) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Position (Volume) Sequence	(0020,930E)	1	Identifies the position of the plane of this frame. Only a single Item shall be included in this Sequence.
>Image Position (Volume)	(0020,9301)	1	The x, y, and z coordinates, in mm, of the upper left hand corner (center of the first voxel transmitted) of the plane in the Volume Frame of Reference.

C.7.6.16.2.22 Plane Orientation (Volume) Macro

Table C.7.6.16.2.22-1 specifies the Attributes of the Plane Orientation (Volume) Functional Group Macro.

Table C.7.6.16.2.22-1. Plane Orientation (Volume) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Orientation (Volume) Sequence	(0020,930F)	1	Identifies orientation of the plane of this frame. Only a single Item shall be included in this Sequence.
>Image Orientation (Volume)	(0020,9302)	1	The direction cosines of the first row and the first column of the frame with respect to the Volume Frame of Reference.

C.7.6.16.2.23 Temporal Position Macro

Table C.7.6.16.2.23-1 specifies the Attributes of the Temporal Position Functional Group Macro.

Table C.7.6.16.2.23-1. Temporal Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Temporal Position Sequence	(0020,9310)	1	Identifies the temporal position of the plane of this frame. Only a single Item shall be included in this Sequence.
>Temporal Position Time Offset	(0020,930D)	1	Time offset of the frame in the set of frames with different temporal positions, in seconds.

C.7.6.16.2.24 Image Data Type Macro

Table C.7.6.16.2.24-1 specifies the Attributes of the Image Data Type Functional Group Macro.

Table C.7.6.16.2.24-1. Image Data Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Image Data Type Sequence	(0018,9807)	1	Identifies the data type characteristics of this frame. Only a single Item shall be included in this Sequence.
>Data Type	(0018,9808)	1	Identification of the data type of a frame. See Section C.7.6.16.2.24.1 for Defined Terms and further explanation.
>Aliased Data Type	(0018,980B)	1	Indicates whether this data type is "aliased". Enumerated Values: **YES** data are aliased values **NO** data are not aliased values See Section C.7.6.16.2.24.2 for further explanation.
>Zero Velocity Pixel Value	(0018,9810)	1C	Data value at which velocity is zero. See Section C.7.6.16.2.24.3 for further information. Required if Data Type (0018,9808) is TISSUE_VELOCITY, FLOW_VELOCITY or DIRECTION_POWER. May be present otherwise.

C.7.6.16.2.24.1 Data Type

Data Type (0018,9808) indicates the data type of an image frame. Table C.7.6.16.2.24.1-1 lists Defined Terms for this value.

Table C.7.6.16.2.24.1-1. Data Type Defined Terms

Defined Term Name	Defined Term Description
TISSUE_INTENSITY	Tissue intensity typically displayed as grayscale (e.g., B-mode)

Defined Term Name	Defined Term Description
TISSUE_VELOCITY	Velocity (Doppler shifts) of tissue
FLOW_VELOCITY	Velocity (Doppler shifts) of blood flow
FLOW_POWER	Power contained in the Doppler signal
DIRECTION_POWER	Directional power contained in the Doppler signal
FLOW_VARIANCE	Statistical variance of blood velocity relative to mean
ELASTICITY	Scalar value related to the elastic properties of the tissue
PERFUSION	Scalar value related to the volume of blood perfusing into tissue
SOUND_SPEED	Speed of sound in tissue
ATTENUATION	Reduction in strength of ultrasound signal as the wave traverses through the medium

C.7.6.16.2.24.2 Aliased Data Type

Some data types require special treatment when interpolating data values whose type is "aliased", such as FLOW_VELOCITY when derived from discrete data samples as is done for PW Doppler or sampled CW Doppler. Values of these types are "cyclical" in that the maximum value should be considered adjacent to the minimum value in any interpolation algorithm. Aliased Data Type (0018,980B) indicates whether modular arithmetic is necessary for the associated data type.

Note

For example, when Data Type (0018,9808) is FLOW_VELOCITY, Aliased Data Type (0018,980B) should be set to YES indicating that an interpolation algorithm should support aliased data. When several FLOW_VELOCITY values near the maximum or minimum are interpolated, this algorithm should produce a value near the maximum or minimum. It would be incorrect to use an interpolation algorithm such as the arithmetic mean, which would erroneously produce a result near the mid-point of the range.

C.7.6.16.2.24.3 Zero Velocity Pixel Value

Certain data types represent velocity that is directional by nature. For these data types, there shall be one particular pixel data value that corresponds to zero velocity. Zero Velocity Pixel Value (0018,9810) indicates the pixel data value corresponding to zero velocity.

The VR of Zero Velocity Pixel Value (0018,9810) corresponds to the value of Pixel Representation (0028,0103): If Pixel Representation (0028,0103) is 0000H (unsigned integer), the VR of Zero Velocity Pixel Value (0018,9810) shall be US; otherwise the VR of Zero Velocity Pixel Value (0018,9810) shall be SS.

C.7.6.16.2.25 Unassigned Shared and Per-frame Converted Attributes Macros

Attributes that are present in the Classic images to be converted but that are not defined in specific Modules or specific Functional Groups required or supported by the IOD, or have their values changed during conversion, either may:

- be identical in all images, in which case they shall be included in the top level Data Set or in the Unassigned Shared Converted Attributes Sequence, or
- only be present in some images, or have a different number of values, or different values, in which case they shall be included in the Unassigned Per-Frame Converted Attributes Sequence.

Note

1. An example of an Attribute that might be included in the Unassigned Shared Converted Attributes Macro is Filter Type (0018,1160), which typically would be the same for all Classic CT images in a set, and is not included in any modality-specific Module or Functional Group Macro.
2. An example of an Attribute that might be included in the Unassigned Per-Frame Converted Attributes Macro is Slice Location (0020,1041), which typically would be different for each Classic CT image in a set, and is not included in any modality-specific Module or Functional Group Macro.

3. An example of an Attribute that might be included in the Unassigned Shared Converted Attributes Macro is Series Number (0020,0011), which typically would be the same for all Classic CT images in a set (but is not required to be), and will be replaced with a different value in the top-level Data Set, and hence if the original is to be preserved, needs to be recorded.

4. An example of an Attribute that might be included in the Unassigned Per-Frame Converted Attributes Macro is Instance Number (0020,0013), which typically would be different for each Classic CT image in a set, and will be replaced with a different value in the top-level Data Set, and hence if the original is to be preserved, needs to be recorded.

5. The UIDs of the converted Instances are recorded in the Conversion Source Attributes Sequence, and are not included in the Unassigned Shared and Per-Frame Converted Attributes Macros.

For the purpose of comparing values, an Attribute that is not present in a Classic image to be converted is considered the same as an Attribute that is present but has no value. Sequence Attributes match when they have the same number of Items and Item contents in the same order (irrespective of whether the Sequences or Items are encoded with fixed or variable length).

The Unassigned Shared Converted Attributes Sequence, and the Unassigned Per-Frame Converted Attributes Sequence may be absent, if there are no such Attributes available to be included. E.g., there may be no shared Attributes with the same values, all the shared Attributes may be included in the top-level Data Set, there may be no Attributes that vary per-frame or an individual frame may have no such Attribute.

The necessary Private Creator Data Element within each Sequence Item accompanies Private Data Elements. There is no requirement to preserve the private block of Data Elements used in the Classic images to be converted. Nor is there a requirement that a Private Data Element use the same private block in all of the Classic images.

Matching of Private Attribute Values for the purpose of determining whether they are shared or per-frame may be performed using the equivalent meaning if the Value Representation is Explicit and not UN, or known through other means, otherwise, byte matching of the UN VR shall be performed.

C.7.6.16.2.25.1 Unassigned Shared Converted Attributes Macro

Table C.7.6.16.2.25.1-1 specifies the Attributes of the Unassigned Shared Converted Attributes Functional Group Macro.

Table C.7.6.16.2.25.1-1. Unassigned Shared Converted Attributes Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Unassigned Shared Converted Attributes Sequence	(0020,9170)	1C	Contains all of the Standard and Private Attributes that are present in all of the converted Classic images, that have the same number of values, that have the same values, and that are not in the top-level Data Set. Only a single Item shall be included in this Sequence. Required if any unassigned shared Attributes are present.

C.7.6.16.2.25.2 Unassigned Per-Frame Converted Attributes Macro

Table C.7.6.16.2.25.2-1 specifies the Attributes of the Unassigned Per-Frame Converted Attributes Functional Group Macro.

Table C.7.6.16.2.25.2-1. Unassigned Per-Frame Converted Attributes Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Unassigned Per-Frame Converted Attributes Sequence	(0020,9171)	1C	Contains all of the Standard and Private Attributes that are present in only some of the converted Classic images, or that have a different number of values, or that have different values. Only a single Item shall be included in this Sequence. Required if any unassigned per-frame Attributes are present for this frame.

C.7.6.16.2.25.3 Image Frame Conversion Source Macro

Table C.7.6.16.2.25.2-1 specifies the Attributes of the Image Frame Conversion Source Functional Group Macro.

Table C.7.6.16.2.25.3-1. Image Frame Conversion Source Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Conversion Source Attributes Sequence	(0020,9172)	1	The image or other composite SOP Instance that was converted to this frame. Only a single Item shall be included in this Sequence.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			

C.7.6.16.2.26 Stored Value Color Range Macro

Table C.7.6.16.2.26-1 defines the Attributes of the Stored Value Color Range Functional Group Macro

Table C.7.6.16.2.26-1. Stored Value Color Range Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Stored Value Color Range Sequence	(0028,1230)	1	Specifies the range of stored pixel values of this frame mapped using the Palette Color LUT. Only a single Item shall be included in this Sequence.
>Minimum Stored Value Mapped	(0028,1231)	1	Minimum Stored Value to map. See Section C.7.6.16.2.26.1.
>Maximum Stored Value Mapped	(0028,1232)	1	Maximum Stored Value to map. See Section C.7.6.16.2.26.1.

C.7.6.16.2.26.1 Stored Value Color Range Macro Attributes Description

The voxel values of the Parametric Map shall be mapped to RGB values using the following transformation.

All values smaller than Minimum Stored Value Mapped (0028,1231) shall be treated as equal to this minimum value.

All values larger than Maximum Stored Value Mapped (0028,1232) shall be treated as equal to this maximum value.

The values between Minimum Stored Value Mapped (0028,1231) and Maximum Stored Value Mapped (0028,1232) shall be mapped to the Palette Color LUT using a linear interpolation function.

Note

The Palette Color LUT can be segmented and interpolation needs to accommodate the segmentation.

In case of floating point mapping the second value of the Palette Color Lookup Table Descriptor is not used in the mapping as the Minimum Stored Value Mapped (0028,1231) is used as start value for the LUT values.

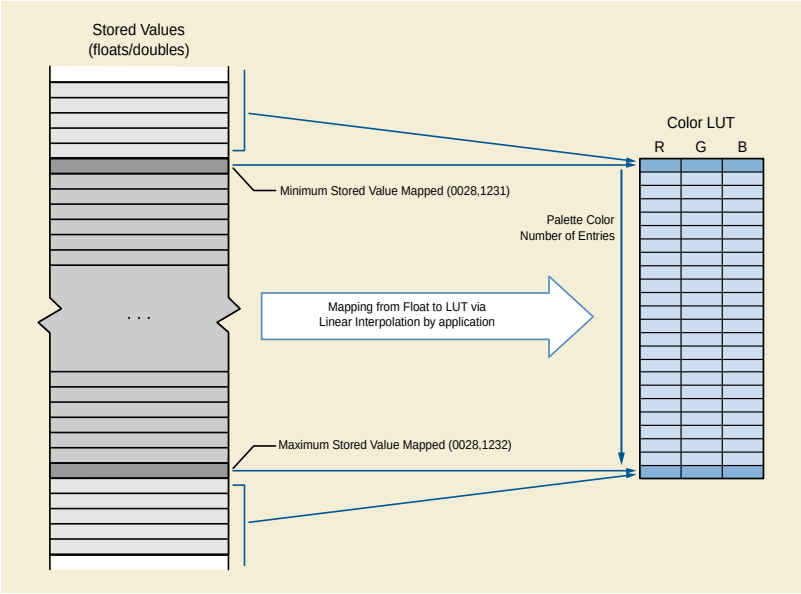


Figure C.7.6.16.2.26.2-1. Stored Value Color Range

C.7.6.16.2.27 Frame Usefulness Macro

Table C.7.6.16.2.27-1 specifies the Attributes of the Frame Usefulness Functional Group Macro, related to the clinical usefulness of the current frame.

Table C.7.6.16.2.27-1. Frame Usefulness Functional Group Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Usefulness Group Sequence	(0034,0009)	1	Sequence that contains the Functional Groups Sequence Attributes corresponding to the current frame or audio sample. Only a single Item shall be included in this Sequence.
>Includes Information	(0034,000C)	3	Whether or not the current frame includes useful information, i.e. not noise nor void Enumerated Values: **YES** **NO**
>Includes Imaging Subject	(0034,0008)	3	Whether or not the current frame includes the imaging subject. Enumerated Values: **YES** **NO**

C.7.6.16.2.28 Camera Position Macro

Table C.7.6.16.2.28-1 specifies the Attributes of the Camera Position Functional Group Macro, related to the position of the camera or the acquisition device for the current frame, with regards to the patient.

Table C.7.6.16.2.28-1. Camera Position Functional Group Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Camera Position Group Sequence	(0034,000B)	1	Sequence that contains the Functional Groups Sequence Attributes corresponding to the current frame or audio sample. Only a single Item shall be included in this Sequence.
>Render Projection	(0070,1602)	1	Projection style. Enumerated Values: **PERSPECTIVE**
>Viewpoint Position	(0070,1603)	1	Position of the viewpoint in volume space. A point (x,y,z) in the Frame Reference Coordinate System referenced in the Frame of Reference Module.
>Viewpoint LookAt Point	(0070,1604)	1	Point the viewpoint is looking at. A point (x,y,z) in the Frame Reference Coordinate System referenced in the Frame of Reference Module.
>Viewpoint Up Direction	(0070,1605)	1	Vertical orientation of the view. A vector (x,y,z) in the Frame Reference Coordinate System referenced in the Frame of Reference Module.
>Render Field of View	(0070,1606)	1	The field of view specified as a 6-tuple of values (X_{left}, X_{right}, Y_{top}, Y_{bottom}, $Distance_{near}$, $Distance_{far}$) in the Viewpoint Coordinate System, in mm. See Section C.11.30.1.

C.7.6.16.2.29 Time of Frame Macro

Table C.7.6.16.2.29-1 specifies the Attributes of the Time of Frame Functional Group Macro, related to the time of frame.

Table C.7.6.16.2.29-1. Time of Frame Functional Group Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Time of Frame Group Sequence	(0034,000D)	1	Time characteristics of the current frame or audio sample. Only a single Item shall be included in this Sequence.
>Frame Origin Timestamp	(0034,0007)	1	This timestamp contains the capture time of the payload content for this frame or audio sample. It is in TAI, not UTC.

C.7.6.17 Multi-frame Dimension Module

The Multi-frame Dimension Module contains a Sequence with Items pointing to Attributes defining a set of dimensions that are usually known prior to the acquisition commencing. It is up to the generating applications to decide what Attributes are important to describe the multi-frame dimensions.

The application that generates the Concatenation or SOP Instances may use the order of Dimension Index Pointers (0020,9165) in the Dimension Index Sequence (0020,9222) to guide the receiving application in determining the order of the presentation of image frames. The first index has the highest ranking, the next index has a lower ranking, etc. Frames with higher values for the dimension with the highest ranking would only be presented after all frames that have values for Dimension Index Pointers (0020,9165) of the lower rankings have been presented.

If the set of Dimension Index Pointers does not provide an Attribute set whose values are unique for each frame then the order for the frames with the same value set will be incompletely specified. The receiving application could use the logical frame number to

resolve this ambiguity. If the Attribute set contains more dimensions than are needed to specify a unique ordering, the lower order ranking Attribute(s) will have no effect on the ordering.

Note

For example if there were the following indices in the following order:

- Stack ID (1-3)
- In-stack Position Number (1-2 for Stack ID 1, 1-4 for Stack ID 2, 1-3 for Stack ID 3)
- Effective Echo Time (1-2), i.e., every slice has been scanned with 2 different effective echo's

Then the frames could be presented in the following order:

(Stack ID, In-stack Position, Effective Echo Time)

(1,1,1), (1,1,2), (1,2,1), (1,2,2),

(2,1,1), (2,1,2), (2,2,1), (2,2,2), (2,3,1), (2,3,2), (2,4,1), (2,4,2)

(3,1,1), (3,1,2), (3,2,1), (3,2,2), (3,3,1), (3,3,2)

The actual order of the frames in the object is up to the generating application.

If the effective echo time was not included in the Dimension Index Pointers in the above example then the order of sorting for the frames with the same indices will be undefined - in this case there would be 2 frames with the index set (Stack ID, In-stack Position) = (1,1) and the order of these frames is not specified.

If there were another Attribute appended to the Dimension Index Pointers, for example TR, then the TR index would not be used in determining the order of the frames. So the Index Frame Pointers would contain (Stack ID, In-stack Position, Effective Echo Time, TR) but the TR index would be irrelevant for frame ordering purposes.

Table C.7.6.17-1 specifies the Attributes of the Multi-frame Dimension Module.

Table C.7.6.17-1. Multi-frame Dimension Module Attributes

Attribute Name	Tag	Type	Attribute Description
Dimension Organization Sequence	(0020,9221)	1	Sequence that lists the Dimension Organization UIDs referenced by the containing SOP Instance. See Section C.7.6.17.2 for further explanation. One or more Items shall be included in this Sequence.
>Dimension Organization UID	(0020,9164)	1	Uniquely identifies a set of dimensions referenced within the containing SOP Instance. See Section C.7.6.17.2 for further explanation.
Dimension Organization Type	(0020,9311)	3	Dimension organization of the Instance. Defined Terms: **3D** Spatial Multi-frame image of equally spaced parallel planes (3D volume set) **3D_TEMPORAL** Temporal loop of equally spaced parallel-plane 3D volume sets. **TILED_FULL** Tiled image in which each frame represents a single tile and the spatial positions of the tiles are implicitly defined as per Section C.7.6.17.3. **TILED_SPARSE** Tiled image in which each frame represents a single tile and the spatial positions of tiles are explicitly defined by per-frame Functional Group Macro entries.

Attribute Name	Tag	Type	Attribute Description
Dimension Index Sequence	(0020,9222)	1C	Identifies the Sequence containing the indices used to specify the dimension of the multi-frame object. One or more Items shall be included in this Sequence. Required if Dimension Organization Type (0020,9311) is absent or not TILED_FULL. May be present otherwise.
>Dimension Index Pointer	(0020,9165)	1	Contains the Data Element Tag that is used to identify the Attribute connected with the index. See Section C.7.6.17.1 for further explanation.
>Dimension Index Private Creator	(0020,9213)	1C	Identification of the creator of a group of Private Data Elements. Required if the Dimension Index Pointer (0020,9165) value is the Data Element Tag of a Private Attribute.
>Functional Group Pointer	(0020,9167)	1C	Contains the Data Element Tag of the Functional Group Sequence that contains the Attribute that is referenced by the Dimension Index Pointer (0020,9165). See Section C.7.6.17.1 for further explanation. Required if the value of Dimension Index Pointer (0020,9165) is the Data Element Tag of an Attribute that is contained within a Functional Group Sequence.
>Functional Group Private Creator	(0020,9238)	1C	Identification of the creator of a group of Private Data Elements. Required if the Functional Group Pointer 0020,9167) value is the Data Element Tag of a Private Attribute.
>Dimension Organization UID	(0020,9164)	1	Uniquely identifies a set of dimensions referenced within the containing SOP Instance. In particular the dimension described by this Sequence Item is associated with this Dimension Organization UID. See Section C.7.6.17.2 for further explanation.
>Dimension Description Label	(0020,9421)	3	Free text description that explains the meaning of the dimension.

C.7.6.17.1 Dimension Indices

With the Dimension Index Sequence (0020,9222), Data Element Tags are specified that identify the indices used for a particular SOP Instance.

The actual index values for each frame in a multi-frame header are stored in a single Dimension Index Values Attribute (0020,9157) defined in the Frame Content Functional Group. For each SOP Instance this Attribute has a Value Multiplicity equal to the number of Items in the Sequence. The ordering of the Items in the Sequence defines the ordering in the Dimension Index Values Attribute: Item 1 of the Sequence relates to Value 1, Item 2 to Value 2, etc.

The Dimension Index Pointer (0020,9165) references a single Attribute that describes the actual values that define the dimension. Each Attribute referenced in the Dimension Index Sequence (0020,9222) will have an index stored in the Dimension Index Values (0020,9157) for each frame. Each index value is an ordinal number starting from 1 and monotonically increasing by 1 within the scope of a Dimension Organization UID (0020,9164). These values are independent of the actual values of the Attribute referenced by the Dimension Index Pointer (0020,9165), i.e., the index values are logical indices, rather than actual indices. Frames assigned the same index shall contain nominally the same value for the referenced Attribute. If the referenced Attribute is not present for some frames, or is present but has no value, then a single index shall be assigned to indicate the lack of the value (i.e., all such frames shall have the same index value, which is different from other index values). It is at the discretion of the SOP Instance creator whether the Attribute values are equivalent, and therefore appropriate for assignment to the same index value.

The Dimension Index Pointer (0020,9165) shall contain the Data Element Tag (gggg,eeee) of the Attribute being indexed.

The Dimension Index Pointer (0020,9165) shall not contain the Data Element Tag for Frame Content Sequence (0020,9111) or Dimension Index Values (0020,9157).

Note

1. Dimension Index Pointer (0020,9165) may point to a Sequence containing a Functional Group. In that case all the Attributes of the Sequence are associated with the index value.

2. The Dimension Index Pointer (0020,9165) may point to a Data Element Tag (gggg,eeee) that is not present for all frames of an object, or does not have a value for all frames of an object. For such frames, index values are still assigned, as described above.

3. The indices used in the Dimension Index Values (0020,9157) may or may not be identical to the value of indexed Attribute referenced by Dimension Index Pointer (0020,9165). For example, if the referenced Attribute is itself encoded in an index-like fashion (being an ordinal number starting from 1), such as In-Stack Position Number (0020,9057), then index value 1 would typically correspond to In-Stack Position Number (0020,9057) value 1. On the other hand, if the referenced Attribute encodes some physical measure, such as a time or distance, or a categorical value, such as a string describing the phase of contrast, or a more complex description such as an entire Functional Group, then the index value is independent of the encoded value.

4. The scope of the values of Dimension Index Pointer (0020,9165) is defined to be within a single Dimension Organization UID (0020,9164). If the same Dimension Organization UID (0020,9164) is present in multiple Instances (whether part of a Concatenation or not), at least one of those Instances (though not necessarily every Instance) will contain a value of 1 for the Dimension Index Values (0020,9157).

The Functional Group Pointer (0020,9167) value is the Data Element Tag (gggg,eeee) of the Functional Group Sequence that contains the Attribute being indexed. If the Dimension Index Pointer 0020,9165) contains a Data Element Tag that identifies a Functional Group Sequence then the Functional Group Pointer (0020,9167) shall not be present.

If the Dimension Index Pointer (0020,9165) Attribute contains a Private Data Element, then the Dimension Index Private Creator (0020,9213) shall contain the Private Creator of the block of Private Data Elements.

If the Functional Group Pointer (0020,9167) Attribute contains a Private Data Element, then the Functional Group Private Creator (0020,9238) shall contain the Private Creator of the block of Private Data Elements.

Note

An example of the usage of the Dimension Index Sequence (0020,9222) and Dimension Index Values (0020,9157) Attributes:

Dimension Index Sequence (0020,9222) specifies two indices:

- Cardiac Trigger Delay Time (0020,9153)
- Image Position (Patient) (0020,0032)

The Dimension Index Sequence (0020,9222) is filled with the following contents:

Item	Attribute	Value
1	Dimension Index Pointer	(0020,9153)
	Functional Group Pointer	(0018,9118)
	…	
2	Dimension Index Pointer	(0020,0032)
	Functional Group Pointer	(0020,9113)
	…	

The Dimension Index Values (0020,9157) (in the Frame Content Functional Group) for each frame consists of two values:

Index of Cardiac Trigger Delay Time \ Index of Image Position

The SOP Instance creator is responsible for maintaining consistency between the actual value of the Attribute listed as the Dimension Index Pointer (0020,9165) and the corresponding value in the Dimension Index Values (0020,9157) Attribute.

See Figure C.7.6.17-1 for an illustration of this example.

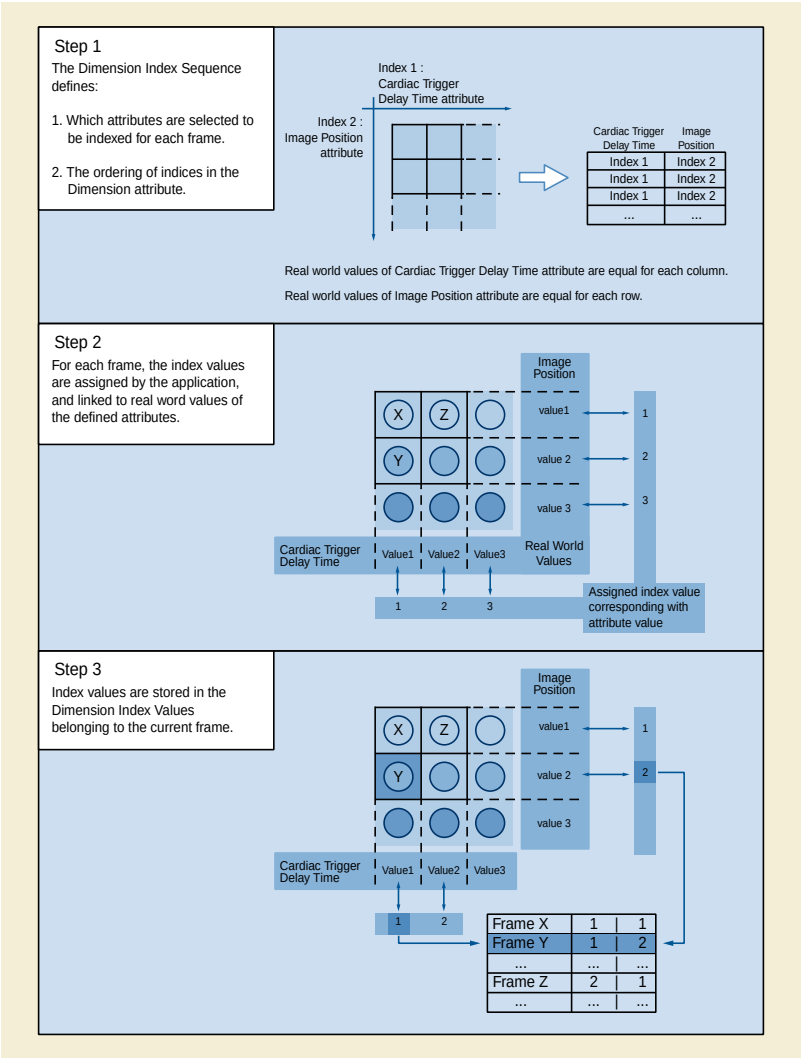


Figure C.7.6.17-1. Example of Dimension Index Sequence and Dimension Index Values Attributes

C.7.6.17.2 Dimension Organization UID

The Dimension Organization UID (0020,9164) value identifies a set of dimensions to which an Item of the Dimension Index Sequence (0020,9222) belongs.

When different SOP Instances share the same Dimension Organization UID (0020,9164) for a particular Item of the Dimension Index Sequence (0020,9222), equivalent indices from the corresponding Dimension Index Values (0020,9157) shall have the same meaning across the SOP Instances.

This mechanism allows an image creator to explicitly specify that indices are intended to convey identical information across SOP Instances.

Dimension Organization Sequence (0020,9221) contains a summary of all the Dimension Organization UID (0020,9164) values used in a SOP Instance.

Note

Figure C.7.6.17-2 illustrates how this is used for a SOP Instance created by a multi-planar reformat application from a SOP Instance containing three Items in the Dimension Index Sequence. The meaning of the indices for Temporal Position Index (0020,9128), and MR Echo Sequence (0018,9114) were preserved in the derived SOP Instance, so it shares the Dimension

Organization UID for these Attributes with the original. Since the reformat was performed with a different orientation, the meaning of the In-Stack Position Number (0020,9057) was not preserved. Therefore a new Dimension Organization UID (0020,9164) was created.

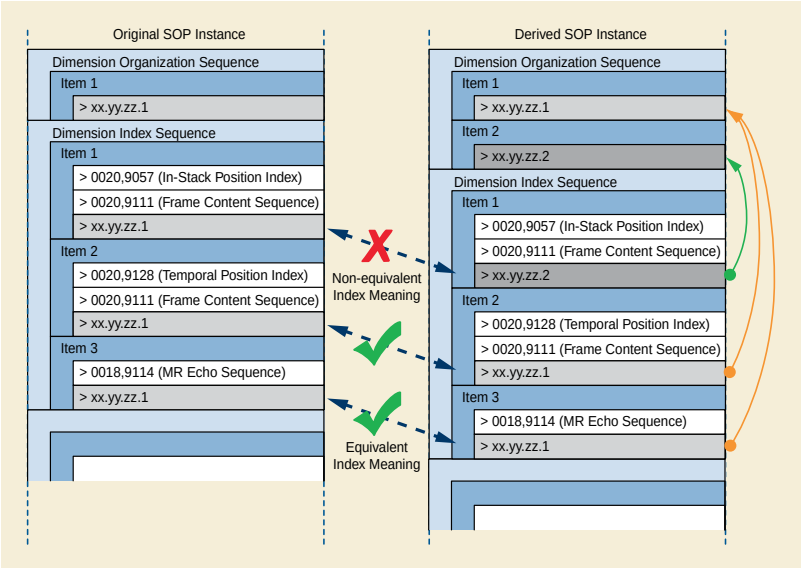


Figure C.7.6.17-2. Example of Use of Dimension Organization Module

C.7.6.17.3 Spatial Location and Optical Path of Tiled Images

If Dimension Organization Type (0020,9311) is present with a value of TILED_FULL, then the Per-Frame Functional Group Macros that would otherwise describe the spatial location of each tile explicitly (e.g., the X, Y and Z offsets from the origin in the Slide Coordinate System Plane Position (Slide)), and the optical path, may be omitted.

A value of TILED_FULL indicates that the frames across all Instances of a ~~Concatentation~~Concatenation, or a single Instance in the absence of a Concatenation, comprise a non-sparse non-overlapping representation of an entire rectangular region, and are sequentially encoded as successive frames in Pixel Data (7FE0,0010) in an implicit order varying:

- first along the row direction from left to right, where the row direction is defined in the Slide Coordinate System by the first three values of Image Orientation (Slide) (0048,0102),
- then along the column direction from top to bottom, where the column direction is defined in the Slide Coordinate System by the second three values of Image Orientation (Slide) (0048,0102),
- then along the depth direction from the glass slide towards the coverslip, where the depth direction is defined in the Slide Coordinate System from zero to positive,
- then along optical paths, where the direction is defined by successive Items of the Optical Path Sequence (0048,0105) in the order in which they are listed in that Sequence.

If Dimension Organization Type (0020,9311) is absent or has a value of TILED_SPARSE, then the spatial location of each tile is explicitly encoded using information in the Per-Frame Functional Group Sequence, and the recipient shall not make any assumption about the spatial position or optical path or order of the encoded frames but shall rely on the values of the relevant Per-Frame Functional Group Macro.

C.7.6.18 Physiological Synchronization

C.7.6.18.1 Cardiac Synchronization Module

Table C.7.6.18-1 specifies the Attributes of the Cardiac Synchronization Module.

Table C.7.6.18-1. Cardiac Synchronization Module Attributes

Attribute Name	Tag	Type	Attribute Description
Cardiac Synchronization Technique	(0018,9037)	1C	Defines if a cardiac synchronization technique was applied during or after the acquisition. Enumerated Values: **NONE** **REALTIME** total time for the acquisition is shorter than cardiac cycle, no gating is applied **PROSPECTIVE** certain thresholds have been set for a gating window that defines the acceptance of measurement data during the acquisition **RETROSPECTIVE** certain thresholds have been set for a gating window that defines the acceptance of measurement data after the acquisition **PACED** there is a constant RR interval (e.g., Pacemaker), which makes thresholding not required Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Cardiac Signal Source	(0018,9085)	1C	Cardiac Signal Source. Defined Terms: **ECG** electrocardiogram **VCG** vector cardiogram **PP** peripheral pulse **MR** magnetic resonance, i.e., M-mode or cardiac navigator Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals other than NONE.
Cardiac RR Interval Specified	(0018,9070)	1C	R-R interval in ms measured prior to or during the scan. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals other than NONE. Note Heart Rate (0018,1088) is not used in this Module, since its value can be derived as 1/ Cardiac RR Interval Specified (0018,9070).
Cardiac Beat Rejection Technique	(0018,9169)	1C	Cardiac arrhythmia rejection technique. Defined Terms: **NONE** **RR_INTERVAL** rejection based on deviation from average RR interval **QRS_LOOP** rejection based on deviation from regular QRS loop **PVC** rejection based on PVC criteria Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.

Attribute Name	Tag	Type	Attribute Description
Low R-R Value	(0018,1081)	2C	R-R interval low limit for beat rejection, in ms. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
High R-R Value	(0018,1082)	2C	R-R interval high limit for beat rejection, in ms. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
Intervals Acquired	(0018,1083)	2C	Number of R-R intervals acquired and used to create the image (not including the intervals rejected). Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals other than NONE.
Intervals Rejected	(0018,1084)	2C	Number of R-R intervals rejected. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Cardiac Synchronization Technique (0018,9037) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Cardiac Synchronization Technique (0018,9037) equals other than NONE.
Skip Beats	(0018,1086)	3	Number of beats prescribed to be skipped after each detected arrhythmia.
Cardiac Framing Type	(0018,1064)	1C	Description of type of framing performed. See Section C.7.6.18.1.1.1 for description and Defined Terms. Required if type of framing is not time forward from trigger, may be present otherwise.

Note

Low R-R Value (0018,1081), High R-R Value (0018,1082), Intervals Acquired (0018,1083) and Intervals Rejected (0018,1084) in this Module apply to the entire Image. The Cardiac Synchronization Sequence (0018,9118) in the Cardiac Synchronization Functional Group uses the same Attributes and specifies the values for a single frame.

C.7.6.18.1.1 Attribute Descriptions

C.7.6.18.1.1.1 Cardiac Framing Type

Cardiac Framing Type (0018,1064) is the mechanism used to select the data acquired to construct the frames within a specified cardiac timing interval.

Defined Terms:

FORW time forward from trigger
BACK time back before trigger
PCNT percentage of R-R forward from trigger

C.7.6.18.2 Respiratory Synchronization Module

Table C.7.6.18-2 specifies the Attributes of the Respiratory Synchronization Module.

Table C.7.6.18-2. Respiratory Synchronization Module Attributes

Attribute Name	Tag	Type	Attribute Description
Respiratory Motion Compensation Technique	(0018,9170)	1C	Applied technique to reduce respiratory motion artifacts. Defined Terms: **NONE** **BREATH_HOLD** **REALTIME** Image acquisition shorter than respiratory cycle **GATING** Prospective gating **TRACKING** Prospective through-plane or in-plane motion tracking **PHASE_ORDERING** Prospective phase ordering **PHASE_RESCANNING** Prospective techniques, such as real-time averaging, diminishing variance and motion adaptive gating **RETROSPECTIVE** Retrospective gating **CORRECTION** Retrospective image correction Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Respiratory Signal Source	(0018,9171)	1C	Signal source from which respiratory motion is derived. Defined Terms: **NONE** **BELT** includes various devices that detect or track expansion of the chest **NASAL_PROBE** **CO2_SENSOR** **NAVIGATOR** MR navigator and organ edge detection **MR_PHASE** phase (of center k-space line) **ECG** baseline demodulation of the ECG Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Respiratory Motion Compensation Technique (0018,9170) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Respiratory Motion Compensation Technique (0018,9170equals other than NONE.
Respiratory Trigger Delay Threshold	(0020,9256)	1C	Respiratory trigger threshold in percent of the chest expansion for the frame relative to the last Respiratory-Peak. See Section C.7.6.16.2.17.1 for further explanation. Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD and if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Respiratory Trigger Type	(0020,9250)	1C	Characteristic of the respiratory signal used to the define the respiratory triggering. Defined Terms: **TIME** **AMPLITUDE** **BOTH** Required if the value is not TIME, may be present otherwise.

C.7.6.18.3 Bulk Motion Synchronization Module

Table C.7.6.18-3 specifies the Attributes of the Bulk Motion Synchronization Module.

Table C.7.6.18-3. Bulk Motion Synchronization Module Attributes

Attribute Name	Tag	Type	Attribute Description
Bulk Motion Compensation Technique	(0018,9172)	1C	Applied technique to reduce bulk or other physiology motion artifacts. Defined Terms: **NONE** **REALTIME** image acquisition shorter than motion cycle **GATING** prospective gating **TRACKING** prospective through and/or in-plane motion tracking **RETROSPECTIVE** retrospective gating **CORRECTION** retrospective image correction Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Bulk Motion Signal Source	(0018,9173)	1C	Signal source to measure motion. Defined Terms: **JOINT** joint motion detection **NAVIGATOR** MR navigator and organ edge detection **MR_PHASE** phase (of center k-space line) Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Bulk Motion Compensation Technique (0018,9172) equals other than NONE. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Bulk Motion Compensation Technique (0018,9172) equals other than NONE.

C.7.6.19 Supplemental Palette Color Lookup Table Module

This Module is used in conjunction with Multi-frame IODs that use RGB color in a number of frames. The value of Pixel Presentation (0008,9205) for such frames equals COLOR.

Table C.7.6.19-1 specifies the Attributes that describe the Lookup table data.

Table C.7.6.19-1. Supplemental Palette Color Lookup Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
Red Palette Color Lookup Table Descriptor	(0028,1101)	1	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). See Section C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). See Section C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1	Specifies the format of the Blue Palette Color Lookup table Data (0028,1203). See Section C.7.6.3.1.5 for further explanation.
Red Palette Color Lookup Table Data	(0028,1201)	1	Red Palette Color Lookup Table Data. See Section C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1	Green Palette Color Lookup Table Data. See Section C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1	Blue Palette Color Lookup Table Data. See Section C.7.6.3.1.6 for further explanation.

C.7.6.20 Patient Orientation Module

This section describes Attributes of the Patient Orientation Module by describing the patient orientation related to gravity and equipment. Table C.7.6.20-1 contains IOD Attributes that describe the Patient Orientation.

Table C.7.6.20-1. Patient Orientation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-15 "Patient Orientation Macro Attributes"			

C.7.6.21 Image - Equipment Coordinate Relationship Module

This section describes the Image - Equipment Coordinate Relationship Module. Table C.7.6.21-1 contains the Attributes that specify how the equipment (e.g., gantry) and patient oriented coordinate system (in conjunction with Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) Attributes) are related.

Table C.7.6.21-1. Image - Equipment Coordinate Relationship Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image to Equipment Mapping Matrix	(0028,9520)	1	A 4x4 rigid transformation matrix that maps patient coordinate space of the reconstructed image to the equipment defined original coordinate space. Matrix elements shall be listed in row-major order. See Section C.7.6.21.1.
Equipment Coordinate System Identification	(0028,9537)	1	Identification of the type of equipment coordinate system in which the projection images were acquired. See Section C.7.6.21.2. Defined Terms: **ISOCENTER**

C.7.6.21.1 Image to Equipment Mapping Matrix

The Image to Equipment Mapping Matrix (0028,9520) is used to describe the relationship between the patient oriented coordinate system and a modality specific equipment coordinate system. This mapping can only be used with systems that have a well-defined equipment coordinate system (such as XA, etc.).

The Image to Equipment Mapping Matrix ${}^{A}M_{B}$ describes how to transform a point (${}^{B}x$,${}^{B}y$,${}^{B}z$) with respect to the Patient-Based Coordinate System into (${}^{A}x$,${}^{A}y$,${}^{A}z$) with respect to the equipment coordinate system according to the equation below.

$$\begin{bmatrix} A_x \\ A_y \\ A_z \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & T_x \\ M_{21} & M_{22} & M_{23} & T_y \\ M_{31} & M_{32} & M_{33} & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} B_x \\ B_y \\ B_z \\ 1 \end{bmatrix} \quad \text{(C.7.6.21.1-1)}$$

The Image to Equipment Mapping Matrix is a rigid transformation that involves only translations and rotations. Mathematically, the matrix shall be orthonormal and can describe six degrees of freedom: three translations, and three rotations.

Note

Both the Patient-Based Coordinate System and the Equipment-Based Coordinate System are expressed in millimeters.

C.7.6.21.2 Equipment Coordinate System Identification

The Equipment Coordinate System Identification (0028,9537) identifies the Reference Coordinate System to which the Image to Equipment Mapping Matrix (0028,9520) is related.

The Defined Term ISOCENTER refers to a coordinate reference system where the origin corresponds with the center of rotation of the projections.

C.7.6.22 Specimen Module

Table C.7.6.22-1 specifies the Attributes that identify one or more Specimens being imaged.

Table C.7.6.22-1. Specimen Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.7.6.22-2 "Specimen Macro Attributes"			

Table C.7.6.22-2. Specimen Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Container Identifier	(0040,0512)	1	The identifier for the container that contains the specimen(s) being imaged. See Section C.7.6.22.1.1.
Issuer of the Container Identifier Sequence	(0040,0513)	2	Organization that assigned the Container Identifier. Zero or one Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
Alternate Container Identifier Sequence	(0040,0515)	3	Sequence of alternate identifiers for the container that contains the specimen(s) being imaged. These may have been assigned, e.g., by the manufacturer, or by another institution that collected the specimen. One or more Items are permitted in this Sequence.
>Container Identifier	(0040,0512)	1	The identifier for the container that contains the specimen(s) being imaged.
>Issuer of the Container Identifier Sequence	(0040,0513)	2	Organization that assigned the Container Identifier. Zero or one Item shall be included in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
Container Type Code Sequence	(0040,0518)	2	Type of container that contains the specimen(s) being imaged. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 8101 "Container Types".*
Container Description	(0040,051A)	3	Description of the container.
Container Component Sequence	(0040,0520)	3	Description of one or more components of the container (e.g., description of the slide and of the coverslip). One or more Items are permitted in this Sequence.
>Container Component Type Code Sequence	(0050,0012)	1	Type of container component. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 8102 "Container Component Types".*
>Manufacturer	(0008,0070)	3	Manufacturer of the container component.
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the container component.
>Container Component ID	(0050,001B)	3	Manufacturer's identifier of the container component, e.g., Lot Number and/or Version.
>Container Component Length	(0050,001C)	3	Length in mm of container component.
>Container Component Width	(0050,0015)	3	Width in mm of container component.
>Container Component Diameter	(0050,001D)	3	Diameter in mm of container component for cylindrical or circular components.

Attribute Name	Tag	Type	Attribute Description
>Container Component Thickness	(0050,0013)	3	Thickness in mm of container component
>Container Component Material	(0050,001A)	3	Material of container component. Defined Terms: **GLASS** **PLASTIC** **METAL**
>Container Component Description	(0050,001E)	3	Container component text description.
Specimen Description Sequence	(0040,0560)	1	Sequence of identifiers and detailed description of the specimen(s) being imaged. One or more Items shall be included in this Sequence. Each specimen imaged in the Pixel Data shall be identified by an Item in this Sequence. Other specimens in/on the container, but not imaged in the Pixel Data, may also be identified by Items in this Sequence.
>Specimen Identifier	(0040,0551)	1	A departmental information system identifier for the Specimen. See Section C.7.6.22.1.1 and Section C.7.6.22.1.2. If a single specimen is present in a container, the value of the Specimen Identifier and the value of the Container Identifier are typically the same.
>Issuer of the Specimen Identifier Sequence	(0040,0562)	2	The name or code for the institution that has assigned the Specimen Identifier. Zero or one Item shall be included in this Sequence.
>>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”			
>Specimen UID	(0040,0554)	1	Unique Identifier for Specimen. See Section C.7.6.22.1.2.
>Specimen Type Code Sequence	(0040,059A)	3	Specimen Type. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 8103 “Anatomic Pathology Specimen Types”.*
>Specimen Short Description	(0040,0600)	3	Short textual specimen description (may include ancestor specimen descriptions).
>Specimen Detailed Description	(0040,0602)	3	Detailed textual specimen description (may include ancestor specimen descriptions).
>Specimen Preparation Sequence	(0040,0610)	2	Sequence of Items identifying the process steps used to prepare the specimen for image acquisition. This includes description of all processing necessary to interpret the image. Zero or more Items shall be included in this Sequence. This Sequence includes description of the specimen sampling step from an ancestor specimen, potentially back to the original part collection. See Section C.7.6.22.1.3.

Attribute Name	Tag	Type	Attribute Description
>>Specimen Preparation Step Content Item Sequence	(0040,0612)	1	Sequence of Content Items identifying the processes used in one preparation step to prepare the specimen for image acquisition. One or more Items shall be included in this Sequence.
>>>Include Table 10-2 “Content Item Macro Attributes Description”			*BTID 8001 “Specimen Preparation”*
>Include Table 10-8 “Primary Anatomic Structure Macro Attributes”			*Original anatomic location in patient of specimen. This location may be identical to that of the parent specimen, may be further refined by modifiers depending on the sampling procedure for this specimen, or may be a distinct concept.* *BCID 8134 “Anatomic Structures”*
>Specimen Localization Content Item Sequence	(0040,0620)	1C	Sequence of Content Items identifying the location of the specimen in the container and/or in the image. See Section C.7.6.22.1.4. One or more Items shall be included in this Sequence. Required if multiple specimens present in the image. May be present otherwise.
>>Include Table 10-2 “Content Item Macro Attributes Description”			*DTID 8004 “Specimen Localization”.*

C.7.6.22.1 Specimen Module Attributes

C.7.6.22.1.1 Container Identifier and Specimen Identifier

"Specimen" is the role played by a discrete physical object (or a collection of objects that are considered as a unit) that is the subject of pathology examination.

A specimen is a physical object (or a collection of objects) when the laboratory considers it a single discrete, uniquely identified unit that is the subject of one or more steps in the laboratory (diagnostic) workflow. This includes objects at all levels of processing, including fresh tissue, dissected organs, tissue embedded in paraffin, sections made from embedded tissue, and liquid preparations.

Specimens are physically managed by being placed in or on a container. The concept of container includes buckets, cassettes, vials, and slides. While there is usually one specimen per container, it is possible, in some laboratory workflows, for multiple specimens to be in/on a container.

Both specimens and specimen containers have logical identifiers for workflow management. The logical identifier of a container is usually conveyed on a label on the container. The specimen itself will typically not be physically labeled with its identifier. For the usual case of a single specimen in/on a container, the logical identifiers may be identical. However, when there are multiple specimens in/on a container, each specimen receives a distinct logical identifier. These identifiers are encoded in the SOP Instance using Attributes Container Identifier (0040,0512) and Specimen Identifier (0040,0551).

Note

1. This definition of "specimen" extends the common definition beyond the part or parts that were submitted for examination (e.g., from surgery) to include any derivative piece that may be separately analyzed or examined, such as a block or slide preparation.

2. Although many Pathology Information Systems use a hierarchical system for identifying parts, blocks and slides, there should be no assumption made that this will be the case and in particular, there should be no attempt to parse a given Specimen Identifier to retrieve an accession number or other higher level identifier.

C.7.6.22.1.2 Specimen Identifier and Specimen UID

Specimen Identifier (0040,0551) must be unique at least within the Study; the actual scope of uniqueness is determined by the departmental information system that assigns the IDs. Each specimen shall also be assigned a globally unique Specimen UID (0040,0554)

that allows referencing beyond the scope of a Study. This UID may be used, for instance, if a specimen is delivered to another institution for further analysis.

C.7.6.22.1.3 Specimen Preparation Sequence and Specimen Preparation Step Content Item Sequence

Interpretation of specimen images requires information about the source of the specimen and its preparation (e.g., sampling, fixation, staining). The processing steps used to prepare a specimen are recorded in the Specimen Preparation Sequence (0040,0610). This Sequence may include one Item for each processing step (as defined in the laboratory workflow) in the history of the specimen, and those Items are composed of a set of Content Items in the Specimen Preparation Step Content Item Sequence (0040,0612).

The Specimen Preparation Sequence may include description of the original part collected from the patient, the processing of that part, the sampling of tissue from the part and the preparation of that sample, and the further sub-sampling and processing of the tissue. In other words, the description of a specific specimen may include descriptions of the specimen's ancestors.

The Specimen Preparation Sequence Items shall be in ascending chronological order.

C.7.6.22.1.4 Specimen Localization Content Item Sequence

When there are multiple specimens in/on a container, the Specimen Localization Content Item Sequence (0040,0620) is used to identify the location of the specimen in the container, as there is no physical label with the Specimen Identifier. This Content Item Sequence, in accordance with TID 8004 “Specimen Localization”, allows the specimen to be localized by a distance in one to three dimensions from a reference point on the container, by an identified physical description such as a colored ink, or by its location as shown in a referenced image of the container. The referenced image may use an overlay, burned-in annotation, or an associated Presentation State SOP Instance to specify the location of the specimen.

C.7.6.23 Enhanced Palette Color Lookup Table Module

Table C.7.6.23-1 specifies the Attributes that define data flow through the Enhanced Blending and Display Pipeline. See Section C.7.6.23.1 for an overview of the Enhanced Blending and Display Pipeline.

Table C.7.6.23-1. Enhanced Palette Color Lookup Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
Data Frame Assignment Sequence	(0028,1401)	1	Sequence of Items each assigning frames of one particular value of Data Type (0018,9808) to a data path in the Enhanced Blending and Display Pipeline. One, two, or three Items shall be included in this Sequence.
>Data Type	(0018,9808)	1	Identification of the data type of frames using this data path assignment.
>Data Path Assignment	(0028,1402)	1	The data path to use for this data type in the Enhanced Blending and Display Pipeline. Enumerated Values: **PRIMARY_PVALUES** **PRIMARY_SINGLE** **SECONDARY_SINGLE** **SECONDARY_HIGH** **SECONDARY_LOW** See Section C.7.6.23.2 for usage.
>Bits Mapped to Color Lookup Table	(0028,1403)	3	The number of most significant bits of each value of Pixel Data (7FE0,0010) from this frame contributing to the Palette Color Lookup Table input. If absent, Bits Stored (0028,0101) bits of each value of Pixel Data (7FE0,0010) from this frame contributes to the Palette Color Lookup Table input. See Section C.7.6.23.3 for usage.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.11-2b "VOI LUT Macro Attributes"			
Blending LUT 1 Sequence	(0028,1404)	1C	Specification of the weight of the primary path input to the Blending Operation, i.e., the value that is referred to as "Weight 1" in the Enhanced Blending and Display Pipeline. Only a single Item shall be included in this Sequence. Required if there are one or more Items of the Data Path Assignment Sequence (0028,1402) other than PRIMARY_PVALUES.
>Blending LUT 1 Transfer Function	(0028,1405)	1	Specifies the algorithm used to determine the output value of Blending LUT 1. Enumerated Values: **CONSTANT** **ALPHA_1** **ALPHA_2** **TABLE** See Section C.7.6.23.4 for details.
>Blending Weight Constant	(0028,1406)	1C	Constant value of the Weight input to blending operation. Shall be from 0.0 to 1.0, inclusive. Required if Blending LUT 1 Transfer Function (0028,1405) is CONSTANT.
>Blending Lookup Table Descriptor	(0028,1407)	1C	Specifies the format of Blending Lookup Table Data (0028,1408) in this Sequence Item. The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.23.5 for further explanation. Required if Blending LUT 1 Transfer Function (0028,1405) is TABLE.
>Blending Lookup Table Data	(0028,1408)	1C	Contains the Blending Lookup Table values for this Weight input to the Blending Operation. Required if Blending LUT 1 Transfer Function (0028,1405) is TABLE.
Blending LUT 2 Sequence	(0028,140C)	1C	Specification of the weight of the secondary path input to the Blending Operation, i.e., the value that is referred to as "Weight 2" in the Enhanced Blending and Display Pipeline. Only a single Item shall be included in this Sequence. Required if there are one or more Items of the Data Path Assignment Sequence (0028,1402) other than PRIMARY_PVALUES.
>Blending LUT 2 Transfer Function	(0028,140D)	1	Specifies the algorithm used to determine the output value of Blending LUT 2. Enumerated Values: **CONSTANT** **ONE_MINUS** **ALPHA_1** **ALPHA_2** **TABLE** See Section C.7.6.23.4 for details.

Attribute Name	Tag	Type	Attribute Description
>Blending Weight Constant	(0028,1406)	1C	Constant value of the Weight input to blending operation. Shall be from 0.0 to 1.0, inclusive. Required if Blending LUT 2 Transfer Function (0028,140D) is CONSTANT.
>Blending Lookup Table Descriptor	(0028,1407)	1C	Specifies the format of Blending Lookup Table Data (0028,1408) in this Sequence Item. The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.23.5 for further explanation. Required if Blending LUT 2 Transfer Function (0028,140D) is TABLE.
>Blending Lookup Table Data	(0028,1408)	1C	Contains the Blending Lookup Table values for this Weight input to the Blending operation. Required if Blending LUT 2 Transfer Function (0028,140D) is TABLE.
Enhanced Palette Color Lookup Table Sequence	(0028,140B)	1C	This Sequence contains the Palette Color Lookup Table. One or two Items shall be included in this Sequence. Required if Data Path Assignment (0028,1402) is present with a value other than PRIMARY_PVALUES.
>Data Path ID	(0028,140E)	1	Identifier of the data path in which this Palette Color Lookup Table is used. Enumerated Values: **PRIMARY** **SECONDARY** Each Item shall have a distinct value of Data Path ID.
>RGB LUT Transfer Function	(0028,140F)	1	Specifies the mapping that takes place between the input value and RGB input to the Blending Operation. Enumerated Values: **EQUAL_RGB** Output is R=G=B=input value **TABLE** Output is RGB LUT values
>Alpha LUT Transfer Function	(0028,1410)	1	Specifies the transformation that is used to create the Alpha input to the Blending LUTs. Note Depending on the values of Blending LUT 1 Transfer Function (0028,1405) and Blending LUT 2 Transfer Function (0028,140D) the Alpha LUT value may be ignored. It is recommended that IDENTITY be used if this is the case. Enumerated Values: **NONE** **IDENTITY** **TABLE**

Attribute Name	Tag	Type	Attribute Description
>Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). The second value (first stored pixel value mapped) shall be zero. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). The second value (first stored pixel value mapped) shall be zero. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203). The second value (first stored pixel value mapped) shall be zero. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Alpha Palette Color Lookup Table Descriptor	(0028,1104)	1C	Specifies the format of the Alpha Palette Color Lookup Table Data. The second value (first stored pixel value mapped) shall be zero. Required if Alpha LUT Transfer Function (0028,1410) is TABLE.
>Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if RGB LUT Transfer Function (0028,140F) is TABLE.
>Alpha Palette Color Lookup Table Data	(0028,1204)	1C	Alpha LUT contains the blending values for the data frames. Required if Alpha LUT Transfer Function (0028,1410) is TABLE.
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15.1.1 When present, defines the color space of the output of the Enhanced Blending and Display Pipeline. Required if Data Path Assignment (0028,1402) is present and there exists any value other than PRIMARY_PVALUES.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.7.6.23.1 Description of the Enhanced Blending and Display Pipeline

The Enhanced Blending and Display Pipeline describes a scheme for blending of data frames of different Data Types and a color/gray-scale mapping for display recommended by the provider of this information. There are no requirements upon an receiving application to utilize this recommendation in the processing and display of the referenced image.

The blending transformation model in Figure C.7.6.23-1 applies for mapping images derived from one, two, or three data frames with the same image position and orientation but of different values of Data Type (0018,9808) to grayscale P-Values or color PCS-values for presentation. These inputs to the pipeline are frames of pixel values obtained from Pixel Data (7FE0,0010) and structured as described by Attributes of the Image Pixel Module. Co-located pixels from each data frame are processed through the Pipeline, resulting in one output sample at that location.

The model utilizes up to two data paths called the Primary and the Secondary data paths. Each input data frame may be initially processed by a Modality LUT and a VOI LUT. If not explicitly specified, the Modality LUT and VOI LUT are assumed to be identity transformations. The Primary path may be used alone to obtain only grayscale transformation without blending. In this case, the Primary data path input after going through the Modality LUT and VOI LUT is mapped through a Presentation LUT to obtain device independent grayscale values (P-Values) for presentation.

Either Primary or Secondary paths alone or both paths together may be used to obtain color transformation with blending. Up to one data frame input in the Primary data path and up to two data frames input in the Secondary data path are allowed for this blending transformation. These frames may be mapped to color using one-input or two-input palette color lookup tables depending on the number of data frames input to the data path. Alternatively if a path has one data frame, values may be converted to RGB (where R=G=B) before blending, if pseudo-color presentation of this data path is not desired. RGB values from Primary and Secondary data paths are combined via a "Blending Operation" in which the RGB color components are multiplied by a corresponding blending weight function (Weight 1 and Weight 2, respectively), and for each color component the two products are added together to produce the blended output value of that component. All inputs to the Blending Operation are normalized to the range 0.0 to 1.0, inclusive, even if they are fixed integer values that had been the entries in a lookup table.

Each of the Weight inputs to the blending operation is the output of a corresponding Blending LUT Transfer Function, which is selectable as either a constant or a derivation of the data frame values as described in Section C.7.6.23.4.

The RGB output from the Blending Operation is clamped to limit each color component (R, G, and B) to fall within the range 0.0 to 1.0, inclusive. The clamping function simply sets the value of any color component to 1.0 if the output from the Blending operation for that component exceeds 1.0. The RGB output of the clamping function is made available for use in rendering and slicing algorithms. Further, the output of the clamping function is transformed by the Profile Connection Space Transformation to device independent color values (PCS-values) for presentation.

If the input data frame values are representative of real world data, then they can be mapped to the real world values and units using the Real World Value Mapping Macro.

Note

Annex QQ “Enhanced US Data Type Blending Examples (Informative)” in PS3.17 describes a number of examples of the Enhanced Blending and Display Pipeline with specific Attribute values for each example that invoke particular data flows through the pipeline.

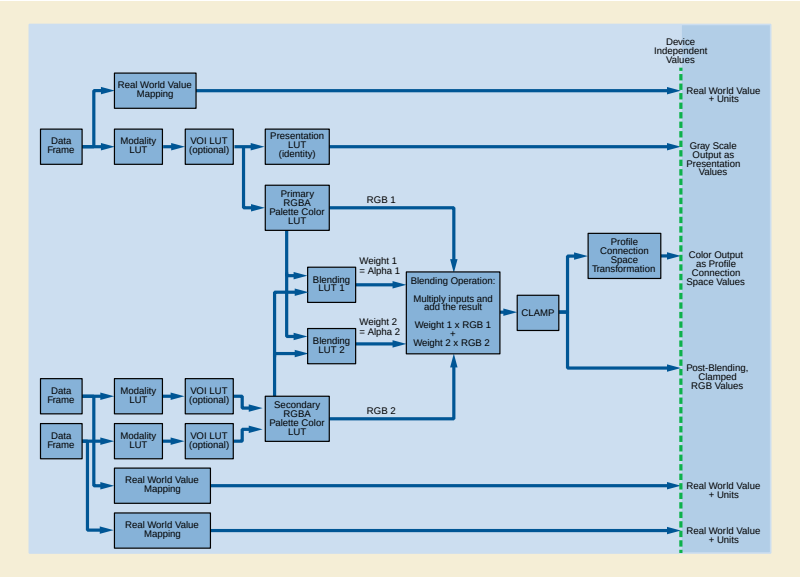


Figure C.7.6.23-1. Enhanced Blending and Display Pipeline

C.7.6.23.2 Data Path Assignment

Data Path Assignment (0028,1402) specifies the data path to use in the Enhanced Blending and Display Pipeline for each data frames of a particular data type.

Enumerated Values:

PRIMARY_PVALUES Data Frame values are passed through the Presentation LUT to produce grayscale P-Values; no blending is performed

PRIMARY_SINGLE Data Frame values are inputs to the Primary Palette Color Lookup Table

SECONDARY_SINGLE Data Frame values are inputs to the Secondary Palette Color Lookup Table

SECONDARY_HIGH Data Frame values having Data Path Assignment (0028,1402) of SECONDARY_HIGH are concatenated as the most significant bits with Data Frame values having Data Path Assignment of SECONDARY_LOW to form inputs to the Secondary Palette Color Lookup Table

SECONDARY_LOW Data Frame values having Data Path Assignment (0028,1402) of SECONDARY_LOW are concatenated as the least significant bits with Data Frame values having Data Path Assignment of SECONDARY_HIGH to form inputs to the Secondary Palette Color Lookup Table

C.7.6.23.3 Bits Mapped to Color Lookup Table

The number of entries of each Palette Color Lookup Table is specified in the Palette Color Lookup Table Descriptors of the lookup table components. As described in Section C.7.6.3.1.5, a maximum of 65,536 (2^{16}) data entries is permitted, which would require input values of 16 bits to access all Palette Color Lookup Table entries. For tables with less than the maximum number of Palette Color Lookup Table entries, correspondingly smaller input values are required.

In the Enhanced Blending and Display Pipeline, the Palette Color Lookup Table input values are obtained from one or two data frames, depending on the values of the Data Path Assignment (0028,1402) Attributes; for Data Path Assignment (0028,1402) = PRIMARY_SINGLE or SECONDARY_SINGLE, the input values are obtained from stored pixel values of a single data frame (after processing through the Modality LUT and/or VOI LUT), while for Data Path Assignment (0028,1402)= SECONDARY_HIGH and SECONDARY_LOW, the input values are constructed from stored pixel values of two data frames (after processing through Modality LUTs and/or VOI LUTs) as described below.

The number of bits in each data frame stored pixel value is specified by the value of Bits Stored (0028,0101). It is possible that the number of bits in the PRIMARY_SINGLE or SECONDARY_SINGLE data frame or the sum of the numbers of bits in the SECONDARY_HIGH and SECONDARY_LOW data frames is greater than the number of bits needed to address all Palette Color Lookup Table entries. The values of Bits Mapped to Color Lookup Table (0028,1403) specify the number of bits from the corresponding data frame stored pixel values that contribute to the Palette Color Lookup Table input values, as follows:

If Data Path Assignment is PRIMARY_SINGLE or SECONDARY_SINGLE, the input to the Palette Color Lookup Table is the number of most significant bits specified by Bits Mapped to Color Lookup Table (0028,1403) from the data frame stored pixel values. For Data Path Assignment SECONDARY_HIGH or SECONDARY_LOW, the number of most significant bits specified by Bits Mapped to Color Lookup Table (0028,1403) from each data frame's stored pixel values are concatenated to create the Palette Color Lookup Table input values, with the SECONDARY_HIGH frame's bits comprising the most significant part of the input value and the SECONDARY_LOW frame's bits comprising the least significant part of the input value.

If the resulting Palette Color Lookup Table input value is greater than the number of Palette Color Lookup Table entries as specified by the Palette Color Lookup Table Descriptor first value, then the output from the Palette Color Lookup Table shall be the last value in the Palette Color Lookup Table. However, it is recommended that the values of Bits Mapped To Color Lookup Table (0028,1403) and number of Palette Color Lookup Table entries be selected such that all input values are mapped to distinct entries in the Palette Color Lookup Table.

C.7.6.23.4 Blending LUT Transfer Function

The value of Blending LUT 1 Transfer Function (0028,1405) and Blending LUT 2 Transfer Function (0028,140D) specify the algorithm used to determine the output values of the Blending LUT 1 and Blending LUT 2, respectively.

Enumerated Values:

CONSTANT A constant floating point value from 0.0 to 1.0, inclusive
ALPHA_1 Pass-through the Alpha 1 input value from the Alpha Palette Color Lookup Table of the Primary data path
ALPHA_2 Pass-through the Alpha 2 input value from the Alpha Palette Color Lookup Table of the Secondary data path
TABLE The output of a Table defining a function of the Alphas from both data paths
ONE_MINUS The Blending LUT 2 value is (1 - Blending LUT 1 output); used for Blending LUT 2 Transfer Function (0028,140D) only

If the value is TABLE:

- The Alpha 1 input value from the Alpha Palette Color Lookup Table of the Primary data path and the Alpha 2 input value from the Alpha Palette Color Lookup Table of the Secondary data are concatenated to form an index into a Lookup Table, with the Alpha 1 value providing the most significant bits of the index and the Alpha 2 value providing the least significant bits of the index.
- If the index is too large for the number of entries in the Lookup Table, the last value of the Lookup Table is used for any index value greater than the number of Lookup Table entries. If the index is too small for the number of entries in the Lookup Table, than not all entries in the Lookup Table are accessed. The total number of bits in the index value shall be equal to or less than 16.

C.7.6.23.5 Blending LUT Descriptor

The three values of the Blending Lookup Table Descriptor (0028,1407) describe the format of the data in Blending Lookup Table Data (0028,1408).

The first value is the number of entries in the lookup table. When the number of table entries is equal to 65,536 (2^{16}), then this value shall be 0. The number of entries shall be equal to the number of possible values in the input.

Note

For example, for 8 bit input to the Blending LUT the tables must have 256 entries, while for 16 bit input to the Blending LUT the tables must have 65,536 entries.

The second value is the first input value mapped, and shall always be 0 for an Blending LUT. This input value is mapped to the first entry in the LUT. Subsequent input values are mapped to the subsequent entries in the LUT Data up to an input value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. There are no input values greater than number of entries - 1.

The third value specifies the number of bits for each entry in the LUT Data. This value shall be between 8 and 16, inclusive. The LUT Data shall be stored in a format equivalent to 16 bits allocated where the high bit is equal to bits stored - 1, where bits stored is the third value.

C.7.6.23.6 Lossy Compression and Palette Color Lookup Tables (Informative)

Image objects containing non-monotonic Palette Color LUTs that are lossy compressed may potentially experience a change in the index values that results in the displayed image having a significantly different appearance than the original image.

C.7.6.24 Floating Point Image Pixel Module

Table C.7.6.24-1 describes the Floating Point Image Pixel Module. This Module differs from the Section C.7.6.3 Image Pixel Module in that:

- instead of integer stored pixel values, float stored pixel values are used
- Bits Stored (0028,0101) and High Bit (0028,0102) are not used because the stored pixel values always occupy the entire word
- Pixel Representation (0028,0103) is not used because the stored pixel values are always signed
- Photometric Interpretation is constrained
- Pixel Data Provider URL (0028,7FE0) is not used

Table C.7.6.24-1. Floating Point Image Pixel Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**
Rows	(0028,0010)	1	Number of rows in the image.
Columns	(0028,0011)	1	Number of columns in the image.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS3.5 for further explanation. Enumerated Values: **32**
Float Pixel Data	(7FE0,0008)	1	A data stream of the pixel samples that comprise the Image. The order of pixels encoded for each image plane is left to right, top to bottom, i.e., the upper left pixel (labeled 1,1) is encoded first followed by the remainder of row 1, followed by the first pixel of row 2 (labeled 2,1) then the remainder of row 2 and so on.
Pixel Aspect Ratio	(0028,0034)	1C	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. Required if the aspect ratio values do not have a ratio of 1:1 and the physical pixel spacing is not specified by Pixel Spacing (0028,0030), or Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), either for the entire Image or per-frame in a Functional Group Macro. See Section C.7.6.3.1.7.
Float Pixel Padding Value	(0028,0122)	3	One limit (inclusive) of a range of pixel values used in an image to pad to rectangular format or to signal background that may be suppressed.

Attribute Name	Tag	Type	Attribute Description
Float Pixel Padding Range Limit	(0028,0124)	1C	Pixel value that represents one limit (inclusive) of a range of padding values used together with Float Pixel Padding Value (0028,0122). Required if Float Pixel Padding Value (0028,0122) is present. Note 1. If only a single padding value rather than a range is required, then both Float Pixel Padding Value (0028,0122) and Float Pixel Padding Range Limit (0028,0124) will contain the same value. 2. The general considerations described in Section C.7.5.1.1.2 may be helpful in understanding the corresponding floating point Attributes, but are not normative.

C.7.6.25 Double Floating Point Image Pixel Module

Table C.7.6.25-1 describes the Double Floating Point Image Pixel Module. This Module differs from the Section C.7.6.3 Image Pixel Module in that:

- instead of integer stored pixel values, double float stored pixel values are used
- Bits Stored (0028,0101) and High Bit (0028,0102) are not used because the stored pixel values always occupy the entire word
- Pixel Representation (0028,0103) is not used because the stored pixel values are always signed
- Photometric Interpretation is constrained
- color palette tables are not used
- Pixel Data Provider URL (0028,7FE0) is not used

Table C.7.6.25-1. Double Floating Point Image Pixel Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**
Rows	(0028,0010)	1	Number of rows in the image.
Columns	(0028,0011)	1	Number of columns in the image.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS3.5 for further explanation. Enumerated Values: **64**
Double Float Pixel Data	(7FE0,0009)	1	A data stream of the pixel samples that comprise the Image. The order of pixels encoded for each image plane is left to right, top to bottom, i.e., the upper left pixel (labeled 1,1) is encoded first followed by the remainder of row 1, followed by the first pixel of row 2 (labeled 2,1) then the remainder of row 2 and so on.

Attribute Name	Tag	Type	Attribute Description
Pixel Aspect Ratio	(0028,0034)	1C	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size. Required if the aspect ratio values do not have a ratio of 1:1 and the physical pixel spacing is not specified by Pixel Spacing (0028,0030), or Imager Pixel Spacing (0018,1164) or Nominal Scanned Pixel Spacing (0018,2010), either for the entire Image or per-frame in a Functional Group Macro. See Section C.7.6.3.1.7.
Double Float Pixel Padding Value	(0028,0123)	3	One limit (inclusive) of a range of pixel values used in an image to pad to rectangular format or to signal background that may be suppressed.
Double Float Pixel Padding Range Limit	(0028,0125)	1C	Pixel value that represents one limit (inclusive) of a range of padding values used together with Float Pixel Padding Value (0028,0122). Required if Double Float Pixel Padding Value (0028,0123) is present. Note 1. If only a single padding value rather than a range is required, then both Double Float Pixel Padding Value (0028,0123) and Double Float Pixel Padding Range Limit (0028,0125) will contain the same value. 2. The general considerations described in Section C.7.5.1.1.2 may be helpful in understanding the corresponding floating point Attributes, but are not normative.

C.7.6.26 Real-Time Bulk Data Flow Module

This module references pixels/waveforms that are not contained within the DICOM ~~dataset~~data set but conveyed in the associated Flows, as described in Section 6.1 in PS3.22.

Table C.7.6.26-1 specifies the Attributes for the Real-Time Bulk Data Flow Module.

Table C.7.6.26-1. Real-Time Bulk Data Flow Module Attributes

Attribute Name	Tag	Type	Attribute Description
Real-Time Bulk Data Flow Sequence	(0034,000A)	1	Identifies the Source and Flows of a SMPTE ST 2110 communication providing Bulk Data. At least one item shall be included in this sequence.
>Source Identifier	(0034,0005)	1	UUID of the Source of the Flow(s). See Section C.7.6.26.1.1.
>Flow Identifier Sequence	(0034,0001)	1	Identifies the Flow(s) provided by the Source. One or more items shall be included in this sequence.
>>Flow Identifier	(0034,0002)	1	UUID of the Flow. See Section C.7.6.26.1.2.
>>Flow Transfer Syntax UID	(0034,0003)	1	UID of the encoding method of the referenced Flow See Section C.7.6.26.1.3.
>>Flow RTP Sampling Rate	(0034,0004)	1	Sampling rate in Hertz used by RTP for generating timestamp See Section C.7.6.26.1.4.

In case the Source is producing different Flows of the same Essence (e.g., video with two different sampling rates), the sequence must include at least the audio or video Flow that is associated with the present RTV Flow, and may in addition include the other Flow(s) , enabling the receiver to subscribe to another Flow.

C.7.6.26.1 Real-Time Bulk Data Flow Module Attributes

C.7.6.26.1.1 Source Identifier

The Source Identifier(0034,0005) is a Universally Unique Identifier (UUID). The value is 128 bits long encoded in binary. It shall correspond to the value of the Source Identifier of the related bulk data Flow which may contain this Source Identifier in the RTP Extended Header. In case such Source Identifier is not present in the related bulk data flow, this Source Identifier shall be set to enable multiple IODs to refer the same Source.

C.7.6.26.1.2 Flow Identifier

The Flow Identifier (0034,0002) is a Universally Unique Identifier (UUID). The value is 128 bits long encoded in binary. It shall correspond to the value of the Flow Identifier of the bulk data Flow which may contain this Flow Identifier in the RTP Extended Header. In case such Flow Identifier is not present in the related bulk data flow, this Flow Identifier shall be set to enable multiple IODs to refer the same Flow.

C.7.6.26.1.3 Flow Transfer Syntax UID

The Flow Transfer Syntax UID (0034,0003) shall be the one relative to the corresponding Flow. The sequence shall have at least one item in which the Flow Transfer Syntax UID and the Flow RTP Sampling Rate correspond to the Transfer Syntax UID (0002,0010) and RTV Flow RTP Sampling Rate (0002,0037) , respectively, of the DICOM-RTV Meta Information Header.

C.7.6.26.1.4 Flow RTP Sampling Rate

The Flow RTP Sampling Rate (0034,0004) shall be the one defined in the SDP of the corresponding Flow.

C.7.6.27 Current Frame Functional Groups Module

Table C.7.6.27-1 defines the Attributes related to the current frame when the IOD is transported using Real-Time Communication. It corresponds to the "per-frame" Attribute for the non-Real-Time IODs.

Note

The group number (0006H) of the Sequence containing the Attributes of the Current Frame Functional Groups Module is used to contain Attributes that are specific to real-time transfer. If this information needs to be kept in a persistent object, its contents have to be copied into an Attribute that has a group number of 0008H or higher. The Current Frame Functional Groups Module is relative to the dynamic part of the RTP Payload. Its group number is lower than that of other Attributes in order to be placed before the static part of the RTP Payload, but higher than the Attributes of the RTV Metadata Information, in order to be placed after the header of the RTP Payload, as is done in PS3.10.

Table C.7.6.27-1. Current Frame Functional Groups Module Attributes

Attribute Name	Tag	Type	Attribute Description
Current Frame Functional Groups Sequence	(0006,0001)	1	Sequence that contains the Functional Groups Sequence Attributes corresponding to the current frame or audio sample. Only a single Item shall be included in this Sequence.
>Include one or more Functional Group Macros that are contained in every frame.			For each IOD that includes this module, a table is defined in which the permitted Functional Group Macros and their usage is specified.

C.7.6.27.1 Current Frame Functional Groups Module Attributes

C.7.6.27.1.1 Frame Origin Timestamp

Frame Origin Timestamp (0034,0007) contains 10 bytes conforming with the IEEE 1588:2008 (PTPv2) standard. IEEE 1588:2008 represents seconds and nanoseconds since Epoch, defined as 1 of January, 1970, at 00:00:00 TAI (International Atomic Time). The first 6 bytes contain the number of seconds, and the last 4 bytes contain the number of nanoseconds. The Time Source and Time Distribution Protocol values defined in Table C.7-7 “Synchronization Module Attributes” describe how the time was obtained.

If the RTP Header extension of a frame contains an PTP Origin Timestamp, that values shall be used for the Frame Origin Timestamp. Otherwise, the Frame Origin Timestamp value can be derived from Flow RTP sampling rate, the RTP Timestamp, and the reference time for the RTP Timestamp.

Frame Origin Timestamp is used to pair content from different Flows (payload flow with metadata flow), through a time alignment mechanism.

C.7.6.28 Real-Time Acquisition Module

Table C.7.6.28-1 defines the Attributes related to all frames when the IOD is transported using Real-Time Communication.

Table C.7.6.28-1. Real-Time Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shared Functional Group Sequence	(5200,9229)	1	Sequence that contains the Functional Group Macros that are shared for all frames. Only a single Item shall be included in this Sequence.
>Include one or more Functional Group Macros that are shared by all frames.			For each IOD that includes this module, a table is defined in which the permitted Functional Group Macros and their usage is specified. The Item may be empty if the requirements for inclusion of the Functional Groups are not satisfied.
Stereo Pairs Present	(0022,0028)	1	The multi-frame pixel data consists of left and right stereoscopic pairs. See Section C.7.6.28.1.1 for further explanation. Enumerated Values: **YES** **NO**

C.7.6.28.1 Real-Time Acquisition Module Attributes

C.7.6.28.1.1 Stereo Pairs Present

Stereo Pairs Present (0022,0028) shall have the value of YES when frame is encoded as left and right stereoscopic pair.

C.7.7 Patient Summary Module

Retired. See PS3.3-2004.

C.7.8 Study Content Module

Retired. See PS3.3-2004.

C.7.9 Palette Color Lookup Table Module

Table C.7-22 specifies the Attributes that describe the Lookup table data for images with Palette Color photometric interpretation.

When the Palette Color Lookup Table Module is present in an Image IOD, the conditional requirements for the use of Palette Color Lookup Table Data (0028,1201-1203) and Segmented Palette Color Lookup Table Data (0028,1221-1223), described in Table C.7-22, shall take precedence over the conditional requirements described in the Image Pixel Module (see Section C.7.6.3). When the Palette Color Lookup Table Module is present in a Presentation State IOD, the Palette Color Lookup Table Data (0028,1201-1203) Attributes are mandatory and the Segmented Palette Color Lookup Table Data (0028,1221-1223) shall not be present. When the Palette Color Lookup Table Module is present in a Color Palette IOD, either the Palette Color Lookup Table Data (0028,1201-1203) or Segmented Palette Color Lookup Table Data (0028,1221-1223) Attributes may be used.

When the Palette Color Lookup Table Module is present in a Color Palette IOD, the 3rd value of Palette Color Lookup Table Descriptor (0028,1101-1103) (i.e, the number of bits for each entry in the Lookup Table Data) shall be 8.

Table C.7-22. Palette Color Lookup Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.7-22a "Palette Color Lookup Table Macro Attributes"			

Table C.7-22a. Palette Color Lookup Table Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Red Palette Color Lookup Table Descriptor	(0028,1101)	1	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). See Section C.7.6.3.1.5 for further explanation.
Green Palette Color Lookup Table Descriptor	(0028,1102)	1	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). See Section C.7.6.3.1.5 for further explanation.
Blue Palette Color Lookup Table Descriptor	(0028,1103)	1	Specifies the format of the Blue Palette Color Lookup table Data (0028,1203). See Section C.7.6.3.1.5 for further explanation.
Palette Color Lookup Table UID	(0028,1199)	3	Palette Color Lookup Table UID. See Section C.7.9.1 for further explanation.
Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. Required if segmented data is NOT used in an Image IOD or Color Palette IOD, or if the IOD is a Presentation State IOD. See Section C.7.6.3.1.6 for further explanation.
Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. Required if segmented data is NOT used in an Image IOD or Color Palette IOD, or if the IOD is a Presentation State IOD. See Section C.7.6.3.1.6 for further explanation.
Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. Required if segmented data is NOT used in an Image IOD or Color Palette IOD, or if the IOD is a Presentation State IOD. See Section C.7.6.3.1.6 for further explanation.
Segmented Red Palette Color Lookup Table Data	(0028,1221)	1C	Segmented Red Palette Color Lookup Table Data. Required if segmented data is used in an Image IOD or Color Palette IOD; shall not be present in a Presentation State IOD. See Section C.7.9.2 for further explanation.
Segmented Green Palette Color Lookup Table Data	(0028,1222)	1C	Segmented Green Palette Color Lookup Table Data. Required if segmented data is used in an Image IOD or Color Palette IOD; shall not be present in a Presentation State IOD See Section C.7.9.2 for further explanation.
Segmented Blue Palette Color Lookup Table Data	(0028,1223)	1C	Segmented Blue Palette Color Lookup Table Data. Required if segmented data is used in an Image IOD or Color Palette IOD; shall not be present in a Presentation State IOD. See Section C.7.9.2 for further explanation.

C.7.9.1 Palette Color Lookup Table UID

This Attribute uniquely identifies a palette color lookup table set (red, green, blue).

Note

This can be used to avoid reloading a palette if a system already has that palette loaded without examining all the data entries in the palette.

If this Attribute is present in a Color Palette IOD, it shall have the same value as the SOP Instance UID.

C.7.9.2 Segmented Palette Color Lookup Table Data

The Segmented Palette Color Lookup Table Data (0028,1221-1223) is stored as a series of segments, see Table C.7-23. When the segments are expanded into the actual lookup table data, it shall have the number of table entries specified by the first value of the Palette Color Lookup Table Descriptors (0028,1101-1103), Number of Table Entries.

These lookup tables shall be used only when segmented lookup table data use is desirable and there is a single sample per pixel (single image plane) in the image.

Table C.7-23. Compressed Palette Color Lookup Table Data

Segment 0
Segment 1
…
Segment n

There are currently three types of segments: discrete, linear, and indirect. The segments type is identified by the opcodes in Table C.7-24.

Table C.7-24. Segment Types

Opcode	Segment type
0	Discrete
1	Linear
2	Indirect
3 & above	reserved

C.7.9.2.1 Discrete Segment Type

The discrete segment is used to represent a series of palette components that are not monotonic with respect to their predecessors or successors. The Segment Length indicates the number of lookup table entries.

The format of the Discrete Segment Type shall be as in Table C.7-25.

Table C.7-25. Discrete Segment Type

Segment Opcode = 0
Segment Length
Segment Length number of lookup table entries

C.7.9.2.2 Linear Segment Type

The linear segment represents a series of palette components whose values may be represented by a straight line.

X = palette address, Y = Value contained in the palette.

($\cancel{X_0}X_0$, $\cancel{Y_0}Y_0$) = end of the previous segment

($\cancel{X_0}X_0$ + Segment Length, $\cancel{Y_1}Y_1$) = end of this linear segment

Where: ~~Y1~~Y_1 is contained in the data portion of this segment.

During expansion, the application should "connect" the previous segment's endpoint, (~~Xo~~X_0, ~~Yo~~Y_0), with this segment's endpoint, (~~Xo~~X_0 + Segment Length, ~~Y1~~Y_1) using a straight line, by computing the values for each point between the endpoints.

Note

Because the linear segment uses the end point from the previous segment, a linear segment can not be the first segment.

The linear segment's format shall be as in Table C.7-26.

Table C.7-26. Linear Segment Type

Segment Opcode = 1
Segment Length
Y1

C.7.9.2.3 Indirect Segment Type

The indirect segment allows the re-use of repetitive regions within lookup table without respecifying the segment. The opcode is followed by the number of segments to copy and one offset pointer to the first segment to copy. The byte offset is relative to the beginning of the lookup table. For example, if an indirect segment wants to point to the first segment, then the offset will be zero. The offset is a 32 bit value but is stored in the segment as a least significant 16 bit value followed by a most significant 16 bit value. An indirect segment shall not point to or copy another indirect segment. This avoids the need for recursion and also avoids the possibility of infinite loops.

The indirect segment's format shall be as follows:

Table C.7-27. Indirect Segment Type

Segment Opcode = 2
Number of segments to copy
Least significant 16 bits of byte offset to first segment to copy
Most significant 16 bits of byte offset to first segment to copy

C.8 Modality Specific Modules

C.8.1 Computed Radiography Modules

This Section describes Computed Radiography Series and Image Modules. These Modules contain Attributes that are specific to Computed Radiography images. There is no Computed Radiography Equipment Module.

C.8.1.1 CR Series Module

Table C.8-1 contains IOD Attributes that describe a computed radiography Series performed on the patient.

Table C.8-1. CR Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Body Part Examined	(0018,0015)	2	Text description of the part of the body examined. See Annex L “Correspondence of Anatomic Region Codes and Body Part Examined Defined Terms” in PS3.16 for Defined Terms

Attribute Name	Tag	Type	Attribute Description
View Position	(0018,5101)	2	Radiographic view associated with Patient Position (0018,5100). For humans: Defined Terms: **AP** Anterior/Posterior **PA** Posterior/Anterior **LL** Left Lateral **RL** Right Lateral **RLD** Right Lateral Decubitus **LLD** Left Lateral Decubitus **RLO** Right Lateral Oblique **LLO** Left Lateral Oblique For animals, capitalized versions with hyphens replaced by underscores of the abbreviations defined in "Smallwood et al. A Nomenclature for Radiographic Projections Used In Veterinary Medicine" shall be used. See CID 7484 “DX View for Animals”, in which these abbreviations are listed. Note 1. For example, the Defined Term "CD10DI_CRPRO" would be used for a "Cd10Di-CrPrO" or "caudal 10-degree distal-cranioproximal oblique". 2. The Code String value representation for this Attribute constrains the characters to uppercase, digits and underscore.
Filter Type	(0018,1160)	3	Label for the type of filter inserted into the X-Ray beam
Collimator/grid Name	(0018,1180)	3	Label describing any grid inserted.
Focal Spot(s)	(0018,1190)	3	Size of the focal spot in mm. For devices with variable focal spot or multiple focal spots, small dimension followed by large dimension.
Plate Type	(0018,1260)	3	Label of the type of storage phosphor plates used in this Series
Phosphor Type	(0018,1261)	3	Label of type of phosphor on the plates

C.8.1.2 CR Image Module

Table C.8-2 contains IOD Attributes that describe computed radiography images.

Table C.8-2. CR Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME1** **MONOCHROME2**
KVP	(0018,0060)	3	Peak kilo voltage output of the X-Ray generator used
Plate ID	(0018,1004)	3	The ID or serial number of the sensing plate upon which the image was acquired

Attribute Name	Tag	Type	Attribute Description
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID).
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to center of field of view. Note This value is traditionally referred to as Source Object Distance (SOD).
Exposure Time	(0018,1150)	3	Time of X-Ray exposure in msec
X-Ray Tube Current	(0018,1151)	3	X-Ray Tube Current in mA.
Exposure	(0018,1152)	3	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current.
Exposure in µAs	(0018,1153)	3	The exposure expressed in µAs, for example calculated from Exposure Time and X-Ray Tube Current.
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel. Specified by a numeric pair - row spacing value (delimiter) column spacing value - in mm. In the case of CR, the front plane is defined to be the external surface of the CR plate closest to the patient and radiation source.
Include Table 10-10 “Basic Pixel Spacing Calibration Macro Attributes”			
Generator Power	(0018,1170)	3	Power in kW to the X-Ray generator.
Acquisition Device Processing Description	(0018,1400)	3	Describes device-specific processing associated with the image (e.g., Organ Description)
Acquisition Device Processing Code	(0018,1401)	3	Code representing the device-specific processing associated with the image (e.g., CR Organ Filtering code)
Cassette Orientation	(0018,1402)	3	Orientation of cassette, used to properly position the image for display. Enumerated Values: **LANDSCAPE** **PORTRAIT**
Cassette Size	(0018,1403)	3	Size of cassette. Defined Terms: **18CMX24CM** **8INX10IN** **24CMX30CM** **10INX12IN** **30CMX35CM** **30CMX40CM** **11INX14IN** **35CMX35CM** **14INX14IN** **35CMX43CM** **14INX17IN**

Attribute Name	Tag	Type	Attribute Description
Exposures on Plate	(0018,1404)	3	Total number of X-Ray exposures that have been made on the plate identified in Plate ID (0018,1004)
Relative X-Ray Exposure	(0018,1405)	3	Relative X-Ray exposure on the plate. Meaning of values is implementation specific. May be used to adjust the dynamic range of the plate digitizer (scanner). Note This value is manufacturer-specific. DICOM specifies Standard Attributes in Table 10-23 “Exposure Index Macro Attributes”, which are recommended.
Sensitivity	(0018,6000)	3	Read out sensitivity. Note This value is manufacturer-specific. DICOM specifies Standard Attributes in Table 10-23 'Exposure Index Macro', which are recommended.
Include Table 10-7 “General Anatomy Optional Macro Attributes”			*Anatomic Region Sequence DCID 4009 “DX Anatomy Imaged”for humans, and CID 7482 “DX Anatomy Imaged for Animals” for animals.*
Include Table 10-23 “Exposure Index Macro Attributes”			

C.8.2 CT Modules

This Section describes the CT Image Module. This Module contains all Attributes that are specific to CT images.

C.8.2.1 CT Image Module

The table in this Section contains IOD Attributes that describe CT images.

Table C.8-3. CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.2.1.1.1 for specialization.
Multi-energy CT Acquisition	(0018,9361)	3	Indicates whether the image is created by means of Multi-energy technique. Enumerated Values: **YES** **NO**
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.8.2.1.1.2 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.2.1.1.3 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.2.1.1.4 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.2.1.1.5 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See Section C.8.2.1.1.6 for specialization.

Attribute Name	Tag	Type	Attribute Description
Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV+b If Image Type (0008,0008) Value 1 is ORIGINAL and Value 3 is not LOCALIZER, and Multi-energy CT Acquisition (0018,9361) is either absent or NO, output units shall be Hounsfield Units (HU).
Rescale Slope	(0028,1053)	1	m in the equation specified in Rescale Intercept (0028,1052).
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for Defined Terms and further explanation. Required if the Rescale Type is not HU (Hounsfield Units), or Multi-energy CT Acquisition (0018,9361) is YES. May be present otherwise.
KVP	(0018,0060)	2	Peak kilo voltage output of the X-Ray generator used. Shall be empty if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362).
Acquisition Number	(0020,0012)	2	A number identifying the single continuous gathering of data over a period of time that resulted in this image
Scan Options	(0018,0022)	3	Parameters of scanning sequence. ~~Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).~~
Data Collection Diameter	(0018,0090)	3	The diameter in mm of the region over which data were collected. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Data Collection Center (Patient)	(0018,9313)	3	The x, y, and z coordinates (in the Patient-Based Coordinate System) in mm of the center of the region in which data were collected. See Section C.8.15.3.6.1.
Reconstruction Diameter	(0018,1100)	3	Diameter in mm of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011).

Attribute Name	Tag	Type	Attribute Description
Reconstruction Target Center (Patient)	(0018,9318)	3	The x, y, and z coordinates (in the Patient-Based Coordinate System) of the reconstruction center target point as used for reconstruction in mm. See Section C.8.15.3.6.1. Note If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (Patient) (0018,9313) Attribute.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID). Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to isocenter (center of field of view). Note This value is traditionally referred to as Source Object Distance (SOD). ~~Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).~~
Gantry/Detector Tilt	(0018,1120)	3	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations.
Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation; below the center is positive.
Rotation Direction	(0018,1140)	3	Direction of rotation of the source when relevant, about nearest principal axis of equipment. Enumerated Values: **CW** clockwise **CC** counter clockwise
Exposure Time	(0018,1150)	3	Time of X-Ray exposure in msec. If Acquisition Type (0018,9302) equals SPIRAL, the value of this Attribute shall be Revolution Time (0018,9305) divided by the Spiral Pitch Factor (0018,9311). See Section C.8.15.3.8.1 and Section C.8.15.3.2.1. Shall not be present if ~~this Attribute~~the corresponding Attribute, Exposure Time in ms (0018,9328), is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
X-Ray Tube Current	(0018,1151)	3	X-Ray Tube Current in mA. Shall not be present if ~~this Attribute~~the corresponding Attribute, X-Ray Tube Current in mA (0018,9330), is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).

Attribute Name	Tag	Type	Attribute Description
Exposure	(0018,1152)	3	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current. Shall not be present if ~~this Attribute~~the corresponding Attribute, Exposure in mAs (0018,9332), is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Exposure in µAs	(0018,1153)	3	The exposure expressed in µAs, for example calculated from Exposure Time and X-Ray Tube Current. Shall not be present if ~~this Attribute~~the corresponding Attribute, Exposure in mAs (0018,9332), is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Filter Type	(0018,1160)	3	Label for the type of filter inserted into the X-Ray beam. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Generator Power	(0018,1170)	3	Power in kW to the X-Ray generator. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Focal Spot(s)	(0018,1190)	3	Size of the focal spot in mm. For devices with variable focal spot or multiple focal spots, small dimension followed by large dimension. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data
Revolution Time	(0018,9305)	3	The time in seconds of a complete revolution of the source around the gantry orbit.
Single Collimation Width	(0018,9306)	3	The width of a single row of acquired data (in mm). Note Adjacent physical detector rows may have been combined to form a single effective acquisition row. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).
Total Collimation Width	(0018,9307)	3	The width of the total collimation (in mm) over the area of active X-Ray detection. Note This will be equal the number of effective detector rows multiplied by single collimation width. Shall not be present if this Attribute is present in Multi-energy CT Acquisition Sequence (0018,9362) and the value of this Attribute is not the same in all Items of the Multi-energy CT Acquisition Sequence (0018,9362).

Attribute Name	Tag	Type	Attribute Description
Table Speed	(0018,9309)	3	The distance in mm that the table moves in one second during the gathering of data that resulted in this image.
Table Feed per Rotation	(0018,9310)	3	Motion of the table (in mm) during a complete revolution of the source around the gantry orbit.
Spiral Pitch Factor	(0018,9311)	3	Ratio of the Table Feed per Rotation (0018,9310) to the Total Collimation Width (0018,9307).
Exposure Modulation Type	(0018,9323)	3	A label describing the type of exposure modulation used for the purpose of limiting the dose. Defined Terms: **NONE**
Estimated Dose Saving	(0018,9324)	3	A percent value of dose saving due to the use of Exposure Modulation Type (0018,9323). A negative percent value of dose savings reflects an increase of exposure.
CTDIvol	(0018,9345)	3	Computed Tomography Dose Index ($CTDI_{vol}$), in mGy according to IEC 60601-2-44, Ed.2.1 (Clause 29.1.103.4), The Volume $CTDI_{vol}$. It describes the average dose for this image for the selected CT conditions of operation.
CTDI Phantom Type Code Sequence	(0018,9346)	3	The type of phantom used for CTDI measurement according to [IEC 60601-2-44]. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4052 "Phantom Devices".*
Water Equivalent Diameter	(0018,1271)	3	The diameter, in mm, of a cylinder of water having the same X-Ray attenuation as the patient for this reconstructed slice (e.g., as described in [AAPM Report 220]).
Water Equivalent Diameter Calculation Method Code Sequence	(0018,1272)	1C	The method of calculation of Water Equivalent Diameter (0018,1271). Required if Water Equivalent Diameter (0018,1271) is present. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 10024 "Water Equivalent Diameter Method".*
Image and Fluoroscopy Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of the entire Irradiation Event from which this image was reconstructed. Note 1. All of the images reconstructed from the same Irradiation Event will have the same value for this Attribute, which is the total for the Irradiation Event, which is repeated in each image, regardless of whether or not the Irradiation Event UID (0008,3010) is present with a value in the Multi-frame Dimension Module. I.e., the values for each image should not be summed. The sum of the area dose products of all encoded Irradiation Events may not result in the total area dose product to which the patient was exposed. 2. This may be an estimated value based on assumptions about the Patient's body size and habitus. 3. This value is required by [IEC 60601-2-63].
Include Table 10-7 "General Anatomy Optional Macro Attributes"			*Anatomic Region Sequence DCID 4030 "CT, MR and PET Anatomy Imaged".*

Attribute Name	Tag	Type	Attribute Description
Include Table 10-25 “Optional View and Slice Progression Direction Macro Attributes”			
Calcium Scoring Mass Factor Patient	(0018,9351)	3	The calibration factor for the calcium mass score. These factors incorporate the effects of • KV value of the CT image • the patient size. • machine specific corrections See Section C.8.2.1.1.7.
Calcium Scoring Mass Factor Device	(0018,9352)	3	The calibration factors for the calcium mass score of the device. These factors incorporate the effects of • KV value of the CT image • machine specific corrections This a multi-value Attribute, the first value specifies the mass factor for a small patient size, the second value for a medium patient size and the third value for a large patient size. See Section C.8.2.1.1.7.
Energy Weighting Factor	(0018,9353)	1C	The weighting factor of the data from the primary source in a multiple energy composition image. This factor incorporates the effects of • the specific X-Ray source and kV value • examination specific characteristics. Required if one Derivation Code Sequence (0008,9215) Item value is (113097, DCM, "Multi-energy proportional weighting"). May be present otherwise.
CT Additional X-Ray Source Sequence	(0018,9360)	3	Contains the Attributes describing additional acquisition parameters beyond the primary source in a multiple X-Ray source system or a multi-energy acquisition. The primary X-Ray source is specified in other Attributes of this Module. One or more Items are permitted in this Sequence.
>KVP	(0018,0060)	1	Peak kilo voltage output of the X-Ray generator used.
>X-Ray Tube Current in mA	(0018,9330)	1	Nominal X-Ray tube current in milliamperes.
>Data Collection Diameter	(0018,0090)	1	The diameter in mm of the region over which data were collected.
>Focal Spot(s)	(0018,1190)	1	Used nominal size of the focal spot in mm.
>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam.
>Filter Material	(0018,7050)	1	The X-Ray absorbing material used in the filter.
>Exposure in mAs	(0018,9332)	3	The exposure expressed in milliampere seconds, for example calculated from exposure time and X-Ray tube current.

Attribute Name	Tag	Type	Attribute Description
>Energy Weighting Factor	(0018,9353)	1C	The weighting factor of the data from this additional source in a multiple energy composition image. This factor incorporates the effects of • the specific X-Ray source and kV value • examination specific characteristics. Required if one Derivation Code Sequence (0008,9215) Item value is (113097, DCM, "Multi-energy proportional weighting"). May be present otherwise.
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
Include Table 10-27 "RT Equipment Correlation Macro Attributes Description"			

C.8.2.1.1 CT Image Attribute Descriptions

C.8.2.1.1.1 Image Type

For CT Images, Image Type (0008,0008) is specified to be Type 1.

Defined Terms for Value 3:

AXIAL a CT Cross-sectional Image
LOCALIZER a CT Localizer Image

Note

Cross-sectional images include transverse, coronal, sagittal and oblique images.

Image Type (0008,0008) Value 4 shall be present if Multi-energy CT Acquisition (0018,9361) has a value of YES.

Defined Terms for Value 4 for Multi-energy CT Images:

VMI a Virtual Monoenergetic Image. Each real-world value mapped pixel represents CT Hounsfield units and is analogous to a CT image created by a monoenergetic (of a specific keV value) X-Ray beam.
MAT_SPECIFIC a Material-Specific Image. Each real-world value mapped pixel value represents a property of a material such as attenuation, concentration or density.
MAT_REMOVED An image with the attenuation contribution of one or more materials removed. For pixels that did not contain any of the removed material(s), the pixel values are unchanged.
MAT_FRACTIONAL a Material-Fractional Image. Each real-world value mapped pixel represents the fraction of a voxel occupied by a material.
EFF_ATOMIC_NUM an Effective Atomic Number Image. Each real-world value mapped pixel represents Effective Atomic Number of the materials in the voxel.
ELECTRON_DENSITY an Electron Density Image. Each real-world value mapped pixel represents the number of electrons per unit volume or the electron density relative to water.
MAT_MODIFIED a Material-Modified Image. CT Image where real-world value mapped pixels have been modified to highlight a certain target material (either by partially suppressing the background or by enhancing the target material), or to partially suppress the target material.
MAT_VALUE_BASED a Value-Based Image. CT Image where real-world value mapped pixels represent a certain value for a specified material

Note

Multi-energy CT images are not necessarily DERIVED and may be ORIGINAL\PRIMARY.

When an image is created by a generic transformation an implementation-specific Value 4 may be provided.

C.8.2.1.1.2 Samples Per Pixel

Enumerated Values:

1

C.8.2.1.1.3 Photometric Interpretation

Enumerated Values:

MONOCHROME1
MONOCHROME2

See Section C.7.6.3.1.2 for definition of these terms.

C.8.2.1.1.4 Bits Allocated

Enumerated Values:

16

C.8.2.1.1.5 Bits Stored

Enumerated Values:

12
13
14
15
16

C.8.2.1.1.6 High Bit

For CT Images, High Bit (0028,0102) shall be one less than the value of Bits Stored (0028,0101).

C.8.2.1.1.7 Calcium Scoring Mass Factor Patient and Device

The calibration factors for the Calcium Scoring Mass Factor Patient (0018,9351) and Calcium Scoring Mass Factor Device (0018,9352) Attributes are defined by the International Consortium for Multi-Detector CT Evaluation of Coronary Calcium, see McCollough, C.H. "A multi-institutional, multi-manufacturer, international standard for the quantification of coronary artery calcium using cardiac CT".

C.8.2.2 Multi-energy CT Image Module

The table in this Section contains IOD Attributes that describe a Multi-energy CT image.

Table C.8.2.2-1. Multi-energy CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT Acquisition Sequence	(0018,9362)	1	The attributes of a Multi-energy CT Image acquisition. One Item shall be included in this Sequence.
>Multi-energy Acquisition Description	(0018,937B)	3	Human readable summary of the Multi-Energy technique applied during the acquisition.
>Include Table C.8.2.2-2 “Multi-energy CT X-Ray Source Macro Attributes”			
>Include Table C.8.2.2-3 “Multi-energy CT X-Ray Detector Macro Attributes”			
>Include Table C.8.2.2-4 “Multi-energy CT Path Macro Attributes”			
>Include Table C.8-124 “CT Exposure Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Include Table C.8-125 “CT X-Ray Details Sequence Macro Attributes”			
>Include Table C.8-119 “CT Acquisition Details Macro Attributes”			
>Include Table C.8-122 “CT Geometry Macro Attributes”			
Include Table C.8.15.3.13-1 “Multi-energy CT Processing Macro Attributes”			
Include Table C.8.15.3.12-1 “Multi-energy CT Characteristics Macro Attributes”			

C.8.2.2.1 Multi-energy CT X-Ray Source Macro

Attributes for the CT X-Ray Source(s).

Table C.8.2.2-2. Multi-energy CT X-Ray Source Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT X-Ray Source Sequence	(0018,9365)	1	X-Ray Source (see Section C.8.2.2.1.1) information. One or more Items shall be included in this Sequence.
>X-Ray Source Index	(0018,9366)	1	Identification number of this item in the Multi-energy CT X-Ray Source Sequence. The number shall be 1 for the first Item and increase by 1 for each subsequent Item.
>X-Ray Source ID	(0018,9367)	1	Identifier of the physical X-Ray source. This might be the serial number. The X-Ray Source ID (0018,9367) will have the same value for different values of X-Ray Source Index (0018,9366) if a single source generates different nominal energies.
>Multi-energy Source Technique	(0018,9368)	1	Technique used to acquire Multi-energy data. Defined Terms: **SWITCHING_SOURCE** a physical X-Ray source (tube) uses beam mode switching **CONSTANT_SOURCE** a physical X-Ray source (tube) uses a beam with constant characteristics
>Source Start DateTime	(0018,9369)	1	The date and time this X-Ray source (see Section C.8.2.2.1.1) was first used in this Multi-energy acquisition.
>Source End DateTime	(0018,936A)	1	The date and time this X-Ray source (see Section C.8.2.2.1.1) was last used in this Multi-energy acquisition.
>Switching Phase Number	(0018,936B)	1C	A number, unique within the sequence, to identify the switching phase. Required if Multi-energy Source Technique (0018,9368) is "SWITCHING_SOURCE".
>Switching Phase Nominal Duration	(0018,936C)	3	Duration, in microseconds, that the energy is nominally in the target KV for this switching phase. I.e., the Switching Phase Nominal Duration does not include the Switching Phase Transition Duration (0018,936D). The target KV is the value of KVP (0018,0060) for the item in the CT X-Ray Details Sequence (0018,9325) that identifies the Multi-energy CT Path Index (0018,937A) that corresponds to this X-Ray Source. Note Applicable if Multi-energy Source Technique (0018,9368) is "SWITCHING_SOURCE".

Attribute Name	Tag	Type	Attribute Description
>Switching Phase Transition Duration	(0018,936D)	3	Duration, in microseconds, that the energy has left the target KV for this switching phase, but has not yet reached the target KV for the next phase. The target KV is the value of KVP (0018,0060) for the item in the CT X-Ray Details Sequence (0018,9325) that identifies the Multi-energy CT Path Index (0018,937A) that corresponds to this X-Ray Source. Note Applicable if Multi-energy Source Technique (0018,9368) is "SWITCHING_SOURCE".
>Generator Power	(0018,1170)	3	Power in kW going into the X-Ray generator.

C.8.2.2.1.1 Multi-energy X-Ray Source Description

Each item in the Multi-energy CT X-Ray Source Sequence (0018,9365) might describe either a constant source, a constant source with energy selective filter or one output corresponding to a specific energy of a KV switching source. The attributes will refer to a source, meaning one item in the Multi-energy CT X-Ray Source Sequence (0018,9365). The attributes use the phrase "physical X-Ray Source" when it is necessary to refer to the actual device (tube) rather than the current item.

C.8.2.2.2 Multi-energy CT X-Ray Detector Macro

Attributes for the CT X-Ray Detector(s).

Table C.8.2.2-3. Multi-energy CT X-Ray Detector Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT X-Ray Detector Sequence	(0018,936F)	1	X-Ray Detector (see Section C.8.2.2.1.1) information. One or more Items shall be included in this Sequence.
>X-Ray Detector Index	(0018,9370)	1	Identification number of this item in the Multi-energy CT X-Ray Detector Sequence. The number shall be 1 for the first Item and increase by 1 for each subsequent Item.
>X-Ray Detector ID	(0018,9371)	1	Identifier of the physical X-Ray detector. This might be the serial number. When a single detector discriminates different energies, the X-Ray Detector ID (0018,9371) will have the same value in different Items of Multi-energy CT X-Ray Detector Sequence (0018,936F).
>Multi-energy Detector Type	(0018,9372)	1	Technology used to detect multiple energies. Defined Terms: **INTEGRATING** physical detector integrates the full X-Ray spectrum. **MULTILAYER** physical detector layers absorb different parts of the X-Ray spectrum **PHOTON_COUNTING** physical detector counts photons with energy discrimination capability
>X-Ray Detector Label	(0018,9373)	3	Label of this item in the Multi-energy CT X-Ray Detector Sequence. Note The label might be High, Low or some nominal bin energy.

Attribute Name	Tag	Type	Attribute Description
>Nominal Max Energy	(0018,9374)	1C	Nominal maximum energy in keV of photons that are integrated/counted by the detector (see Section C.8.2.2.1.1). Due to energy resolution limits of the detector, some photons above the nominal maximum may be counted. Required if Multi-energy Detector Type (0018,9372) is PHOTON_COUNTING. May be present otherwise.
>Nominal Min Energy	(0018,9375)	1C	Nominal minimum energy in keV of photons that are integrated/counted by the detector (see Section C.8.2.2.1.1). Due to energy resolution limits of the detector, some photons below the nominal minimum may be counted. Required if Multi-energy Detector Type (0018,9372) is PHOTON_COUNTING. May be present otherwise.
>Effective Bin Energy	(0018,936E)	3	Energy of the heterogeneous (polychromatic) photon beam represented by this detector (see Section C.8.2.2.1.1) calculated as if it were monochromatic. Note E.g., this can be calculated based on the beam spectrum or derived from the attenuation of phantom measurement.

C.8.2.2.2.1 Multi-energy X-Ray Detector Description

Each item in the Multi-energy CT X-Ray Detector Sequence (0018,936F) might describe either an integrating detector or one output corresponding to a specific spectrum of a physical detector like:

- One layer of a multi-layer detector.
- One energy bin of a photon counting detector.
- One energy threshold of a photon counting detector.

The sequence attribute descriptions will refer to a detector, meaning one item in the Multi-energy CT X-Ray Detector Sequence (0018,936F). The attributes use the phrase "physical detector" when it is necessary to refer to the actual device rather than the current item.

C.8.2.2.3 Multi-energy CT Path Macro

A Multi-energy ~~CTPath~~CT Path is an X-Ray source paired with a corresponding X-Ray detector for a particular energy level.

Table C.8.2.2-4. Multi-energy CT Path Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT Path Sequence	(0018,9379)	1	Describes the paths corresponding to each energy level of a Multi-energy acquisition. Each path consists of a source (see Section C.8.2.1.1.1) and a detector (see Section C.8.2.2.1.1). Two or more Items shall be included in this Sequence. See also Section C.8.2.2.1 and Section C.8.2.2.2.
>Multi-energy CT Path Index	(0018,937A)	1	Identification number of the element in the Multi-energy CT Path Sequence. The number shall be 1 for the first Item and increase by 1 for each subsequent Item.
>Referenced X-Ray Source Index	(0018,9377)	1	References the X-Ray Source Index (0018,9366) in the Multi-energy CT X-Ray Source Sequence (0018,9365) in this path.

Attribute Name	Tag	Type	Attribute Description
>Referenced X-Ray Detector Index	(0018,9376)	1	References the X-Ray Detector Index (0018,9370) in the Multi-energy CT X-Ray Detector Sequence (0018,936F) in this path.

C.8.3 MR Modules

This Section describes the MR Image Module. This Module contains all Attributes that are specific to MR images.

C.8.3.1 MR Image Module

Table C.8-4 contains the Attributes that describe MR images.

Table C.8-4. MR Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.3.1.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.8.3.1.1.2 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.3.1.1.3 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.3.1.1.4 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).
Scanning Sequence	(0018,0020)	1	Description of the type of data taken. Enumerated Values: **SE** Spin Echo **IR** Inversion Recovery **GR** Gradient Recalled **EP** Echo Planar **RM** Research Mode Note Multi-valued, but not all combinations are valid (e.g., SE/GR, etc.).
Sequence Variant	(0018,0021)	1	Variant of the Scanning Sequence. Defined Terms: **SK** segmented k-space **MTC** magnetization transfer contrast **SS** steady state **TRSS** time reversed steady state **SP** spoiled **MP** MAG prepared **OSP** oversampling phase **NONE** no sequence variant

Attribute Name	Tag	Type	Attribute Description
Scan Options	(0018,0022)	2	Parameters of scanning sequence. Defined Terms: **PER** Phase Encode Reordering **RG** Respiratory Gating **CG** Cardiac Gating **PPG** Peripheral Pulse Gating **FC** Flow Compensation **PFF** Partial Fourier - Frequency **PFP** Partial Fourier - Phase **SP** Spatial Presaturation **FS** Fat Saturation
MR Acquisition Type	(0018,0023)	2	Identification of data encoding scheme. Enumerated Values: **2D** frequency x phase **3D** frequency x phase x phase
Repetition Time	(0018,0080)	2C	The period of time in msec between the beginning of a pulse sequence and the beginning of the succeeding (essentially identical) pulse sequence. Required if Sequence Variant (0018,0021) is SK or if Scanning Sequence (0018,0020) is not EP. May be present otherwise.
Echo Time	(0018,0081)	2	Time in ms between the middle of the excitation pulse and the peak of the echo produced (kx=0). In the case of segmented k-space, the TE(eff) is the time between the middle of the excitation pulse to the peak of the echo that is used to cover the center of k-space (i.e., -kx=0, ky=0).
Echo Train Length	(0018,0091)	2	Number of lines in k-space acquired per excitation per image.
Inversion Time	(0018,0082)	2C	Time in msec after the middle of inverting RF pulse to middle of excitation pulse to detect the amount of longitudinal magnetization. Required if Scanning Sequence (0018,0020) has values of IR.
Trigger Time	(0018,1060)	2C	Time, in msec, between peak of the R wave and the peak of the echo produced. In the case of segmented k-space, the TE(eff) is the time between the peak of the echo that is used to cover the center of k-space. Required for Scan Options (0018,0022) that include heart gating (e.g., CG, PPG, etc.)
Sequence Name	(0018,0024)	3	User defined name for the combination of Scanning Sequence (0018,0020) and Sequence Variant (0018,0021).
Angio Flag	(0018,0025)	3	Angio Image Indicator. Primary image for Angio processing. Enumerated Values: **Y** Image is Angio **N** Image is not Angio
Number of Averages	(0018,0083)	3	Number of times a given pulse sequence is repeated before any parameter is changed
Imaging Frequency	(0018,0084)	3	Precession frequency in MHz of the nucleus being addressed
Imaged Nucleus	(0018,0085)	3	Nucleus that is resonant at the imaging frequency. Examples: 31P, 1H
Echo Number(s)	(0018,0086)	3	The echo number used in generating this image. In the case of segmented k-space, it is the effective Echo Number.

Attribute Name	Tag	Type	Attribute Description
Magnetic Field Strength	(0018,0087)	3	Nominal field strength of MR magnet, in Tesla
Spacing Between Slices	(0018,0088)	3	Spacing between slices, in mm. The spacing is measured from the center-to-center of each slice.
Number of Phase Encoding Steps	(0018,0089)	3	Total number of lines in k-space in the 'y' direction collected during acquisition.
Percent Sampling	(0018,0093)	3	Fraction of acquisition matrix lines acquired, expressed as a percent.
Percent Phase Field of View	(0018,0094)	3	Ratio of field of view dimension in phase direction to field of view dimension in frequency direction, expressed as a percent.
Pixel Bandwidth	(0018,0095)	3	Reciprocal of the total sampling period, in hertz per pixel.
Nominal Interval	(0018,1062)	3	Average R-R interval used for the scans, in msec
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: **Y** yes **N** no
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec
High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Intervals Acquired	(0018,1083)	3	Number of R-R intervals acquired.
Intervals Rejected	(0018,1084)	3	Number of R-R intervals rejected.
PVC Rejection	(0018,1085)	3	Description of type of PVC rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia.
Heart Rate	(0018,1088)	3	Beats per minute.
Cardiac Number of Images	(0018,1090)	3	Number of images per cardiac cycle.
Trigger Window	(0018,1094)	3	Percent of R-R interval, based on Heart Rate (0018,1088), prescribed as a window for a valid/usable trigger.
Reconstruction Diameter	(0018,1100)	3	Diameter in mm. of the region from within which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011).
Receive Coil Name	(0018,1250)	3	Receive coil used.
Transmit Coil Name	(0018,1251)	3	Transmit coil used.
Acquisition Matrix	(0018,1310)	3	Dimensions of the acquired frequency /phase data before reconstruction. Multi-valued: frequency rows\frequency columns\phase rows\phase columns.

Attribute Name	Tag	Type	Attribute Description
In-plane Phase Encoding Direction	(0018,1312)	3	The axis of phase encoding with respect to the image. Enumerated Values: **ROW** phase encoded in rows. **COL** phase encoded in columns.
Flip Angle	(0018,1314)	3	Steady state angle in degrees to which the magnetic vector is flipped from the magnetic vector of the primary field.
SAR	(0018,1316)	3	Calculated whole body Specific Absorption Rate in watts/kilogram.
Variable Flip Angle Flag	(0018,1315)	3	Flip angle variation applied during image acquisition. Enumerated Values: **Y** yes **N** no
dB/dt	(0018,1318)	3	The rate of change of the gradient coil magnetic flux density with time (T/s).
Temporal Position Identifier	(0020,0100)	3	Temporal order of a dynamic or functional set of Images.
Number of Temporal Positions	(0020,0105)	3	Total number of temporal positions prescribed.
Temporal Resolution	(0020,0110)	3	Time delta between Images in a dynamic or functional set of Images.
Include Table 10-7 "General Anatomy Optional Macro Attributes"			*Anatomic Region Sequence DCID 4030 "CT, MR and PET Anatomy Imaged".*
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
B1rms	(0018,1320)	3	B1+ rms value in units of micro_tesla (uT) for the acquisition producing the image. See [IEC 60601-2-33].

C.8.3.1.1 MR Image Attribute Descriptions

C.8.3.1.1.1 Image Type

For MR Images, Image Type (0008,0008) is specified to be Type 1.

Defined Terms for Value 3:

DENSITY MAP
DIFFUSION MAP
IMAGE ADDITION
MODULUS
SUBTRACT
MPR
OTHER
PHASE MAP
PHASE SUBTRACT
PROJECTION IMAGE
T1 MAP
T2 MAP
VELOCITY MAP

C.8.3.1.1.2 Samples Per Pixel

Enumerated Values:

1

C.8.3.1.1.3 Photometric Interpretation

Enumerated Values:

MONOCHROME1
MONOCHROME2

See Section C.7.6.3.1.2 for definition of these terms.

C.8.3.1.1.4 Bits Allocated

Enumerated Values:

16

C.8.4 Nuclear Medicine Modules

This Section describes Nuclear Medicine Series, Equipment, and Image Modules. These Modules contain Attributes that are specific to the NM Image IOD.

Note

There are some cases where it may be necessary to use several SOP Instances to encode a single NM acquisition. For example, the matrix size must remain constant within a SOP Instance. Multiple matrix sizes require multiple SOP Instances. Similarly, multiple gated stress levels require separate SOP Instances for each stress level. However, a receiving AE is not expected to recombine them.

C.8.4.1 NM Series Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.4.2 NM Equipment Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.4.3 NM Image Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.4.4 NM Spect Acquisition Image Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.4.5 NM Multi-gated Acquisition Image Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.4.6 NM/PET Patient Orientation Module

Table C.8-5 specifies the Attributes that describe the NM/PET Patient Orientation.

Table C.8-5. NM/PET Patient Orientation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Orientation Code Sequence	(0054,0410)	2	Sequence that describes the orientation of the patient with respect to gravity. See Section C.8.4.6.1.1 for further explanation. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 19 "Patient Orientation".* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
>Patient Orientation Modifier Code Sequence	(0054,0412)	2C	Patient Orientation Modifier. Required if needed to fully specify the orientation of the patient with respect to gravity. See Section C.8.4.6.1.2 for further explanation. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 20 "Patient Orientation Modifier".* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
Patient Gantry Relationship Code Sequence	(0054,0414)	2	Describes the orientation of the patient with respect to the gantry. See Section C.8.4.6.1.3 for further explanation. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 21 "Patient Equipment Relationship".* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*

C.8.4.6.1 NM/PET Patient Orientation Attribute Descriptions

C.8.4.6.1.1 Patient Orientation Code Sequence

The Patient Orientation Code Sequence (0054,0410) is used to describe the orientation of the patient with respect to gravity, and is independent of the position in the gantry.

C.8.4.6.1.2 Patient Orientation Modifier Code Sequence

The Patient Orientation Modifier Code Sequence (0054,0412) is used to modify or enhance the orientation specified by Patient Orientation Code Sequence (0054,0410).

C.8.4.6.1.3 Patient Gantry Relationship Code Sequence

Patient Gantry Relationship Code Sequence (0054,0414) is used to describe the patient direction within the gantry, such as head-first or feet-first. When imaging the extremities, these directions are related to normal anatomic position.

Example: In normal anatomic position, the fingers point towards the feet.

C.8.4.7 NM Image Pixel Module

Table C.8-6 specifies the Attributes that describe the pixel data of a NM image.

Table C.8-6. NM Image Pixel Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image. The value shall be 1.

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.4.7.1.1 for further explanation.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. The value shall be the same as the value in Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Pixel Spacing	(0028,0030)	2	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing, in mm. See Section 10.7.1.3 for further explanation of the value order.

C.8.4.7.1 NM Image Pixel Attribute Descriptions

C.8.4.7.1.1 Photometric Interpretation

Enumerated Values:

MONOCHROME2
PALETTE COLOR

See Section C.7.6.3.1.2 for definition of these terms.

C.8.4.8 NM Multi-frame Module

Table C.8-7 specifies the Attributes of a NM Multi-frame Image. This Module is always included in a NM SOP Instance, even if there is only one frame in the image.

A NM Image object is always a multi-dimensional multi-frame image. The order and organization of the frames within each image is defined by the Frame Increment Pointer (0028,0009). The Frame Increment Pointer (0028,0009) references one or more indexing vectors. An indexing vector is a 1 dimensional array with exactly one element for each frame in the image. The value of the nth element in the indexing vector represents the index for the nth frame, in that dimension. Indices are always numbered starting from 1.

Note

The scheme for encoding a multi-dimensional array of frames into a single image object is as follows. First, the definition of the Data Element called the Frame Increment Pointer is changed so that it can be multi-valued (i.e., its VM is now 1-n). Each value of Frame Increment Pointer represents one of the dimensions of the array, with the last value representing the most rapidly changing index. Each value of Frame Increment Pointer is the Tag of a Data Element that is an indexing vector. An indexing vector is a 1 dimensional array with exactly one element for each frame in the image. The value of the nth element in the indexing vector represents the index for the nth frame, in that dimension. For example, suppose you are encoding a Dynamic image consisting of 2 phases (containing 5 and 2 frames, respectively), from each of two detectors, using one isotope, which gives a total of 14 frames in the image. For a Dynamic image, the Frame Increment Pointer is defined as:Frame Increment Pointer = Energy Window Vector (0054,0010) \ Detector Vector (0054,0020) \ Phase Vector (0054,0030) \ Time Slice Vector (0054,0100). Pixel Data (7FE0,0010) would contain the frames in the following order:

Frame	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Energy Window #	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Detector #	1	1	1	1	1	1	1	2	2	2	2	2	2	2
Phase #	1	1	1	1	1	2	2	1	1	1	1	1	2	2
Time Slice #	1	2	3	4	5	1	2	1	2	3	4	5	1	2

and the four vectors would be defined as:

Energy Window Vector = 1,1,1,1,1,1,1,1,1,1,1,1,1

Detector Vector = 1,1,1,1,1,1,1,2,2,2,2,2,2

Phase Vector = 1,1,1,1,1,2,2,1,1,1,1,1,2,2

Time Slice Vector = 1,2,3,4,5,1,2,1,2,3,4,5,1,2

The receiver can tell the relationship of all the frames from these four vectors. For instance, looking at the 11th value in these four vectors tells you that the 11th frame in this multi-frame object is time slice 4 of phase 1 from detector 2 and isotope 1.

The Energy Window, Detector, Phase, Rotation, R-R Interval, and Time Slot Vectors have corresponding Sequence Attributes that contain exactly one Sequence Item for each of the index values in the vector. The Sequence Item contains a set of Attributes that are specific to that group of frames, but change from one group to the next. In the above example there would be a detector Sequence Attribute, an isotope Sequence Attribute and a phase Sequence Attribute (for dynamics, no frame Sequence Attribute is needed). The detector and phase Sequence Attributes would contain two Sequence Items (because there were 2 detectors and 2 phases).

Table C.8-7. NM Multi-frame Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1	Contains the Data Element Tags of one or more frame index vectors. See Section C.8.4.8.1.1 for further specialization.
Energy Window Vector	(0054,0010)	1C	An array that contains the energy window number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Energy Window Vector (0054,0010). See Section C.8.4.8.1.2 for specialization.
Number of Energy Windows	(0054,0011)	1	Number of energy window groupings. See Section C.8.4.8.1.2 for specialization.
Detector Vector	(0054,0020)	1C	An array that contains the detector number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Detector Vector (0054,0020). See Section C.8.4.8.1.3 for specialization.
Number of Detectors	(0054,0021)	1	Number of detectors. See Section C.8.4.8.1.3 for specialization.
Phase Vector	(0054,0030)	1C	An array that contains the phase number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See Section C.8.4.8.1.4 for specialization.
Number of Phases	(0054,0031)	1C	Number of phases. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Phase Vector (0054,0030). See Section C.8.4.8.1.4 for specialization.
Rotation Vector	(0054,0050)	1C	An array that contains the rotation number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Rotation Vector (0054,0050). See Section C.8.4.8.1.5 for specialization.
Number of Rotations	(0054,0051)	1C	Number of rotations. Required if Image Type (0008,0008), Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO. See Section C.8.4.8.1.5 for specialization.
R-R Interval Vector	(0054,0060)	1C	An array that contains the R-R interval number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See Section C.8.4.8.1.6 for specialization.

Attribute Name	Tag	Type	Attribute Description
Number of R-R Intervals	(0054,0061)	1C	Number of R-R intervals. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for R-R Interval Vector (0054,0060). See Section C.8.4.8.1.6 for specialization.
Time Slot Vector	(0054,0070)	1C	An array that contains the time slot number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See Section C.8.4.8.1.7 for specialization.
Number of Time Slots	(0054,0071)	1C	Number of time slots. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slot Vector (0054,0070). See Section C.8.4.8.1.7 for specialization.
Slice Vector	(0054,0080)	1C	An array that contains the spatial slice number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See Section C.8.4.8.1.8 for specialization.
Number of Slices	(0054,0081)	1C	Number of slices. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Slice Vector (0054,0080). See Section C.8.4.8.1.8 for specialization.
Angular View Vector	(0054,0090)	1C	An array that contains the angular view number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Angular View Vector (0054,0090). See Section C.8.4.8.1.9 for specialization.
Time Slice Vector	(0054,0100)	1C	An array that contains the time slice number for each frame. Required if the value of Frame Increment Pointer (0028,0009) includes the Tag for Time Slice Vector (0054,0100). See Section C.8.4.8.1.10 for specialization.

Note

Per the rules in PS3.5, if an Attribute of Type 1C or 2C is not required, it shall not be included.

C.8.4.8.1 NM Multi-frame Attribute Descriptions

C.8.4.8.1.1 Frame Increment Pointer

By definition, NM Images are multi-dimensional Multi-frame Images. The value of Frame Increment Pointer (0028,0009) contains the Tag for one or more frame indexing vectors. This determines the number of dimensions of frame indices in the image, and the order in which these indices vary from one frame to the next, with the last Tag indicating the most rapidly changing index. The Enumerated Values for Frame Increment Pointer (0028,0009) are determined by Image Type (0008,0008) Value 3, as shown in Table C.8-8.

Table C.8-8. Enumerated Values for Frame Increment Pointer

Image Type (0008,0008) Value 3	Frame Increment Pointer (0028,0009)
STATIC or WHOLE BODY	0054H 0010H \ 0054H 0020H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020).
DYNAMIC	0054H 0010H \ 0054H 0020H \ 0054H 0030H \ 0054H 0100H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Phase Vector (0054,0030), Time Slice Vector (0054,0100)
GATED	0054H 0010H \ 0054H 0020H \ 0054H 0060H \ 0054H 0070H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), R-R Interval Vector (0054,0060), Time Slot Vector (0054,0070)
TOMO	0054H 0010H \ 0054H 0020H \ 0054H 0050H \ 0054H 0090H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Rotation Vector (0054,0050), Angular View Vector (0054,0090)

Image Type (0008,0008) Value 3	Frame Increment Pointer (0028,0009)
GATED TOMO	0054H 0010H \ 0054H 0020H \ 0054H 0050H \ 0054H 0060H \ 0054H 0070H \ 0054H 0090H Sequencing is by Energy Window Vector (0054,0010), Detector Vector (0054,0020), Rotation Vector (0054,0050), R-R Interval Vector (0054,0060), Time Slot Vector (0054,0070), Angular View Vector (0054,0090).
RECON TOMO	0054H 0080H Sequencing is by Slice Vector (0054,0080)
RECON GATED TOMO	0054H 0060H \ 0054H 0070H \ 0054H 0080H Sequencing is by R-R Interval Vector (0054,0060), Time Slot Vector (0054,0070), Slice Vector (0054,0080)

C.8.4.8.1.2 Number of Energy Windows and Energy Window Vector

Number of Energy Windows (0054,0011) is the number of distinct energy window groupings acquired in this image. See Section C.8.4.10.1. When Image Type (0008,0008), Value 3, is RECON TOMO or RECON GATED TOMO, then the Number of Energy Windows (0054,0011) shall be 1.

Energy Window Vector (0054,0010) is an indexing vector. The value of the nth element of this vector is the energy window number for the nth frame in this image, and shall have a value from 1 to Number of Energy Windows (0054,0011).

C.8.4.8.1.3 Number of Detectors and Detector Vector

Number of Detectors (0054,0021) is the number of separate detectors that differentiate the frames in this image. When Image Type (0008,0008), Value 3, is RECON TOMO or RECON GATED TOMO, then the Number of Detectors (0054,0021) shall be 1.

Note

Number of Detectors (0054,0021) does not necessarily represent the actual number of detectors used during data acquisition.

Example 1: In a TOMO acquisition in which frames from 2 or more detectors are interleaved to form one continuous set of frames, then no distinction is made between frames on the basis of which detector created them. In this case, the Number of Detectors (0054,0021) would be 1.

Example 2: In a WHOLE BODY acquisition in which a single detector acquires anterior and posterior views in two separate passes, the Number of Detectors (0054,0021) would be 2.

Detector Vector (0054,0020) is an indexing vector. The value of the nth element of this vector is the detector number of the nth frame in this image, and shall have a value from 1 to Number of Detectors (0054,0021).

C.8.4.8.1.4 Number of Phases and Phase Vector

Number of Phases (0054,0031) is the number of dynamic phases, independent of the number of Detectors and Isotopes. See Section C.8.4.14 for definition of a phase.

Phase Vector (0054,0030) is an indexing vector. The value of the nth element of this vector is the phase number of the nth frame in this image, and shall have a value from 1 to Number of Phases (0054,0031).

C.8.4.8.1.5 Number of Rotations and Rotation Vector

Number of Rotations (0054,0051) is the number of separate rotations. See Section C.8.4.12 for definition of a rotation. When Image Type (0008,0008), Value 3, is RECON TOMO, GATED TOMO or RECON GATED TOMO, then the Number of Rotations (0054,0051) shall be 1.

Rotation Vector (0054,0050) is an indexing vector. The value of the nth element of this vector is the rotation number of the nth frame in this image, and shall have a value from 1 to Number of Rotations (0054,0051).

C.8.4.8.1.6 Number of R-R Intervals and R-R Interval Vector

Number of R-R Intervals (0054,0061) is the number of ranges of heartbeat durations collected. A gated acquisition may employ one R-R Interval to collect data from normal beats, a second R-R Interval to collect data from ectopic beats, and possibly others. Each R-R Interval accepts beats whose duration is greater than its Low R-R Value (0018,1081) and shorter than its High R-R Value (0018,1082). Beats that do not fall within these ranges may be accepted by another R-R Interval, or may be rejected.

The Number of R-R Intervals (0054,0061) is the total number of such ranges.

R-R Interval Vector (0054,0060) is an indexing vector. The value of the nth element of this vector is the interval number of the nth frame in this image, and shall have a value from 1 to Number of R-R Intervals (0054,0061).

C.8.4.8.1.7 Number of Time Slots and Time Slot Vector

Number of Time Slots (0054,0071) is the number of frames into which each gating event is divided in a gated acquisition. For example, in a cardiac gated acquisition, data from a number of heartbeats are then combined by summing together the first frames from all beats into a summed first frame, all the second frames into a summed second frame, and so on. The result has the same number of frames as the Number of Time Slots in each beat.

Time Slot Vector (0054,0070) is an indexing vector. The value of the nth element of this vector is the time slot number of the nth frame in this image, and shall have a value from 1 to Number of Time Slots (0054,0071).

C.8.4.8.1.8 Number of Slices and Slice Vector

Number of Slices (0054,0081) is the number of slices in each separate volume.

Note

For images with Image Type (0008,0008), Value 3, equal to RECON GATED TOMO this implies that Number of Slices (0054,0081) is the same for all R-R Intervals and Time Slots.

Slice Vector (0054,0080) is an indexing vector. The value of the nth element of this vector is the slice number of the nth frame in this image, and shall have a value from 1 to Number of Slices (0054,0081).

C.8.4.8.1.9 Angular View Vector

Angular View Vector (0054,0090) is an indexing vector. The value of the nth element of this vector is the angular view number of the nth frame in this image. If Image Type (0008,0008), Value 3, is TOMO or GATED TOMO, then the value shall be from 1 to Number of Frames in Rotation (0054,0053).

C.8.4.8.1.10 Time Slice Vector

Time Slice Vector (0054,0100) is an indexing vector. The value of the nth element of this vector is the time slice number of the nth frame in this image, and shall have a value from 1 to Number of Frames in Phase (0054,0033).

C.8.4.9 NM Image Module

Table C.8-9 contains the Attributes that describe Nuclear Medicine Images.

Table C.8-9. NM Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.4.9.1.1 for specialization.
Image ID	(0054,0400)	3	User or equipment generated Image identifier.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image. May be present otherwise.
Counts Accumulated	(0018,0070)	2	Sum of all gamma events for all frames in the image. See Section C.8.4.9.1.2 for specialization.
Acquisition Termination Condition	(0018,0071)	3	Description of how the data collection was stopped. Defined Terms: **CNTS** counts **DENS** density **MANU** manual **OVFL** data overflow **TIME** time **TRIG** physiological trigger See Section C.8.4.9.1.3 for specialization.
Table Height	(0018,1130)	3	The height of the patient table in mm. The range and values of this element are determined by the manufacturer. Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm. The range and values of this element are determined by the manufacturer. Should not be included if Image Type (0008,0008), Value 3, is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
Actual Frame Duration	(0018,1242)	1C	Elapsed time for data acquisition in msec. Required if Image Type (0008,0008) Value 3 is: WHOLE BODY or STATIC. See Section C.8.4.9.1.4 for specialization.
Count Rate	(0018,1243)	3	Maximum count rate achieved during the acquisition in counts/sec.
Processing Function	(0018,5020)	3	Code or description of processing functions applied to the data.

Attribute Name	Tag	Type	Attribute Description
Corrected Image	(0028,0051)	3	One or more values that indicate which, if any, corrections have been applied to the image. Corrections are applied to all frames in the image. Defined Terms: **UNIF** flood corrected **COR** center of rotation corrected **NCO** non-circular orbit corrected **DECY** decay corrected **ATTN** attenuation corrected **SCAT** scatter corrected **DTIM** dead time corrected **NRGY** energy corrected **LIN** linearity corrected **MOTN** motion corrected **CLN** count loss normalization; Any type of normalization applied to correct for count loss in Time Slots.
Whole Body Technique	(0018,1301)	3	The type of scan performed. Used only if Image Type (0008,0008), Value 3, contains the value WHOLE BODY. Enumerated Values: **1PS** one pass **2PS** two pass **PCN** patient contour following employed **MSP** multiple static frames collected into a whole body frame
Scan Velocity	(0018,1300)	2C	The speed of the camera motion over the body in mm/sec. Required if Image Type (0008,0008) Value 3 contains the value WHOLE BODY.
Scan Length	(0018,1302)	2C	Size of the imaged area in the direction of scanning motion, in mm. Required if Image Type (0008,0008) Value 3 contains the value WHOLE BODY.
Trigger Source or Type	(0018,1061)	3	Text indicating trigger source. Defined Terms: **EKG**
Include Table 10-7 "General Anatomy Optional Macro Attributes"			No CID for the Anatomic Region Sequence is defined.
Real World Value Mapping Sequence	(0040,9096)	3	The mapping of stored values to associated real world values. One or more Items are permitted in this Sequence.
>Include Table C.7.6.16-12b "Real World Value Mapping Item Macro Attributes"			*Measurement Units Code Sequence DCID 84 "PET Units".*
Scan Progression Direction	(0054,0501)	3	The anatomical order in which the slices were acquired. Enumerated Values: **FEET_TO_HEAD** Slices closest to the patient's feet were acquired first. **HEAD_TO_FEET** Slices closest to the patient's head were acquired first.

Note

1. Content Date (0008,0023) and Content Time (0008,0033) are included in the General Image Module, Table C.7-7, whenever the images are temporally related. For this purpose, all NM Images are considered temporally related, so that these elements are included in an NM Image.

2. Referenced Overlay Sequence (0008,1130) and Referenced Curve Sequence (0008,1145) were previously included in this Module as optional Attributes but have been retired. See PS3.3-2004. Referenced Image Real World Value Mapping Sequence (0040,9094) was previously used in this Module to enclose the Real World Value Mapping Sequence (0040,9096) but has been retired. See PS3.3-2011.

C.8.4.9.1 NM Image Module Attribute Descriptions

C.8.4.9.1.1 Image Type

For NM images, Image Type (0008,0008) Value 3 is specified to be Type 1.

Enumerated Values for Value 3:

STATIC
DYNAMIC
GATED
WHOLE BODY
TOMO
GATED TOMO
RECON TOMO
RECON GATED TOMO

Enumerated Values for Value 4:

EMISSION
TRANSMISSION

Note

For NM images, Image Type (0008,0008) Value 1 will be ORIGINAL for all raw data and reconstructed images. DERIVED may be appropriate for some other results images.

For NM images, Image Type (0008,0008) Value 2 will be PRIMARY.

C.8.4.9.1.2 Counts Accumulated

Counts Accumulated (0018,0070) is the total of all gamma events accumulated in all frames of this Image. This Attribute applies to acquisition data, and often does not apply to processed images (DERIVED, SECONDARY).

C.8.4.9.1.3 Acquisition Termination Condition

Acquisition Termination Condition (0018,0071) is the method of acquisition termination that was actually applied to the data collection.

Defined Terms:

CNTS preset count limit was reached
DENS preset count density was reached
MANU acquisition was terminated manually
OVFL acquisition was terminated automatically by pixel data overflow condition
TIME preset time limit was reached
TRIG preset number of physiological triggers was reached

C.8.4.9.1.4 Actual Frame Duration

Actual Frame Duration (0018,1242) is defined as the elapsed time in msec for a single frame of an acquisition. For some types of multi-frame images, Actual Frame Duration (0018,1242) may have a more specialized meaning as defined in the appropriate IOD Module.

C.8.4.10 NM Isotope Module

Table C.8-10 contains Attributes that describe the isotope administered for the acquisition.

Table C.8-10. NM Isotope Module Attributes

Attribute Name	Tag	Type	Attribute Description
Energy Window Information Sequence	(0054,0012)	2	Sequence of Items that describe the energy window groups used. Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of Energy Windows (0054,0011). The first Item corresponds to frames with value of 1 in the Energy Window Vector (0054,0010), the second Item with value 2, etc.
>Energy Window Name	(0054,0018)	3	A user defined name that describes this Energy Window.
>Energy Window Range Sequence	(0054,0013)	3	Sequence of Items that describes this energy window group. One or more Items are permitted in this Sequence.
>>Energy Window Lower Limit	(0054,0014)	3	The lower limit of the energy window in KeV. See Section C.8.4.10.1.1 for further explanation.
>>Energy Window Upper Limit	(0054,0015)	3	The upper limit of the energy window in KeV. See Section C.8.4.10.1.2 for further explanation.
Radiopharmaceutical Information Sequence	(0054,0016)	2	Sequence of Items that describe isotope information. Zero or more Items shall be included in this Sequence.
>Radionuclide Code Sequence	(0054,0300)	2	Sequence that identifies the radionuclide. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 18 “Isotopes in Radiopharmaceuticals”.* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
>Radiopharmaceutical Route	(0018,1070)	3	Route of injection.
>Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route for the radiopharmaceutical. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 11 “Route of Administration”.* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
>Radiopharmaceutical Volume	(0018,1071)	3	Volume of injection in cubic cm.
>Radiopharmaceutical Start Time	(0018,1072)	3	Time of start of injection. See Section C.8.4.10.1.5 for further explanation.
>Radiopharmaceutical Stop Time	(0018,1073)	3	Time of end of injection. See Section C.8.4.10.1.6 for further explanation.
>Radionuclide Total Dose	(0018,1074)	3	Total amount of radionuclide injected. See Section C.8.4.10.1.7 for further explanation.
>Radiopharmaceutical Administration Event UID	(0008,3012)	3	Unique identification of the administration of the radiopharmaceutical to the patient. Note The UID is the same Radiopharmaceutical Administration Event UID that is in the Radiopharmaceutical Radiation Dose Report.

Attribute Name	Tag	Type	Attribute Description
>Calibration Data Sequence	(0054,0306)	3	Sequence that contains calibration data. One or more Items are permitted in this Sequence.
>>Energy Window Number	(0054,0308)	1	The Item number in the Energy Window Information Sequence to which the following calibration data relates. The Items are numbered starting from 1.
>>Syringe Counts	(0018,1045)	3	Pre-injection syringe count rate in counts/sec. See Section C.8.4.10.1.8 for further explanation.
>>Residual Syringe Counts	(0054,0017)	3	Post-injection residue syringe count rate in counts/sec. See Section C.8.4.10.1.9 for further explanation.
>Radiopharmaceutical	(0018,0031)	3	Name of the radiopharmaceutical.
>Radiopharmaceutical Code Sequence	(0054,0304)	3	Sequence that identifies the radiopharmaceutical. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 25 "Radiopharmaceuticals".* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
Intervention Drug Information Sequence	(0018,0026)	3	Sequence of Items that describes the intervention drugs used. One or more Items are permitted in this Sequence.
>Intervention Drug Name	(0018,0034)	3	Name of intervention drug.
>Intervention Drug Code Sequence	(0018,0029)	3	Sequence that identifies the intervention drug name. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 10 "Interventional Drug".* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
>Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route for the intervention drug. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 11 "Route of Administration".* Code Meaning (0008,0104) shall be Type 3 for historical reasons.
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the intervention drug, using the same time base as for Acquisition Time (0008,0032).
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug, using the same time base as for Acquisition Time (0008,0032).
>Intervention Drug Dose	(0018,0028)	3	Intervention drug dose, in mg.

C.8.4.10.1 NM Isotope Module Attribute Descriptions

C.8.4.10.1.1 Energy Window Lower Limit

Energy Window Lower Limit (0054,0014) is the acquisition energy window lower limit in KeV for acceptance of scintillation events into this Isotope.

C.8.4.10.1.2 Energy Window Upper Limit

Energy Window Upper Limit (0054,0015) is the acquisition energy window upper limit in KeV for acceptance of scintillation events into this Isotope.

C.8.4.10.1.3 (Retired)

C.8.4.10.1.4 (Retired)

C.8.4.10.1.5 Radiopharmaceutical Start Time

Radiopharmaceutical Start Time (0018,1072) is the actual time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as for Acquisition Time (0008,0032).

C.8.4.10.1.6 Radiopharmaceutical Stop Time

Radiopharmaceutical Stop Time (0018,1073) is the actual ending time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as for Acquisition Time (0008,0032).

C.8.4.10.1.7 Radionuclide Total Dose

Radionuclide Total Dose (0018,1074) is the radiopharmaceutical dose administered to the patient measured in MegaBecquerels (Mbq) at the Radiopharmaceutical Start Time.

C.8.4.10.1.8 Syringe Counts

Syringe Counts (0018,1045) is the pre-injection syringe acquisition count rate measured in counts/sec, corrected to Acquisition Time (0008,0032) if necessary.

C.8.4.10.1.9 Residual Syringe Counts

Residual Syringe Counts (0054,0017) is the syringe acquisition count rate following patient injection, measured in counts/sec, corrected to Acquisition Time (0008,0032) if necessary.

C.8.4.10.1.10 (Retired)

C.8.4.10.1.11 (Retired)

C.8.4.11 NM Detector Module

Table C.8-11 contains IOD Attributes that describe Nuclear Medicine Detectors used to produce an image.

Table C.8-11. NM Detector Module Attributes

Attribute Name	Tag	Type	Attribute Description
Detector Information Sequence	(0054,0022)	2	Sequence of Items that describe the detectors used. Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of Detectors (0054,0021). The first Item corresponds to frames with value of 1 in Detector Vector (0054,0020), the second Item with value 2, etc.
>Collimator/Grid Name	(0018,1180)	3	Label describing the collimator used (LEAP, hires, etc.)
>Collimator Type	(0018,1181)	2	Collimator type. Defined Terms: **PARA** Parallel (default) **PINH** Pinhole **FANB** Fan-beam **CONE** Cone-beam **SLNT** Slant hole **ASTG** Astigmatic **DIVG** Diverging **NONE** No collimator **UNKN** Unknown

Attribute Name	Tag	Type	Attribute Description
>Field of View Shape	(0018,1147)	3	Shape of the field of view of the Nuclear Medicine detector. Defined Terms: **RECTANGLE** **ROUND** **HEXAGONAL**
>Field of View Dimension(s)	(0018,1149)	3	Dimensions of the field of view, in mm. If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of a circumscribed circle.
>Focal Distance	(0018,1182)	2	Focal distance, in mm. A value of 0 means infinite distance for parallel collimation. See Section C.8.4.11.1.1 for further specialization.
>X Focus Center	(0018,1183)	3	Center of focus along a row. See Section C.8.4.11.1.2 for further explanation.
>Y Focus Center	(0018,1184)	3	Center of focus along a column. See Section C.8.4.11.1.2 for further explanation.
>Zoom Center	(0028,0032)	3	The amount of offset from (0,0) applied to each pixel in the image before application of the zoom factor, specified by a numeric pair: row value (delimiter) column value (in mm). See Section C.8.4.11.1.3 for further explanation.
>Zoom Factor	(0028,0031)	3	The amount of magnification applied to each pixel in the image, specified by a numeric pair: row value (delimiter) column value. See Section C.8.4.11.1.4 for further explanation.
>Center of Rotation Offset	(0018,1145)	3	Average center of rotation offset of Nuclear Medicine detector in mm. See Section C.8.4.11.1.5 for further explanation.
>Gantry/Detector Tilt	(0018,1120)	3	Angle of tilt in degrees of the detector. See Section C.8.4.11.1.6 for further explanation.
>Distance Source to Detector	(0018,1110)	2C	Distance in mm from transmission source to the detector face. Required if Image Type (0008,0008) Value 4 is TRANSMISSION and Value 3 is not any of TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
>Start Angle	(0054,0200)	3	Position of the detector about the patient for the start of the acquisition, in degrees. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in a counter-clockwise direction (detector normal rotating from the patient's back towards the patient's left side). Should not be included if Image Type (0008,0008) Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
>Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm. Should not be included if Image Type (0008,0008) Value 3 is TOMO, GATED TOMO, RECON TOMO or RECON GATED TOMO.
>Image Orientation (Patient)	(0020,0037)	2	The direction cosines of the first row and the first column with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>Image Position (Patient)	(0020,0032)	2	The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the image, in mm. See Section C.7.6.2.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>View Code Sequence	(0054,0220)	3	Sequence that describes the projection of the anatomic region of interest on the image receptor. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 26 “Nuclear Medicine Projections”.* *Code Meaning (0008,0104) shall be Type 3 for historical reasons.*
>>View Modifier Code Sequence	(0054,0222)	2C	View Modifier. Required if needed to fully specify the View. Zero or one Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 23 “Cranio-Caudad Angulation”.* Code Meaning (0008,0104) shall be Type 3 for historical reasons.

C.8.4.11.1 NM Detector Attribute Descriptions

C.8.4.11.1.1 Focal Distance

Focal Distance (0018,1182) for NM Image data is the focal distance, in mm for converging or diverging collimators, measured from the front face of the detector to the focus. Positive values indicate converging and negative values indicate diverging collimators. A value of 0 means infinite distance for parallel collimation.

C.8.4.11.1.2 Focus Center

X Focus Center (0018,1183) and Y Focus Center (0018,1184) for NM Image data is used to define the projection of the focus for a converging or diverging collimator within the un-zoomed Field of View. It is defined in mm for row and column relative to the center of the un-zoomed Field of View.

C.8.4.11.1.3 Zoom Center

Zoom Center (0028,0032) is the offset between the un-zoomed camera field of view and field of view, measured from the center of the un-zoomed camera field of view to the center the of the zoomed field of view. The offset is measured in mm in the un-zoomed camera FOV dimensions. Positive values are to the right and down from the un-zoomed center, as viewed from the image plane. When this Attribute is not given, the Zoom Center is assumed to be 0\0.

C.8.4.11.1.4 Zoom Factor

Zoom Factor (0028,0031) is the magnification factor that was used during the acquisition. When this Attribute is not given, it is assumed to be 1.0\1.0.

Note

Zoom Factor (0028,0031) is informational only. Pixel Spacing (0028,0030) already takes account of this and any other changes to pixel size.

C.8.4.11.1.5 Center of Rotation Offset

Center of Rotation Offset (0018,1145) is the average amount of offset in mm between the Detector Field of View center and the physical center of rotation of the gantry for circular orbital scans. Positive values indicate the physical center is to the right of the image plane center.

If:

1. Image Type (0008,0008) Value 3 is TOMO or GATED TOMO, and
2. Corrected Image (0028,0051) does not include the value "COR", and
3. Center of Rotation Offset (0018,1145) is non-zero,

then the receiver should assume that Center of Rotation correction has not already been done.

If the Center of Rotation Offset is zero, no correction shall be applied.

C.8.4.11.1.6 Gantry/Detector Tilt

Gantry/Detector Tilt (0018,1120) for NM Image data is the angle in degrees of the detector face relative to the patient's major (Head to Feet) axis (or the table supporting the patient). Positive tilt is towards the patient's feet.

C.8.4.12 NM Tomo Acquisition Module

This Module applies to a TOMO Multi-frame Image. This Module is present when Image Type (0008,0008) Value 3, is equal to TOMO, GATED TOMO, RECON TOMO, or RECON GATED TOMO. The elements found in this Module describe the acquisition of the Image.

Table C.8-12. NM Tomo Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Rotation Information Sequence	(0054,0052)	2	Sequence of Items that describe TOMO rotational groups. A new rotation is defined whenever the direction of the detector motion changes, or Table Traverse (0018,1131) changes. Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of Rotations (0054,0051). If Rotation Vector (0054,0050) is present, the first Item corresponds to frames with value of 1 in Rotation Vector (0054,0050), the second Item with value 2, etc.
>Start Angle	(0054,0200)	1	Position of the detector about the patient for the start of this rotation, in degrees. Zero degrees is referenced to the origin at the patient's back. Viewing from the patient's feet, angle increases in a counter-clockwise direction (detector normal rotating from the patient's back towards the patient's left side).
>Angular Step	(0018,1144)	1	The angular scan arc step between views of the TOMO acquisition, in degrees. See Section C.8.4.12.1.1 for further explanation.
>Rotation Direction	(0018,1140)	1	Direction of rotation of the detector about the patient. See Start Angle (0054,0200) for further explanation of direction. Enumerated Values: **CW** clockwise (decreasing angle) **CC** counter-clockwise (increasing angle).
>Scan Arc	(0018,1143)	1	The effective angular range of the scan data in degrees. The value shall be positive.
>Actual Frame Duration	(0018,1242)	1	Nominal acquisition time per angular position, in msec.
>Radial Position	(0018,1142)	3	Radial distance of the detector from the center of rotation, in mm. It shall have a single value that is an average value for this rotation, or it shall have one value per angular view.
>Distance Source to Detector	(0018,1110)	2C	Distance in mm from transmission source to the detector face. Required if Image Type (0008,0008) Value 4 is TRANSMISSION.
>Number of Frames in Rotation	(0054,0053)	1	Number of angular views in this rotation.
>Table Traverse	(0018,1131)	3	Location of the patient table (or gantry relative to the table) in mm. The range and values of this element are determined by the manufacturer.
>Table Height	(0018,1130)	3	The distance in mm of the top of the patient table to the center of rotation. Table height below the center of rotation has a positive value.

Attribute Name	Tag	Type	Attribute Description
Type of Detector Motion	(0054,0202)	3	Describes the detector motion during acquisition. Enumerated Values: **STEP AND SHOOT** Interrupted motion, acquire only while stationary **CONTINUOUS** Gantry motion and acquisition are simultaneous and continuous **ACQ DURING STEP** Interrupted motion, acquisition is continuous

C.8.4.12.1 NM Tomo Acquisition Attribute Descriptions

C.8.4.12.1.1 Angular Step

Angular Step (0018,1144) is the nominal frame-to-frame incremental angle for TOMO and GATED TOMO acquisition images, defined in degrees. Angular Step (0018,1144) shall be a positive number. Summation of Angular Step values is not defined to give accurate Angular Position or Scan Arc values. The Angular Step is the effective angular spacing between resultant frames of the Multi-framed planar image data.

C.8.4.13 NM Multi-gated Acquisition Module

Table C.8-13 contains Attributes that describe a multi-gated acquisition image performed on the patient. This refers to frames acquired while the patient is connected to a gating device.

Table C.8-13. NM Multi-Gated Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Beat Rejection Flag	(0018,1080)	3	Heart beat duration sorting has been applied. Enumerated Values: **Y** yes **N** no
PVC Rejection	(0018,1085)	3	Description of type of arrhythmic beat rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia
Heart Rate	(0018,1088)	3	Average number of heart beats per minute for the collection period for these frames. This shall include all accepted beats as well as rejected beats.
Gated Information Sequence	(0054,0062)	2C	Sequence of Items that describe R-R intervals. Each gated interval is defined by an upper and lower range of heart beat durations. Required if the Frame Increment Pointer (0028,0009) contains the Tag for R-R Interval Vector (0054,0060). Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of R-R Intervals (0054,0061). The first Item corresponds to frames with value of 1 in the R-R Interval Vector (0054,0060), the second Item with value 2, etc.
>Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of the data taking.
>Cardiac Framing Type	(0018,1064)	3	Description of type of framing performed. See Section C.7.6.18.1.1.1 for description and Defined Terms.

Attribute Name	Tag	Type	Attribute Description
>Data Information Sequence	(0054,0063)	2	Sequence of Items that describe gating criteria. Zero or more Items shall be included in this Sequence. See Section C.8.4.13.1.1.
>>Frame Time	(0018,1063)	1	Nominal time per individual frame in msec.
>>Nominal Interval	(0018,1062)	3	Average duration of accepted beats, in msec.
>>Low R-R Value	(0018,1081)	3	R-R interval lower limit for beat rejection, in msec
>>High R-R Value	(0018,1082)	3	R-R interval upper limit for beat rejection, in msec
>>Intervals Acquired	(0018,1083)	3	Number of heartbeats that fall within Low R-R Value (0018,1081) and High R-R Value (0018,1082), and were therefore accepted and contribute gamma events to this R-R Interval.
>>Intervals Rejected	(0018,1084)	3	Number of heartbeats that fall outside Low R-R (0018,1081) and High R-R Value (0018,1082), and do not contribute gamma events to this R-R Interval. However, they may contribute gamma events to other R-R Intervals.
>>Time Slot Information Sequence	(0054,0072)	2C	Sequence of Items that describe Time Slot Information. Required if the Frame Increment Pointer (0028,0009) contains the Tag for Time Slot Vector (0054,0070). Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of Time Slots (0054,0071). The first Item corresponds to frames with value of 1 in the Time Slot Vector (0054,0070), the second Item with value 2, etc.
>>>Time Slot Time	(0054,0073)	3	The total amount of time, in msec, that the acquisition accumulates gamma events into this frame. See Section C.8.4.13.1.2.

C.8.4.13.1 NM Multi-gated Acquisition Attribute Descriptions

C.8.4.13.1.1 Data Information Sequence

Data Information Sequence (0054,0063) shall contain a single Item that applies to the sum of all angular views, except when Image Type (0008,0008) Value 3 is GATED TOMO. In this case it shall have either a single Item that applies to the sum of all angular views, or it shall have one Item for each angular view.

C.8.4.13.1.2 Time Slot Time

The Time Slot Time (0054,0073) records the effective imaging time of each Time Slot. For example, if some of the accepted beats are shorter than others then the last frames may not receive a contribution from the shorter beats. The Time Slot Time for a Time Slot is the total acquisition time for that Time Slot. It is approximately equal to Frame Time (0018,1063) multiplied by the number of accepted beats contributing to the Time Slot.

C.8.4.14 NM Phase Module

Table C.8-14 contains Attributes that describe dynamic phases of a dynamic acquisition image performed on the patient. This Module is present only when Image Type (0008,0008), Value 3, is equal to DYNAMIC. A phase is defined as a collection of frames in which the acquisition time per frame and the time delay between frames remains constant. A new phase shall be defined whenever there is a change in the time between frames, the acquisition time per frame, or the position of the patient relative to the detector.

Table C.8-14. NM Phase Module Attributes

Attribute Name	Tag	Type	Attribute Description
Phase Information Sequence	(0054,0032)	2C	Sequence of Items that describes each dynamic phase. Required if the Frame Increment Pointer (0028,0009) contains the Tag for Phase Vector (0054,0030). Zero or more Items shall be included in this Sequence. The number of Items shall be equal to Number of Phases (0054,0031). The first Item corresponds to frames with value of 1 in Phase Vector (0054,0030), the second Item with value 2, etc.
>Phase Delay	(0054,0036)	1	Time paused between the last frame of the previous phase and the first frame of this phase, in msec.
>Actual Frame Duration	(0018,1242)	1	Nominal time of acquisition per individual frame, in msec.
>Pause Between Frames	(0054,0038)	1	Time paused between each frame of this phase (in msec).
>Number of Frames in Phase	(0054,0033)	1	Number of frames in this phase.
>Trigger Vector	(0054,0210)	3	An array of trigger times when gating information is acquired simultaneously with the dynamic image data. See Section C.8.4.14.1.1 for further explanation.
>Number of Triggers in Phase	(0054,0211)	1C	The number of entries in Trigger Vector (0054,0210) for this phase. Required if Trigger Vector (0054,0210) is present.
>Phase Description	(0054,0039)	3	Description of this phase of the Dynamic image. Enumerated Values: **FLOW** **WASHOUT** **UPTAKE** **EMPTYING** **EXCRETION**

C.8.4.14.1 NM Phase Module Attributes Description

C.8.4.14.1.1 Trigger Vector

Trigger Vector (0054,0210) is an array containing a list of the inter-trigger interval times in milliseconds in the order in which they were acquired, with the first being measured from the start time of the first frame of the image data in the Phase. If this element is used, the start times are required to be the same so that a mathematical correlation can be made between trigger times and frame start times.

C.8.4.15 NM Reconstruction Module

Table C.8-15 contains Attributes that describe Nuclear Medicine reconstructed volumes. Reconstructed volumes are created by applying a transformation (reconstruction) process to the acquired TOMO frames. This Module is present only when Image Type (0008,0008) Value 3 is equal to RECON TOMO or RECON GATED TOMO.

Table C.8-15. NM Reconstruction Module Attributes

Attribute Name	Tag	Type	Attribute Description
Spacing Between Slices	(0018,0088)	2	Spacing between slices, in mm, measured from center-to-center of each slice along the normal to the first image. The sign of the Spacing Between Slices (0018,0088) determines the direction of stacking. The normal is determined by the cross product of the direction cosines of the first row and first column of the first frame, such that a positive spacing indicates slices are stacked behind the first slice and a negative spacing indicates slices are stacked in front of the first slice. See Image Orientation (0020,0037) in the NM Detector Module.
Reconstruction Diameter	(0018,1100)	3	Diameter, in mm, of the region from within which the data was used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011).
Convolution Kernel	(0018,1210)	3	A label describing the convolution kernel or algorithm used to reconstruct the data.
Slice Thickness	(0018,0050)	2	Nominal slice thickness, in mm.
Slice Location	(0020,1041)	3	Relative position of the image plane expressed in mm. See Section C.7.6.2.1.2 for further explanation.
Slice Progression Direction	(0054,0500)	3	Describes the anatomical direction that slices are progressing as the slices are considered in order (as defined by Slice Vector (0054,0080)). Meaningful only for cardiac images. When View Code Sequence (0054,0220) indicates a short axis view, then the Enumerated Values are: Enumerated Values: **APEX_TO_BASE** **BASE_TO_APEX**

C.8.5 Ultrasound Modules

This Section describes Modules that contain Attributes that are specific to Ultrasound images.

C.8.5.1 US Frame of Reference Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.5.2 US Region Calibration (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.5.3 US Image Module (Retired)

This Section was defined in a previous version of the DICOM Standard. The Section is now retired.

C.8.5.4 US Frame of Reference Module

This Section was defined in a previous version of the DICOM Standard. The Section is now retired. See PS3.3-2003.

C.8.5.5 US Region Calibration Module

The US Region Calibration Module has been introduced into the ultrasound IOD to provide access to the full range of data that may be present in a single US image. US images often contain multiple regions that have independent data regions, e.g., quad screen loops that may have different calibration information. The data presented in the various regions of a US image can represent a multiplicity of physical parameters, e.g., spatial distance, blood velocity, time, volume, etc., and these are often contained in the value of the pixel itself. It is therefore imperative that physical information be available for the various regions of a single region independent of each other.

Table C.8-17 contains IOD Attributes that describe an ultrasound region calibration.

Table C.8-17. US Region Calibration Module Attributes

Attribute Name	Tag	Type	Attribute Description
Sequence of Ultrasound Regions	(0018,6011)	1	Defines a Sequence of Ultrasound Regions. One or more Items shall be included in this Sequence.
>Region Location Min x0	(0018,6018)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Min y0	(0018,601A)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Max x1	(0018,601C)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Region Location Max y1	(0018,601E)	1	The bounds of a rectangle specifying the location of the region, x0,y0,x1,y1. See Section C.8.5.5.1.14 for further explanation.
>Physical Units X Direction	(0018,6024)	1	The physical units of the dimensions of the region. See Section C.8.5.5.1.15 for Enumerated Values.
>Physical Units Y Direction	(0018,6026)	1	The physical units of the dimensions of the region. See Section C.8.5.5.1.15 for Enumerated Values.
>Physical Delta X	(0018,602C)	1	The physical value increments per positive X pixel increment. The units are as specified in the Physical Units X Direction (0018,6024). See Section C.8.5.5.1.17 for further explanation.
>Physical Delta Y	(0018,602E)	1	The physical value increments per positive Y pixel increment. The units are as specified in the Physical Units Y Direction (0018,6026). See Section C.8.5.5.1.17 for further explanation.
>Reference Pixel x0	(0018,6020)	3	This coordinate pair, x0,y0, defines the location of a virtual "reference" pixel. See Section C.8.5.5.1.16 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Reference Pixel y0	(0018,6022)	3	This coordinate pair, x0,y0, defines the location of a virtual "reference" pixel. See Section C.8.5.5.1.16 for further explanation.
>Reference Pixel Physical Value X	(0018,6028)	3	The Physical Value at the reference pixel x location. The units are specified in the Physical Units field.
>Reference Pixel Physical Value Y	(0018,602A)	3	The Physical Value at the reference pixel y location. The units are specified in the Physical Units field.
>Region Spatial Format	(0018,6012)	1	The spatial organization of the data within the region. See Section C.8.5.5.1.1 for Enumerated Values.
>Region Data Type	(0018,6014)	1	The type of data within the region. See Section C.8.5.5.1.2 for Enumerated Values.
>Region Flags	(0018,6016)	1	Flags used for special handling of the region. See Section C.8.5.5.1.3 for Enumerated Values and further explanation.
>Pixel Component Organization	(0018,6044)	1C	Describes how the components of a pixel can be described. Required if pixel component calibration exists for this region. See Section C.8.5.5.1.4 for Enumerated Values and further explanation.
>Pixel Component Mask	(0018,6046)	1C	This value is ANDed with the composite pixel code for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code" (SMCPC). Required if Pixel Component Organization = Bit aligned. See Section C.8.5.5.1.5 for further explanation.
>Pixel Component Range Start	(0018,6048)	1C	Defines the start of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Range Stop	(0018,604A)	1C	Defines the stop of the numeric range of values within the composite pixel where calibration is to be defined by the "pixel physical calibration table". To be used only when ranges are used to describe the portion of the composite pixel. Required if Pixel Component Organization = Ranges.
>Pixel Component Physical Units	(0018,604C)	1C	The physical units to be applied to the pixel component. Required if Pixel Component Organization exists. See Section C.8.5.5.1.6 for further explanation.
>Pixel Component Data Type	(0018,604E)	1C	The type of data for the pixel component. Required if Pixel Component Organization exists. See Section C.8.5.5.1.7 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Number of Table Break Points	(0018,6050)	1C	The number of break point coordinate pairs used to describe a piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See Section C.8.5.5.1.8 for further explanation.
>Table of X Break Points	(0018,6052)	1C	An array of X values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See Section C.8.5.5.1.9 for further explanation.
>Table of Y Break Points	(0018,6054)	1C	An array of Y values used to create the piece wise linear curve. Required if Pixel Component Organization equals 0 or 1. Otherwise not used. See Section C.8.5.5.1.9 for further explanation.
>Number of Table Entries	(0018,6056)	1C	The number of entries in the Table of Pixel Values. Required if the value of Pixel Component Organization (0018,6044) is 2 or 3. Otherwise not used. See Section C.8.5.5.1.11 for further explanation.
>Table of Pixel Values	(0018,6058)	1C	A table of Pixel Values used in conjunction with the Table of Parameter Values (0018,605A) or Pixel Value Mapping Code Sequence (0040,9098) to provide a mapping from Pixel Value to a real world value. Required if the Pixel Component Organization equals 2. Otherwise not used. See Section C.8.5.5.1.12 for further explanation.
>Table of Parameter Values	(0018,605A)	1C	A table of Parameter Values used in conjunction with the Table of Pixel Values (0018,6058) to provide a mapping from Pixel Value to Parameter Value. Required if the value of Pixel Component Organization (0018,6044) is 2. Otherwise not used. See Section C.8.5.5.1.13 for further explanation
>Pixel Value Mapping Code Sequence	(0040,9098)	1C	Sequence that, in conjunction with the Table of Pixel Values (0018,6058), provides a mapping from a Pixel Value to an associated Coded Concept. One or more Items shall included in this Sequence. The number of Items shall be equal to the value of Number of Table Entries (0018,6056). Required if the value of Pixel Component Organization (0018,6044) is 3 (Code Sequence look up). See Section C.8.5.5.1.18 for further explanation.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*For IVUS BCID 3497 “IVUS Arterial Morphology”* *No Baseline CID is defined otherwise.*
>Transducer Frequency	(0018,6030)	3	The manufacturer defined description of center frequency of the interrogating ultrasound energy. The units are kilohertz.

Attribute Name	Tag	Type	Attribute Description
>Pulse Repetition Frequency	(0018,6032)	3	The ultrasound pulse repetition frequency, as defined by the manufacturer, used to collect data in the region. The units are in hertz.
>Doppler Correction Angle	(0018,6034)	3	The Doppler correction angle. The units are degrees.
>Steering Angle	(0018,6036)	3	The steering angle, as defined by the manufacturer, used for a steered 2D image. The units are degrees.
>Doppler Sample Volume X Position	(0018,6039)	3	The x displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>Doppler Sample Volume Y Position	(0018,603B)	3	The y displacement, in pixels, from the Reference pixel to the center of the Doppler sample volume.
>TM-Line Position ~~x0~~X0	(0018,603D)	3	The starting and ending coordinates pairs of the ~~m~~M-line. Where the X0,~~Y0are~~Y0 are the starting point and X1,~~Y1are~~Y1 are the end point of the ~~tm~~TM-line. See Section C.8.5.5.1.10 for further explanation.
>TM-Line Position ~~y0~~Y0	(0018,603F)	3	The starting and ending coordinates pairs of the ~~m~~M-line. Where the X0,~~Y0are~~Y0 are the starting point and X1,~~Y1are~~Y1 are the end point of the ~~tm~~TM-line. See Section C.8.5.5.1.10 for further explanation.
>TM-Line Position ~~x1~~X1	(0018,6041)	3	The starting and ending coordinates pairs of the ~~m~~M-line. Where the X0,~~Y0are~~Y0 are the starting point and X1,~~Y1are~~Y1 are the end point of the ~~tm~~TM-line. See Section C.8.5.5.1.10 for further explanation.
>TM-Line Position ~~y1~~Y1	(0018,6043)	3	The starting and ending coordinates pairs of the ~~m~~M-line. Where the X0,~~Y0are~~Y0 are the starting point and X1,~~Y1are~~Y1 are the end point of the ~~tm~~TM-line. See Section C.8.5.5.1.10 for further explanation.

C.8.5.5.1 US Region Calibration Attribute Descriptions

C.8.5.5.1.1 Region Spatial Format

Values for Region Spatial Format (0018,6012) indicate the spatial organization of the data within the region.

Enumerated Values:

0000H None or not applicable
0001H 2D (tissue or flow)
0002H M-Mode (tissue or flow)
0003H Spectral (CW or PW Doppler)
0004H Wave form (physiological traces, Doppler traces,…)
0005H Graphics

C.8.5.5.1.2 Region Data Type

Values for Region Data Type (0018,6014) indicate the type of data within the region.

Enumerated Values:

0000H None or not applicable
0001H Tissue
0002H Color Flow
0003H PW Spectral Doppler
0004H CW Spectral Doppler
0005H Doppler Mean Trace

0006H Doppler Mode Trace
0007H Doppler Max Trace
0008H Volume Trace
000AH ECG Trace
000BH Pulse Trace
000CH Phonocardiogram Trace
000DH Gray bar
000EH Color bar
000FH Integrated Backscatter
0010H Area Trace
0011H d(area)/dt
0012H Other Physiological (Amplitude vs. Time) input

C.8.5.5.1.3 Region Flags

Region Flags (0018,6016) specify characteristics of US Regions.

Bit 0 of the Region Flags specifies the relative priority of the pixel component calibration specified by an US Region in the case where the US Region intersects with other US Regions. The calibration supplied by one or more of the regions may not be valid in the area that they intersect.

Enumerated Values for Bit 0 (lsb):

0 Region pixels are high priority
1 Region pixels are low priority

A high priority region overwrites data of a low priority region when they overlap, thus invalidating any pixel component calibration specified for a low priority region. pixel component calibration of overlapping regions of the same priority is indeterminate where they overlap. Figure C.8-6 shows an example of intersecting regions.

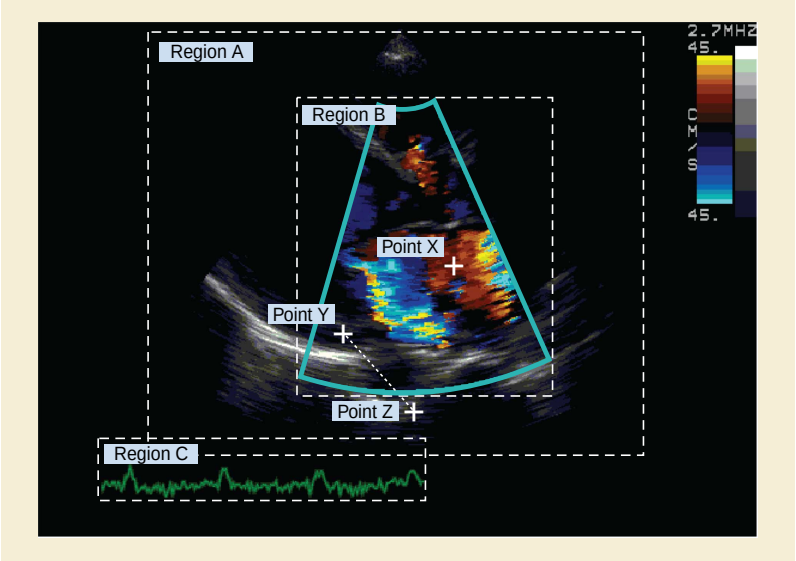


Figure C.8-6. Intersecting Spatial Format Regions and Overlapping Measurement

In this example, Region B is Color Flow while Region A is Tissue Echo. If Region B Color Flow values share the same bit planes as Region A Tissue Echo values, then it is indeterminate whether a pixel in this region is a Color Flow pixel or a Tissue Echo pixel. Since the pixels of the Color Flow region overwrite those of the Tissue Echo region, the Region Flag of the Tissue Echo region is assigned low priority and the Region Flag of the color region is assigned high priority. This means that if both the Tissue Echo and Color Flow regions define pixel component calibration that only the calibration specified by the Color Flow region can be applied to the pixel data value at Point X.

The measurement in Figure C.8-6 is a line between Point Y and Point Z. Both points are in Region A so the distance between them can be calculated using the Region A scaling (assuming that Region A defines both the Physical Units X Direction and Y Direction as being cm). If the points are in Region B, and hence also in Region A, it is still possible to calculate the distance because the region scaling is identical in both regions. The lower priority of Region B only applies to its pixel component calibration, not its X and Y direction scaling.

Enumerated Values for Bit 1 Scaling Protection:

0 Not Protected
1 Protected

Ultrasound systems should set this to 1 if the image is scaled automatically by the ultrasound system. If the image is frame-grabbed and scaling is not available then it should be set to 0. If the region is protected, the region can not be manually rescaled. That is the data defined by the region calibration Module can not be overridden by a reader of that image.

Enumerated Values for Bit 2 Doppler Scale Type:

0 Velocity
1 Frequency

Valid for PW and CW regions only. Indicates which type of Doppler scale is used.

Enumerated Values for Bit 3-4 Scrolling Region:

00 Unspecified
01 Scrolling
10 Sweeping
11 Sweeping then Scrolling

Bit 5-31 Reserved for future use, shall be set to zero.

C.8.5.5.1.4 Pixel Component Organization

Pixel Component Organization (0018,6044) provides an Enumerated Value describing how the components of a pixel can be described. The absence of this Attribute means that pixel component calibration does not exist for this region.

Enumerated Values:

0 Bit aligned positions
1 Ranges
2 Table look up
3 Code Sequence look up

Other values reserved for future use.

Pixel Component Organization defines the way in which the composite pixel values are mapped into real world values with physical units, as illustrated in Figure C.8-7.

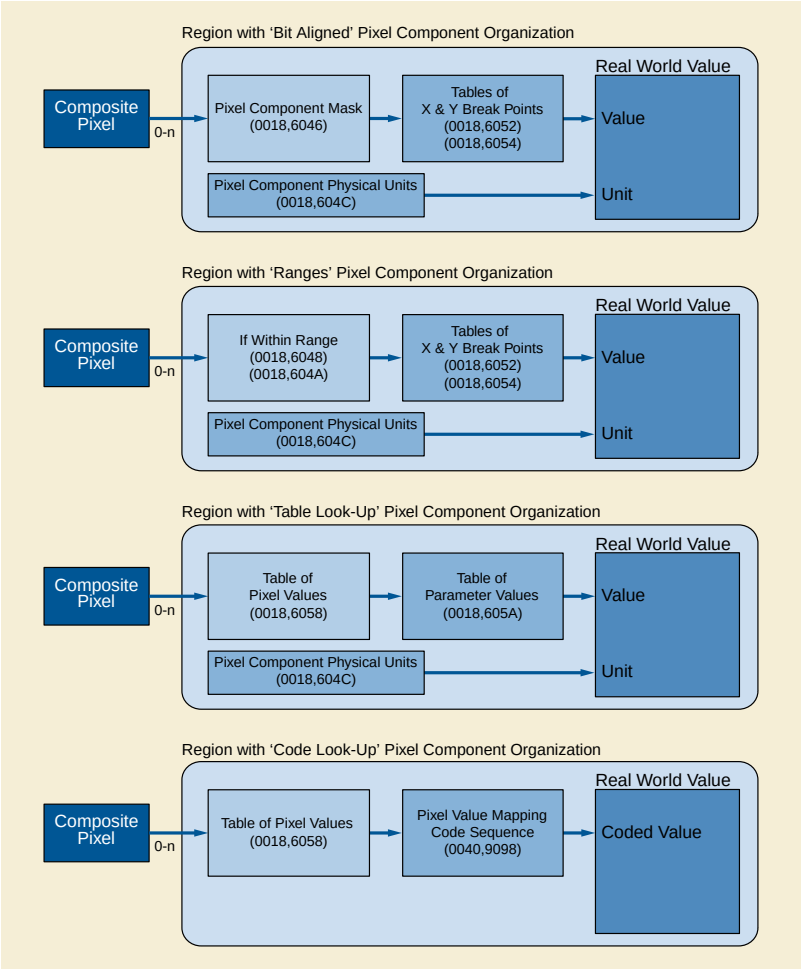


Figure C.8-7. Pixel Component Calibration

An example of Component Calibration for an ultrasound image is shown in Figure C.8-8.

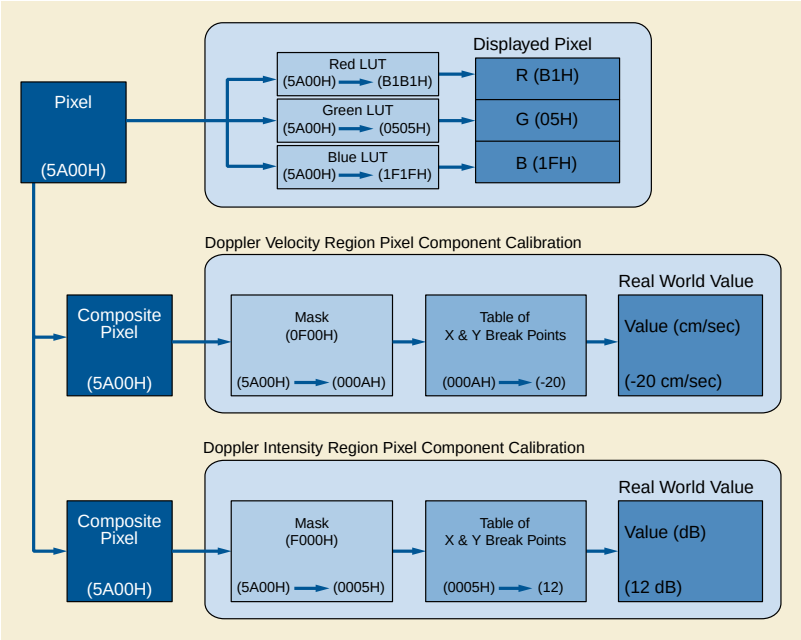


Figure C.8-8. Pixel Component Calibration Example

In this example, some pixels lie within two Regions. One Region specifies pixel component calibration for Doppler velocity values. The second Region specifies pixel component calibration for Doppler magnitude. A particular Pixel Data (7FE0,0010) value will thus map to a displayed value, a Doppler velocity and magnitude value.

The example has a Palette Color Photometric Interpretation with 16 Bits Allocated and Bits Stored per sample. The Palette Color Lookup Tables also have 16 bits for each entry. The fact that the example has just one sample per pixel means that each composite pixel value is identical to the single Pixel Data value. An example Pixel Data value is shown in brackets along with the output values resulting from each step where it is processed.

The Pixel Data value is mapped to red, green, and blue values from the supplied Palette Color Lookup Tables before being displayed. The display device supports 8 bits per sample and thus requires the scaling of the output values from the 16 bit per entry LUTs.

The Doppler Velocity Region maps each pixel value in the Region to the Doppler velocity. The Pixel Component Organization (0018,6044) has a value of zero, indicating bit aligned positions with a bit mask. The Pixel Component Mask (0018,6046) specifies that the least significant 4 bits of the most significant byte convey the Doppler velocity of each pixel. The Pixel Component Physical Units (0018,604C) are cm/sec, and the Pixel Component Data Type (0018,604E) indicates color flow velocity. The Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054) map each masked composite pixel value to a Doppler velocity value in cm/sec.

The Doppler Magnitude Region maps each pixel value in the Region to the Doppler magnitude. The Pixel Component Organization (0018,6044) has a value of zero, indicating bit aligned positions with a bit mask. The Pixel Component Mask (0018,6046) specifies that the most significant 4 bits of the most significant byte convey the Doppler magnitude of each pixel. The Pixel Component Physical Units (0018,604C) is set to dB, and the Pixel Component Data Type (0018,604E) indicates color flow magnitude. The Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054) map each masked composite pixel value to a Doppler magnitude value in dB.

C.8.5.5.1.5 Pixel Component Mask

Pixel Component Mask (0018,6046) is ANDed with the Composite Pixel Code (see Section C.7.6.3.1.1) for each pixel within the region, then shifted right by the number of contiguous least significant zeros in the mask to obtain what will be referred to as the "Shifted Masked Composite Pixel Code".

The mask will most likely (but not necessarily) contain a block of contiguous ones, surrounded by leading and trailing zeros. The purpose of this mask is to keep only those bits within the composite pixel code that pertain to the region. It is to be used only when Pixel Organization is bit aligned positions.

C.8.5.5.1.6 Pixel Component Physical Units

Enumerated Values:

0000H None or not applicable
0001H Percent
0002H dB
0003H cm
0004H seconds
0005H hertz(seconds-1)
0006H dB/seconds
0007H cm/sec
0008H cm^2
0009H cm^2/sec
000AH cm3
000BH cm3/sec
000CH degrees

C.8.5.5.1.7 Pixel Component Data Type

Enumerated Values:

0000H None or not applicable
0001H Tissue
0002H Spectral Doppler
0003H Color Flow Velocity
0004H Color Flow Variance
0005H Color Flow Intensity
0006H Gray bar
0007H Color bar
0008H Integrated Backscatter
0009H Computed Border
000AH Tissue Classification

C.8.5.5.1.8 Number of Table Break Points

The Number of Table Break Points (0018,6050) gives the number of entries in each of two tables: the Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054). These tables are used to designate a curve mapping the value of a pixel component to its actual physical value, as described in Section C.8.5.5.1.9.

C.8.5.5.1.9 Table of X Break Points and Table of Y Break Points

Table of X Break Points (0018,6052) and Table of Y Break Points (0018,6054) are individual arrays of coordinates that interpreted together are used to create a piecewise linear curve. Each X value from the Table of X Break Points is matched with the corresponding Y value from the Table of Y Break Points yielding an (X,Y) coordinate. The set of (X,Y) coordinates describes a piecewise linear curve mapping the value of a pixel component to its actual physical value (in units defined in Pixel Component Physical Units (0018,604C)).

The X direction on the curve has no units, and represents actual pixel component values. If the Pixel Component Organization (0018,6044) is "Bit aligned positions", and the width of the Pixel Component Mask is *n* bits then the X coordinates are in the range 0 through 2n-1. If the Pixel Component Organization is *Ranges*, then the X coordinates are in the range 0 through 2 number of bits in the composite pixel- 1.

Note

The X value is NOT relative to the Pixel Component Range Start (0018,6048). Not all possible X values in the range need be covered by the curve.

For any pixel component value in the range of the curve described by this table, the corresponding Y value is the actual physical value for that pixel, in units specified in Pixel Component Physical Units (0018,604C). If the pixel component value is NOT within the range of specified X values for the curve, then no pixel calibration is defined by this region. It may be possible for pixel calibration to be defined by other spatial regions intersecting this one.

C.8.5.5.1.10 TM-line Position X0, Y0, X1 and Y1

The TM-Line Position X0 (0018,603D) and TM-Line Position Y0 (0018,603F) are the coordinates of the starting point and TM-Line Position X1 (0018,6041), TM-Line Position Y1 (0018,6043) are the coordinates of the end point of the TM-line. The coordinate is defined as the displacement, in pixels, from the Reference pixel. Typically used for M-mode line and CW Doppler.

C.8.5.5.1.11 Number of Table Entries

The Number of Table Entries (0018,6056) gives the number of entries in the Table of Pixel Values, the number of entries in the Table of Parameter Values (0018,605A), if present, and the number of Items in the Pixel Value Mapping Code Sequence (0040,9098), if present.

C.8.5.5.1.12 Table of Pixel Values

The Table of Pixel Values (0018,6058) specifies the pixel values that are mapped to real world parameter values or coded concepts (tissue characterizations). The number of entries in the table is given by Number of Table Entries (0018,6056).

A pixel is calibrated (mapped to a real-world value) by finding an entry in the Table of Pixel Values that matches its Composite Pixel Code (see Section C.7.6.3.1.1). The offset index of this entry is used as an index into the Parameter Value Table (0018,605A) or as a Sequence Item number in the Pixel Value Mapping Code Sequence (0040,9098) to select the real world value. The first Table of Pixel Values entry corresponds to Sequence Item 1.

Note

If a Composite Pixel Code has no matching value in the Pixel Value Table then there is no unambiguous way to determine the corresponding Parameter Value. A method may exist to determine a valid Parameter Value but the specification of such a method is outside the scope of the DICOM Standard. No assumption should be made that linear interpolation will produce a valid result.

C.8.5.5.1.13 Table of Parameter Values

The Table of Parameter Values (0018,605A) provides the real world values for pixel values identified in the Table of Pixel Values (0018,6058). The number of table entries is given by Number of Table Entries (0018,6056) and the physical units are given by Pixel Component Physical Units (0018,604C). Values may repeat when a parameter value is associated with more than one Composite Pixel Code value.

C.8.5.5.1.14 Region Location Min X0, Min Y0, Max X1 and Max Y1

These Attributes specify the location of the region, Region Location Min X0 (0018,6018), Region Location Min Y0 (0018,601A), Region Location Max X1 (0018,601C), Region Location Max Y1 (0018,601E) expressed as offsets to the pixel coordinates. The upper left corner of the entire image is x=0,y=0 and the lower right corner is x=image width - 1, and y=image length - 1. Thus, a region will be specified as within these bounds. Where x0,y0 is the coordinate of the upper left corner of the region and x1,y1 is the coordinate of the lower right corner of the region.

C.8.5.5.1.15 Physical Units X Direction and Physical Units Y Direction

Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) indicate the physical units of the dimensions of the region.

Enumerated Values:

0000H None or not applicable
0001H Percent
0002H dB
0003H cm
0004H seconds
0005H hertz(seconds-1)
0006H dB/seconds
0007H cm/sec
0008H cm^2
0009H cm^2/sec
000AH cm3
000BH cm3/sec

000CH degrees

C.8.5.5.1.16 Reference Pixel X0 and Reference Pixel Y0

This coordinate pair, Reference Pixel X0 (0018,6020), Reference Pixel Y0 (0018,6022) defines the location of a virtual "reference" pixel. This reference pixel location is used to tie the image's pixel coordinate system to the physical coordinate system. For example, the reference pixel could be defined where a depth of zero centimeters occurs in the 2D image, or it could define where the baseline (i.e., zero frequency) resides in a spectral display. The reference pixel location is the relative offset from the Region Location Min X0 (0018,6018) and Region Location Min Y0 (0018,601A), not the image origin. The location is not required to be within the region or even within the image boundary. For this reason, the Reference Pixel X0 and Reference Pixel Y0 values can be positive or negative.

The reference pixel location varies depending on the type and spatial organization of the data within the region.

C.8.5.5.1.16.1 2D - Tissue or Color Flow

Tissue data is tissue echo intensity displayed as grayscale. The Region Data Type (0018,6014) value is 0001H (Tissue). Color flow is Doppler signal displayed as color and encoded as some function of Doppler magnitude and velocity of blood flow or tissue motion. The Region Data Type value is 0002H (Color flow). For 2D, the Region Spatial Format (0018,6012) is 0001H (2D), meaning that the region is a tomographic image. For such 2D regions the reference pixel location is typically at the center of the transducer face on the tissue-transducer interface (skin line).

Figure C.8-1 shows 2D Attribute values of reference pixel location along with Region Location Min and Region Location Max. for 2D-Tissue and 2D-Color Flow Regions:

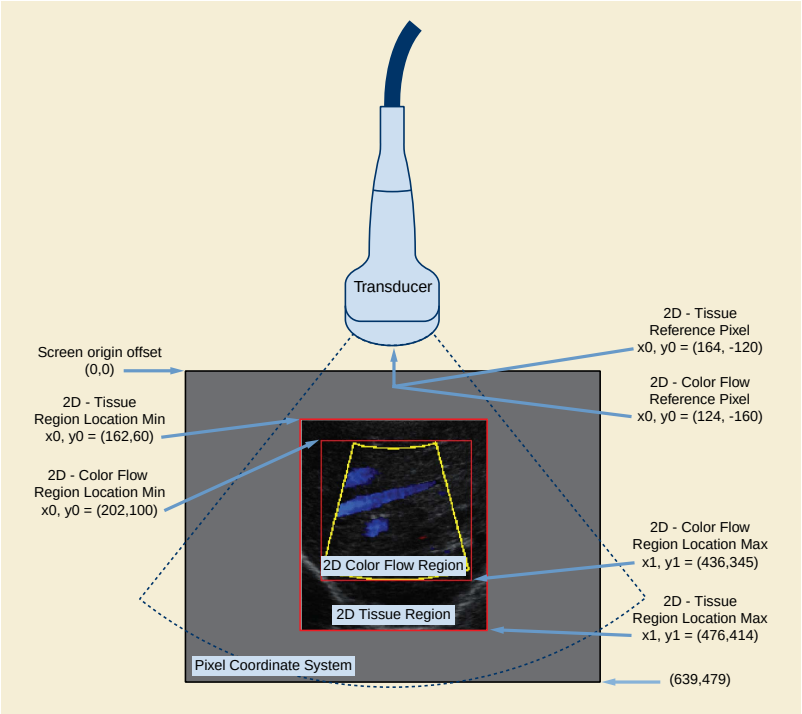


Figure C.8-1. 2D Regions with Reference Pixel

Both the 2D regions-Tissue and Color Flow-share the same physical location at the skin line but the reference pixel location values (Reference Pixel X0 and Reference Pixel Y0) are relative to their respective region origins at the skin line.

C.8.5.5.1.16.2 Spectral - CW or PW Doppler or Doppler Trace

Spectral Doppler is the time varying magnitude of Doppler signal as function of frequency. Region Data Type (0018,6014) value is 0003H (pulsed wave Doppler) or 0004H (continuous wave Doppler). Spectral Doppler regions display the magnitude of Doppler signal with frequency or velocity as the vertical dimension and time as the horizontal dimension. Spectral Doppler regions have a Region

Spatial Format (0018,6012) of 0003H (Spectral). The time dimension for the Region Spatial Format displays horizontally with data scrolling toward the left or sweeping toward the right. The reference pixel location is the pixel in the frame where:

- the time is the time of frame capture (i.e., the time origin for the frame)
- and on the Doppler Baseline (i.e., where the velocity and frequency are zero).

Figure C.8-2 shows an example of reference pixel locations in an image with both a Tissue and a scrolling Spectral (CW or PW Doppler) Region. The user adjusts the depth and position of the Doppler sample volume. The system annotates the sample volume position on the 2D region and specifies the location in Doppler Sample Volume X Position (0018,6039) and Doppler Sample Volume Y Position (0018,603B).

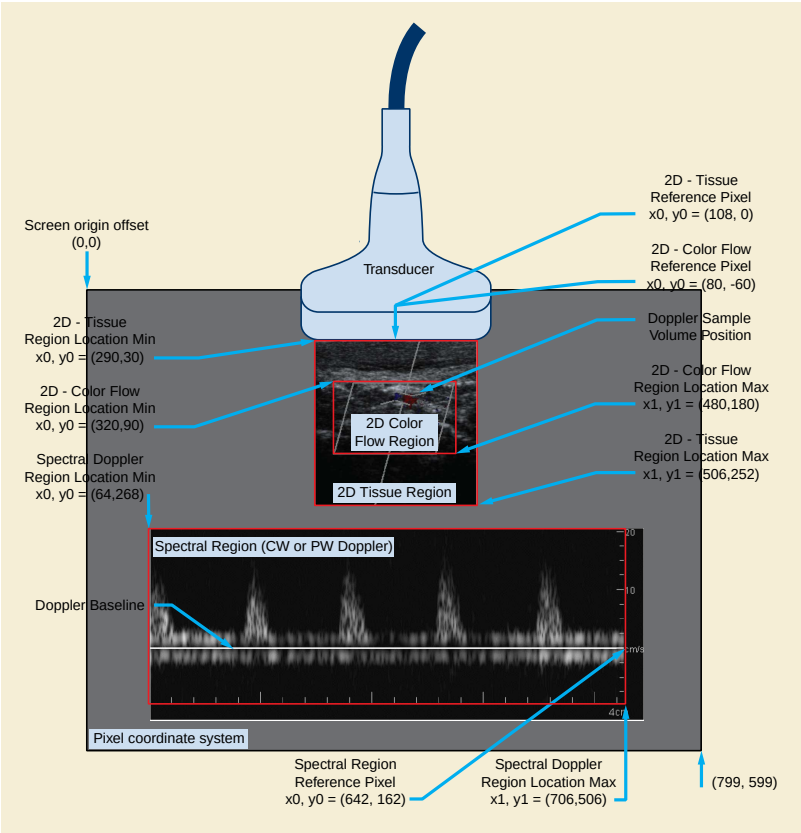


Figure C.8-2. 2D & Doppler Regions with Reference Pixel

The scrolling Spectral Region reference pixel location specifies the horizontal location at the time of the current image frame. Data to the left of this location in the Spectral Region was acquired in the past. Because time increases to the right, the Physical Delta X (0018,602C) for this Region is positive. To specify the location of the most recent data the Reference Pixel x0specifies the time of acquisition, and the Reference Pixel Physical Value X (0018,6028) specifies the reference time to be zero. The Physical Units X Direction (0018,6024) is seconds. For an explanation of how to handle sweeping regions refer to Section C.8.5.5.1.16.7 Treatment of Sweeping Regions.

The Reference Pixel Physical Value Y (0018,602A) value specifies the baseline where velocity or frequency are zero. Typically spectral Doppler regions display positive velocity (cm/Sec) or frequency shift (Hz) above the baseline. This indicates flow toward the transducer face. Negative velocity or frequency information is displayed below the baseline. This indicates flow away from the transducer face. The Physical Delta Y (0018,602E) value is therefore negative because vertical coordinates increment downward.

C.8.5.5.1.16.3 M-Mode - Tissue or Color Flow

M-Mode is tissue or color flow with a Region Spatial Format (0018,6012) of 0002H (M-mode). The vertical reference pixel location is the transducer face.

The horizontal reference pixel location is the pixel in the frame where:

- the time is the time of frame capture (i.e., the time origin for the frame)
- and zero depth from the transducer face

Figure C.8-3 shows an example of reference pixel locations for 2D Tissue and M-Mode Regions within the same image frame. The system annotates the sample line position on the 2D tissue region and specifies its position with the TM-Line Position Attributes (0018,603D), (0018,603F), (0018,6041) and (0018,6043).

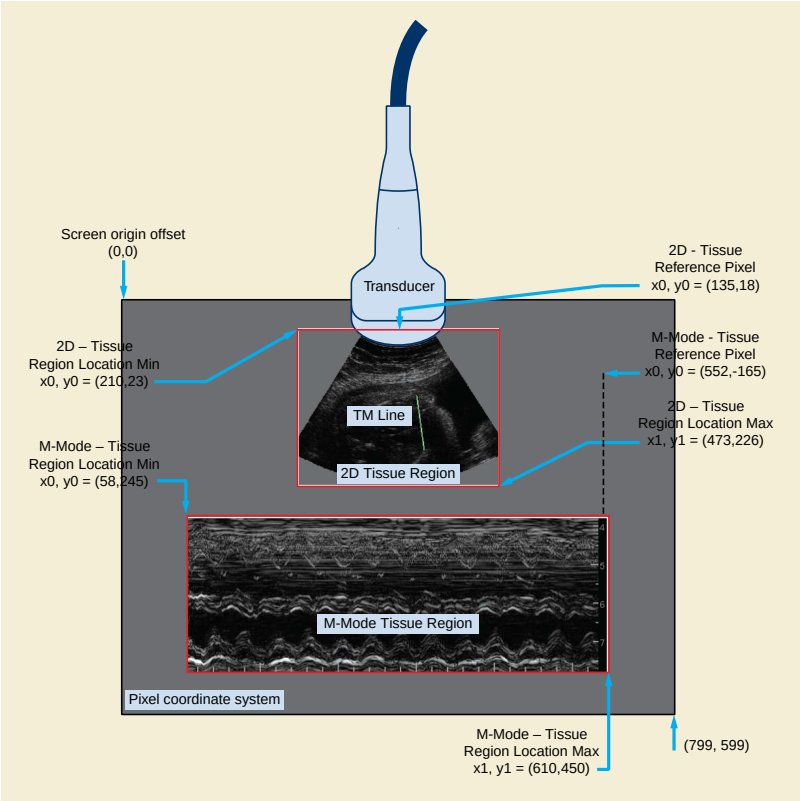


Figure C.8-3. 2D & M-Mode Regions with Reference Pixel Example

The physical length of the TM-Line corresponds directly to the physical height of the M-Mode Region. The M-Mode region's Reference Pixel y0 can be used to calculate the depth of the M-Mode region and facilitate depth measurements. In this example the M-Mode Region Reference Pixel y0 has a negative value corresponding to the distance between the face of the ultrasound probe and the TM-Line starting point. Note that the negative offset in pixel units is determined using the pixel height-width scaling of the M-Mode - Tissue Region as this could differ from the scaling of the 2D - Tissue Region (as it does in this example).

C.8.5.5.1.16.4 Waveform - ECG, Phonocardiogram and Pulse Traces

Waveforms are traces with a Region Spatial Format (0018,6012) value of 0004H (Waveform). The Reference Pixel x0 (0018,6020) specifies the time origin as the time of frame capture. There is typically no baseline position for ECG traces; the Reference Pixel y0 (0018,6022) is arbitrary.

Figure C.8-4 shows an example of reference pixel location for 2D Tissue, M-Mode, and ECG Waveform Regions within the same image frame:

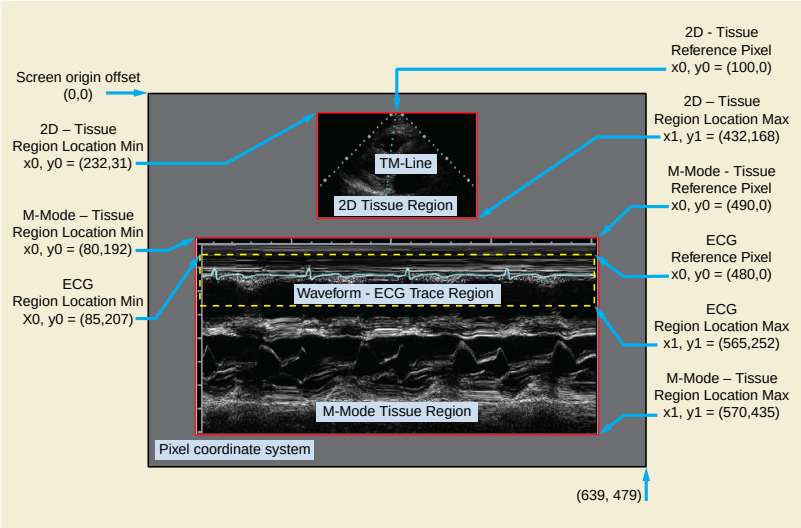


Figure C.8-4. 2D, M-Mode, & Waveform Regions with Reference Pixel

C.8.5.5.1.16.5 Waveform - Doppler Mode, Mean and Max Trace

Doppler Traces have a Region Spatial Format (0018,6012) value of 0004H (Waveform) and a Region Data Type value of 0005H (Doppler Mean Trace), 0006H (Doppler Mode Trace) or 0007H (Doppler Max Trace). The Reference Pixel x0 (0018,6020) specifies the time origin as the time of frame capture. The Reference Pixel y0 (0018,6022) is the Doppler Baseline position (zero velocity / frequency position).

C.8.5.5.1.16.6 Graphics Spatial Formats

For regions with Region Spatial Format (0018,6012) value of 0005H (Graphics) the reference pixel location has no meaning.

C.8.5.5.1.16.7 Treatment of Sweeping Regions

Time-based display of data may scroll the acquired data from a fixed horizontal location to the left. Alternatively, sweep-based display increments the horizontal location of the acquired data, overwriting previously acquired data to the right. When the horizontal location corresponding to zero time has completely swept over the older data, writing wraps from the left of the region. Thus, sweep-based displays have a time discontinuity. The measurement of time intervals across the discontinuity requires special treatment. The time interval between two points across the discontinuity is equal to the region's time width minus the point separation. The sweeping area can be treated as a single region. The Reference Pixel x0 should indicate the time origin for the multi-frame image, which will be the location of the sweeping region's discontinuity line for the first frame of the multi-frame image. In order to specify that this is actually the location of the discontinuity line, the Reference Pixel Physical Value X (0018,6028) must be set to 0 seconds. This indicates that this location corresponds to the time at which the first frame was acquired.

It is useful to be able to calculate the location of the discontinuity line for subsequent frames of a multi-frame image. This is necessary if one is to determine whether two points are on opposite sides of the discontinuity line and also to correctly calculate the difference in time between such points. The x-axis location of the discontinuity line, x, for a given frame number, y, can be calculated from the Reference Pixel x0, x0, the Reference Pixel x1, x1, the time offset for frame y, t, (determined from the Frame Time Vector (0018,1065) or Frame Time (0018,1063)) and the Physical Delta X (0018,602C), p_x, as follows:

$x = x0 + \text{modulus}((t / p_x) / (x1 - x0))$

Alternatively, two regions can be used, one on each side of the time discontinuity. Figure C.8-5 shows the use of two regions. Note that the two region approach is not valid for multi-frame images, as the same region scaling must apply to all the frames.

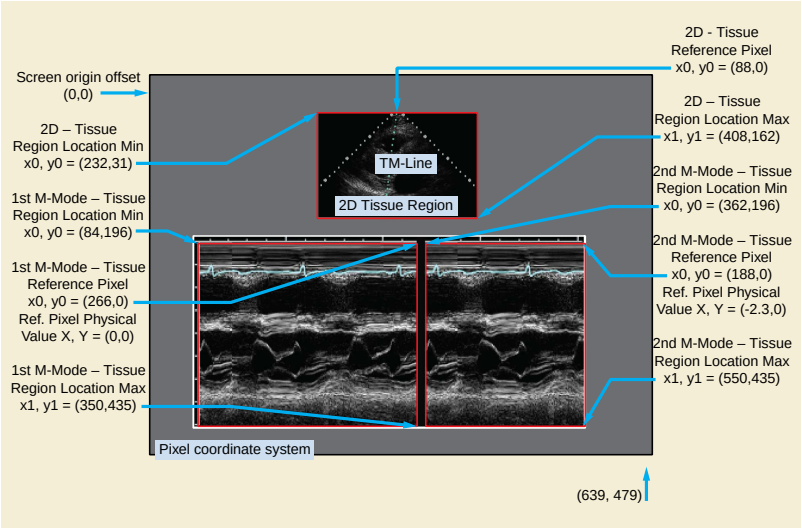


Figure C.8-5. Sweep Example Using Two Regions

The two region approach may also be used in Doppler or physiological sweeping regions.

Time-based display of data may also be a combination of sweeping and scrolling. Sweep-based display is used at the start of acquisition, incrementing the horizontal location of the acquired data from left to right. After the horizontal location corresponding to zero time has completely swept to the right hand limit of the region, writing scrolls to the left from the right hand limit rather than wrapping from the left. A single region should be specified when this combination of behavior is used. The x-axis (zero time) location, x, for a given frame number, y, can be calculated from the Reference Pixel x0, x0, the Reference Pixel x1, x1, the time offset for frame y, t, (determined from the Frame Time Vector (0018,1065) or Frame Time (0018,1063)) and the Physical Delta X, p_x, as follows:

$X = \text{Min}\ (x0 + (t / p_x), x1)$

C.8.5.5.1.17 Physical Delta X and Physical Delta Y

The Physical Delta X (0018,602C) is the physical value increment per positive X pixel increment, which is left to right. The Physical Delta Y (0018,602E) is the physical value increment per positive Y pixel increment, which is top to bottom.

Note

When displaying Doppler data, ultrasound applications typically display the Doppler strip horizontally, with data sweeping (moving time origin) from left (oldest) to right (newest) or scrolling (static time origin) from right to left. The default display of positive velocity values normally indicates flow toward the transducer; negative velocity values indicate flow away from the transducer. In this case a negative Physical Delta Y is required to specify that the direction of positive velocities or frequencies is upward.

C.8.5.5.1.18 Pixel Value Mapping Code Sequence

The Pixel Value Mapping Code Sequence (0040,9098) provides the real world values for pixel values identified in the Table of Pixel Values (0018,6058). The number of Items in the Sequence is given by Number of Table Entries (0018,6056).

Note

Pixel Component Physical Units (0018,604C) does not apply to Sequence of Pixel Value Codes and should be set to 0000H (none or not applicable).

C.8.5.6 US Image Module

Table C.8-18 specifies the Attributes that describe ultrasound images.

Table C.8-18. US Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.8.5.6.1.12 for specialization
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.5.6.1.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.5.6.1.13 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. See Section C.8.5.6.1.14 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. See Section C.8.5.6.1.15 for specialization.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.8.5.6.1.16 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. See Section C.8.5.6.1.3 for specialization.
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the Attribute that is used as the frame increment in Multi-frame pixel data (see Section C.7.6.6). Required if Number of Frames is present. See Section C.8.5.6.1.4 for specialization.
Image Type	(0008,0008)	2	Image identification characteristics. See Section C.8.5.6.1.1 for specialization.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image. May be present otherwise.
Number of Stages	(0008,2124)	2C	Number of Stages in this protocol. Required if image was acquired in a Staged protocol.
Number of Views in Stage	(0008,212A)	2C	Number of views in this Stage. Required if image was acquired in a Staged protocol.
R Wave Time Vector	(0018,6060)	3	The time offset(s) of the reported R Wave peaks, each relative to the time of the start of the acquisition of the first frame in msec. Multi-valued, with one value per reported R Wave.

Attribute Name	Tag	Type	Attribute Description
Ultrasound Color Data Present	(0028,0014)	3	This element indicates if any ultrasound color data is present in an image. Enumerated Values: **00** Ultrasound color data not present in image **01** Ultrasound color data is present in image. See Section C.8.5.6.1.10
Stage Name	(0008,2120)	3	A Stage is a particular time slice of a protocol in which a set of images are collected. The names can be free form text. Recommended text for Stress Echo stage names: **PRE-EXERCISE** **POST-EXERCISE** **PEAK-EXERCISE** **RECOVERY** **BASELINE** **LOW DOSE** **PEAK DOSE**
Stage Code Sequence	(0040,000A)	3	Sequence of Items describing the performed Ultrasound Protocol Stage(s). One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 12002 “Ultrasound Protocol Stage Types”.*
Stage Number	(0008,2122)	3	A number that identifies the Stage. Stage Number starts at one.
View Name	(0008,2127)	3	A View is a particular combination of the position and orientation when a set of images are acquired. Images are acquired at the same View in different Stages for the purpose of comparison.
View Number	(0008,2128)	3	A number that identifies the View. View Number starts at one.
Number of Event Timers	(0008,2129)	3	The number of event timers used at the time of acquisition of a Multi-frame image.
Event Elapsed Time(s)	(0008,2130)	3	An array of values associated with each event timer. Units in milliseconds.
Event Timer Name(s)	(0008,2132)	3	Name that identifies the event timer.
Include Table 10-7 “General Anatomy Optional Macro Attributes”			*For intravascular ultrasound, DCID 3010 “Cardiovascular Anatomic Locations” and DCID 3015 “Coronary Arteries” are specified for the Anatomic Region Sequence and DCID 3019 “Cardiovascular Anatomic Location Modifiers” is specified for the Anatomic Region Modifier Sequence.* *No other CIDs are specified.*
Include Table 10-25 “Optional View and Slice Progression Direction Macro Attributes”			*See Section C.8.5.6.1.19 for CIDs.*

Attribute Name	Tag	Type	Attribute Description
Acquisition DateTime	(0008,002A)	1C	The date and time that the acquisition of data that resulted in this image started. Required if Modality (0008,0060) = IVUS May be present otherwise. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
Trigger Time	(0018,1060)	3	Time interval measured in msec from the start of the R-wave to the beginning of data taking
Nominal Interval	(0018,1062)	3	Average R-R interval used for these data, in msec
Beat Rejection Flag	(0018,1080)	3	Beat length sorting has been applied. Enumerated Values: **Y** yes **N** no
Low R-R Value	(0018,1081)	3	R-R interval low limit for beat rejection, in msec
High R-R Value	(0018,1082)	3	R-R interval high limit for beat rejection, in msec
Heart Rate	(0018,1088)	3	Beats per minute.
IVUS Acquisition	(0018,3100)	1C	Defined Terms: **MOTOR_PULLBACK** **MANUAL_PULLBACK** **SELECTIVE** **GATED_PULLBACK** See Section C.8.5.6.1.21 Required if Modality (0008,0060) = IVUS
IVUS Pullback Rate	(0018,3101)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK. Specified in units of mm/sec. See Section C.8.5.6.1.22
IVUS Gated Rate	(0018,3102)	1C	Required if IVUS Acquisition (0018,3100) value is GATED_PULLBACK. Specified in units of mm/beat. See Section C.8.5.6.1.23
IVUS Pullback Start Frame Number	(0018,3103)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See Section C.8.5.6.1.24
IVUS Pullback Stop Frame Number	(0018,3104)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See Section C.8.5.6.1.25
Lesion Number	(0018,3105)	3	Identifier(s) of the lesion(s) of interest imaged within the current SOP Instance. Each lesion shall have a unique numeric integer identifier within the Study. See Section C.8.5.6.1.26.

Attribute Name	Tag	Type	Attribute Description
Output Power	(0018,5000)	3	Manufacturer defined character string description of ultrasound output level(s) used in generating a given image. Data may be expressed in dB, %, W/cm^2, etc.
Transducer Data	(0018,5010)	3	Manufacturer defined code or description of ultrasound transducer used.
Transducer Identification Sequence	(0018,5011)	3	Identification of the ultrasound transducer used. Only a single Item is permitted in this Sequence.
Include Table 10.36-1 “Device Identification Macro Attributes”			Device Type Code Sequence (3010,002E) BCID 12035 “Ultrasound Transducer Application”.
Transducer Type	(0018,6031)	3	Defined Terms: **SECTOR_PHASED** **SECTOR_MECH** **SECTOR_ANNULAR** **LINEAR** **CURVED LINEAR** **SINGLE CRYSTAL** **SPLIT XTAL CWD** **IV_PHASED** **IV_ROT XTAL** **IV_ROT MIRROR** **ENDOCAV_PA** **ENDOCAV_MECH** **ENDOCAV_CLA** **ENDOCAV_AA** **ENDOCAV_LINEAR** **VECTOR_PHASED**
Focus Depth	(0018,5012)	3	The depth, from the transducer face, of the manufacturer defined beam focus used for the image, in cm.
Processing Function	(0018,5020)	3	Manufacturer defined description of processing of echo information. Data may include code or description of gain (initial, overall, TGC, dynamic range, etc.), preprocessing, postprocessing, Doppler processing parameters, e.g., cutoff filters, etc., as used in generating a given image.
Mechanical Index	(0018,5022)	3	See Section C.8.5.6.1.8 for Description.
Bone Thermal Index	(0018,5024)	3	See Section C.8.5.6.1.8 for Description.
Cranial Thermal Index	(0018,5026)	3	See Section C.8.5.6.1.8 for Description.
Soft Tissue Thermal Index	(0018,5027)	3	See Section C.8.5.6.1.8 for Description.
Soft Tissue-focus Thermal Index	(0018,5028)	3	See Section C.8.5.6.1.8 for Description.
Soft Tissue-surface Thermal Index	(0018,5029)	3	See Section C.8.5.6.1.8 for Description.
Depth of Scan Field	(0018,5050)	3	The depth, in mm, from the transducer face to the deepest point included in the displayed image - the field of view.
Overlay Subtype	(60xx,0045)	3	Defined Term that identifies the intended purpose of the ROI Overlay Type. See Section C.8.5.6.1.11 for specialization.

Note

Referenced Overlay Sequence (0008,1130) and Referenced Curve Sequence (0008,1145) were previously included in this Module as optional Attributes but have been retired. See PS3.3-2004.

C.8.5.6.1 US Image Attribute Descriptions

C.8.5.6.1.1 Image Type

For US Images, Image Type (0008,0008) is specified to be Type 2.

Defined Terms for Value 3:

ABDOMINAL
BREAST
CHEST
ENDOCAVITARY
ENDORECTAL
ENDOVAGINAL
EPICARDIAL
FETAL HEART
GYNECOLOGY
INTRACARDIAC
INTRAOPERATIVE
INTRAVASCULAR
MUSCULOSKELETAL
NEONATAL HEAD
OBSTETRICAL
OPHTHALMIC
PEDIATRIC
PELVIC
RETROPERITONEAL
SCROTAL
SMALL PARTS
TEE
THYROID
TRANSCRANIAL
TTE
US BIOPSY
VASCULAR

Value 4 is constructed as a modality bit map to allow for a description of multi-modality displays. In using this bit map, the sum of the values of the various modalities will unambiguously determine the constituent modalities.

Bit Map Values for Value 4:

0001 2D Imaging
0002 M-Mode
0004 CW Doppler
0008 PW Doppler
0010 Color Doppler
0020 Color M-Mode
0040 3D Rendering
0100 Color Power Mode
0200 Tissue Characterization
0400 Spatially-related frames

Note

1. All Values are hexadecimal encoded as a CS. See PS3.5.

2. For example, Color Flow with CW spectral Doppler would have a value 4 = 0015. Note that no assumption should be made in Color Doppler or Color M-Mode regarding underlying B or M-Mode, respectively.

3. See Section A.59.1 for the relationship between a 3D volume set and the 3D Rendering, 3D MPR View, and Spatially-related frames image types. In the case of "3D Rendering", Derivation Code Sequence (0008,9215) should be used to describe the specific type of 3D rendering (volume rendering, surface rendering, multiplanar reformatting, etc.).

C.8.5.6.1.2 Photometric Interpretation

Defined Terms:

MONOCHROME2
PALETTE COLOR
RGB
YBR_FULL
YBR_FULL_422
YBR_RCT
YBR_ICT
YBR_PARTIAL_420

Note

The ARGB and YBR_PARTIAL_422 photometric interpretations were previously defined but are retired. See PS3.3 2017b.

When Samples per Pixel (0028,0002) is greater than 1, Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT for irreversible JPEG 2000 Transfer Syntaxes, YBR_RCT for reversible JPEG 2000 Transfer Syntaxes, YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264 and HEVC/H.265 Transfer Syntaxes, YBR_FULL_422 for JPEG lossy compressed Transfer Syntaxes and YBR_FULL or RGB for RLE Transfer Syntaxes.

See PS3.5 for additional restrictions imposed by compressed Transfer Syntaxes.

C.8.5.6.1.3 Pixel Representation

For US Images, Pixel Representation (0028,0103) is specified to use the following.

Enumerated Values:

0000H unsigned integer

C.8.5.6.1.4 Frame Increment Pointer

For US Multi-frame images, the Attribute Frame Increment Pointer (0028,0009) of the Multi-frame Module (see Section C.7.6.6) is specified by the following.

Defined Terms:

00181063 sequencing by Frame Time (0018,1063)
00181065 sequencing by Frame Time Vector (0018,1065)

C.8.5.6.1.5 (Retired)

C.8.5.6.1.6 (Retired)

C.8.5.6.1.7 (Retired)

C.8.5.6.1.8 Mechanical Index, Bone Thermal Index, Cranial Thermal Index, Soft Tissue Thermal Index

The thermal and/or mechanical indices, when made available by a manufacturer, are defined according to the *Standard for Real-Time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment*, a voluntary performance standard jointly published by AIUM and NEMA.

C.8.5.6.1.9 Image Transformation Matrix and Image Translation Vector

This section was defined in a previous version of the DICOM Standard. The Section is now retired. See PS3.3-2003.

C.8.5.6.1.10 Ultrasound Color Data Present

Note

This Attribute can be used to indicate if an image contains any Ultrasound color data.

For example: Some Ultrasound images may have a Photometric Interpretation equal to RGB but the image will have no color information if R=G=B for all pixels.

For consistency within a particular implementation Monochrome Ultrasound images may be coded using a color photometric interpretation. In that case inclusion of this Attribute can significantly speed up processing. Since all components are known to be equal only one need be handled. The enhancements can be significant when compressed Transfer Syntaxes are used.

C.8.5.6.1.11 Overlay Subtype

Defined Terms:

ACTIVE 2D/BMODE IMAGE AREA identification of the active area of a 2D/B-mode image

C.8.5.6.1.12 Samples Per Pixel

For US Images, Samples Per Pixel (0028,0002) is specified to use the following values for specific Photometric Interpretations:

Table C.8-19. US Samples Per Pixel

Photometric Interpretation	Samples Per Pixel Value
MONOCHROME2	1
RGB	3
YBR_FULL	3
YBR_FULL_422	3
YBR_RCT	3
YBR_ICT	3
YBR_PARTIAL_420	3
PALETTE COLOR	1

C.8.5.6.1.13 Bits Allocated

For US Images, Bits Allocated (0028,0100) is specified to use the following values for specific Photometric Interpretations:

Table C.8-20. US Bits Allocated

Photometric Interpretation	Bits Allocated Value
MONOCHROME2	8
RGB	8
YBR_FULL	8
YBR_FULL_422	8
YBR_RCT	8
YBR_ICT	8
YBR_PARTIAL_420	8
PALETTE COLOR	8 - 8 bit palette, or 16 - 16 bit palette

C.8.5.6.1.14 Bits Stored

For US Images, Bits Stored (0028,0101) shall be equal to Bits Allocated (0028,0100).

C.8.5.6.1.15 High Bit

For US Images, High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).

C.8.5.6.1.16 Planar Configuration

For US Images, Planar Configuration (0028,0006) is specified to use the following values for specific Photometric Interpretations:

Table C.8-23. US Planar Configuration

Photometric Interpretation	Planar Configuration Value
RGB	0 - color-by-pixel, or 1 - color-by-plane
YBR_FULL	0 or 1 if uncompressed 0 if lossless JPEG, lossless JPEG-LS or reversible JPEG 2000 1 if RLE
YBR_FULL_422	0
YBR_RCT	0
YBR_ICT	0
YBR_PARTIAL_420	0

C.8.5.6.1.19 View Code Sequence

The view of the patient anatomy may be described using coded terminology in the View Code Sequence (0054,0220). The view is typically specified by transducer position relative to the patient anatomy and/or transducer orientation,

The view may be described by a single Code Sequence Item, or by combination of post-coordinated Code Sequence Items. The principal code is specified in View Code Sequence, and modifier terms in the View Modifier Code Sequence (0054,0222). For post-coordinated encoding of view:

- BCID 4 “Anatomic Region” (typically used for the primary coded item)
- BCID 5 “Transducer Approach”
- BCID 6 “Transducer Orientation”
- BCID 7 “Ultrasound Beam Path”

Any of these Context Groups may be used in either the View Code Sequence or the View Modifier Code Sequence.

For cardiac imaging, pre-coordinated view codes are specified:

- BCID 12226 “Echocardiography Image View”

  Note

  Transducer Position Sequence (0008,2240) and Transducer Orientation Sequence (0008,2244), defined in this Module in an earlier edition of the Standard (see PS3.3-2004), are retired.

C.8.5.6.1.20 (Retired)

C.8.5.6.1.21 IVUS Acquisition

Defined Terms:

MOTOR_PULLBACK The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is attached to a motorized mechanism capable of withdrawing the catheter through the vessel at a constant velocity specified by the Attribute IVUS Pullback Rate (0018,3101) from the defined IVUS Pullback Start Frame Number (0018,3103) (see Section C.8.5.6.1.24) to the IVUS Pullback Stop Frame Number (0018,3104) (see Section C.8.5.6.1.25).

MANUAL_PULLBACK The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is manually withdrawn through the vessel region of interest.

SELECTIVE The IVUS imaging catheter is positioned in the blood vessel under examination near the anatomical structures to be examined. Then the catheter is manually withdrawn or advanced through the vessel region of interest.

GATED_PULLBACK The IVUS imaging catheter is positioned in the blood vessel under examination distal to the anatomical structures to be examined. Then the catheter is attached to a motorized mechanism capable of withdrawing the catheter through the vessel at a rate specified by the Attribute IVUS Gated Rate (0018,3102), once per heart cycle, from the defined IVUS Pullback Start Frame Number (0018,3103) (see Section C.8.5.6.1.24) to the IVUS Pullback Stop Frame Number (0018,3104) (see Section C.8.5.6.1.25).

C.8.5.6.1.22 IVUS Pullback Rate

The Attribute IVUS Pullback Rate (0018,3101) is required when IVUS Acquisition (0018,3100) is MOTOR_PULLBACK and it specifies the velocity of withdrawal of the IVUS imaging catheter in millimeters per second.

C.8.5.6.1.23 IVUS Gated Rate

The Attribute IVUS Gated Rate (0018,3102) is required when IVUS Acquisition (0018,3100) is GATED_PULLBACK and it specifies the velocity of withdrawal of the IVUS imaging catheter in millimeters per beat.

C.8.5.6.1.24 IVUS Pullback Start Frame Number

The IVUS Pullback Start Frame Number (0018,3103) specifies the frame number of a IVUS multi-frame acquisition upon which motorized or gated pullback begins.

C.8.5.6.1.25 IVUS Pullback Stop Frame Number

The IVUS Pullback Stop Frame Number (0018,3104) specifies the frame number of a IVUS multi-frame acquisition upon which motorized or gated pullback ends.

C.8.5.6.1.26 Lesion Number

Attribute Lesion Number identifies the lesion(s) of interest imaged within the current SOP Instance. Each lesion shall have a unique numeric integer identifier within the Study. If during a Study the same lesion is imaged more than once, the same Lesion Number should be used for both SOP Instances.

Note

1. Lesion Number is not a DICOM UID.
2. An IVUS pullback may contain multiple values in Lesion Number.

C.8.6 Secondary Capture Modules

C.8.6.1 SC Equipment Module

This Module describes equipment used to convert images into a DICOM format.

Table C.8-24. SC Equipment Module Attributes

Attribute Name	Tag	Type	Attribute Description
Conversion Type	(0008,0064)	1	Describes the kind of image conversion. Defined Terms: **DV** Digitized Video **DI** Digital Interface **DF** Digitized Film **WSD** Workstation **SD** Scanned Document **SI** Scanned Image **DRW** Drawing **SYN** Synthetic Image
Modality	(0008,0060)	3	Source equipment for the image. This type definition shall override the definition in the General Series Module. See Section C.7.3.1.1.1 for Defined Terms.
Secondary Capture Device ID	(0018,1010)	3	User defined identification of the device that converted the image
Secondary Capture Device Manufacturer	(0018,1016)	3	Manufacturer of the Secondary Capture Device
Secondary Capture Device Manufacturer's Model Name	(0018,1018)	3	Manufacturer's model number of the Secondary Capture Device
Secondary Capture Device Software Versions	(0018,1019)	3	Manufacturer's designation of software version of the Secondary Capture Device
Video Image Format Acquired	(0018,1022)	3	Original format of the captured video image (e.g., NTSC, PAL, Videomed-H)
Digital Image Format Acquired	(0018,1023)	3	Additional information about digital interface used to acquire the image

Note

1. The Attributes specified in the General Equipment Module (see Table C.7-8) describe the equipment that created the image being captured. The Attributes of the SC Equipment Module define the equipment that captured the image. The following table illustrates typical scenarios for different conversion types:

Conversion Type (0008,0064)	General Equipment	Secondary Capture Equipment
Digitized Video (DV)	The equipment generating the video signal.	The equipment digitizing the video signal.
Digital Interface (DI)	The equipment on the sending side of the digital interface.	The equipment on the receiving side of the digital interface.
Digitized Film (DF)	The equipment that created the film.	The equipment digitizing the film.
Workstation (WSD)	Application dependent, but often the equipment that placed the image on the workstation screen, or created the modified image.	The equipment that captured the image from the screen, or placed the modified image into a DICOM SOP Instance.
Scanned Document (SD)	The equipment that created the document.	The equipment digitizing the document.
Scanned Image (SI)	The equipment that created the image that was digitized.	The equipment digitizing the image.
Drawing (DRW)	The equipment that created the drawing.	The equipment digitizing (or rasterizing) the drawing.

Conversion Type (0008,0064)	General Equipment	Secondary Capture Equipment
Synthetic Image (SYN)	The equipment creating the original images from which the synthetic image was derived.	The equipment creating the synthetic image.

2. Modality (0008,0060) specified in the General Series Module (see Table C.7-5a) has been specialized by this Module and is defined as a Type 3 Attribute.

C.8.6.2 SC Image Module

Table C.8-25 contains IOD Attributes that describe Secondary Capture Images.

Table C.8-25. SC Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Date of Secondary Capture	(0018,1012)	3	The date the Secondary Capture Image was captured.
Time of Secondary Capture	(0018,1014)	3	The time the Secondary Capture Image was captured.
Nominal Scanned Pixel Spacing	(0018,2010)	3	Physical distance on the media being digitized or scanned between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Shall be consistent with Pixel Aspect Ratio (0028,0034), if present.
Document Class Code Sequence	(0040,E008)	3	Classifications of a scanned document, e.g., for Modality (0008,0060) DOC. Equivalent to HL7 v2.x TXA-2. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Include Table 10-10 “Basic Pixel Spacing Calibration Macro Attributes”			
Include Table 10-25 “Optional View and Slice Progression Direction Macro Attributes”			

Note

The Attributes specified in the General Image Module (see Table C.7-7) describe this image (i.e., the secondary capture image). For example, Instance Number (0020,0013) is the image number of the secondary capture image. Source Image Sequence (0008,2112) may reference the DICOM image from which this image was generated.

C.8.6.3 SC Multi-frame Image Module

Table C.8-25b contains IOD Attributes that describe SC Multi-frame images.

Table C.8-25b. SC Multi-frame Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** Output is in P-Values. Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note If the VOI LUT Module is required by the IOD but no VOI LUT Sequence (0028,3010) or Window Center (0028,1050) is present, then the VOI LUT stage is an identity transformation.
Illumination	(2010,015E)	3	Luminance of a hypothetical viewing device illuminating a piece of monochrome transmissive film, or for the case of reflective media, luminance obtainable from diffuse reflection of the illumination present. Expressed as L0, in candelas per square meter (cd/m^2). Note May be used together with Reflected Ambient Light (2010,0160) to recover Optical Density information from P-Values. See Section C.8.6.3.1.
Reflected Ambient Light	(2010,0160)	3	For scanned monochrome transmissive film viewed on a hypothetical viewing device, the luminance contribution due to reflected ambient light. Expressed as La, in candelas per square meter (cd/m^2). Note May be used together with Illumination (2010,015E) to recover Optical Density information from P-Values. See Section C.8.6.3.1.
Rescale Intercept	(0028,1052)	1C	The value b in the relationship between stored values (SV) in Pixel Data (7FE0,0010) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.

Attribute Name	Tag	Type	Attribute Description
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Defined Terms: **US** Unspecified Required if Photometric Interpretation (0028,0004) is MONOCHROME2, and Bits Stored (0028,0101) is greater than 1. Note This specifies an identity Modality LUT transformation.
Frame Increment Pointer	(0028,0009)	1C	Contains the Data Element Tag of the Attribute that is used as the frame increment in Multi-frame pixel data. See Section C.7.6.6.1.2 for further explanation. Shall be present if Number of Frames is greater than 1, overriding (specializing) the Type 1 requirement on this Attribute in the Multi-frame Module.
Nominal Scanned Pixel Spacing	(0018,2010)	1C	Physical distance on the media being digitized or scanned between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Required if Conversion Type (0008,0064) is DF (Digitized Film). May also be present if Conversion Type (0008,0064) is SD (Scanned Document) or SI (Scanned Image). Shall be consistent with Pixel Aspect Ratio (0028,0034), if present.
Include Table 10-10 “Basic Pixel Spacing Calibration Macro Attributes”			
Digitizing Device Transport Direction	(0018,2020)	3	Enumerated Values: **ROW** **COLUMN**
Rotation of Scanned Film	(0018,2030)	3	Angle of the edge of the film relative to the transport direction in degrees greater than or equal to -45 and less than or equal to +45.

C.8.6.3.1 Scanned Film, Optical Density and P-Values

Illumination (2010,015E) and Reflected Ambient Light (2010,0160) may be used to recover Optical Density information from P-Values.

Monochrome media that is being digitized is often measured in Optical Density values. These values need to be converted to P-Values for storage and display. The P-Values used in an image correspond to the perception of a human observer viewing the film on a hypothetical viewing device (such as a light box), using the specified values of Illumination (2010,015E) and Reflected Ambient Light (2010,0160).

The Grayscale Standard Display Function defined in PS3.14 is used to convert Luminance to P-Values. In the case of scanned film, the Luminance is derived from Optical Density using the specified values of Illumination (2010,015E) and Reflected Ambient Light (2010,0160). An example of this derivation, as well as typical "default" values for these parameters, is specified in PS3.14.

C.8.6.4 SC Multi-frame Vector Module

Table C.8-25c contains IOD Attributes that may be the target of the Frame Increment Pointer (0028,0009) for SC Multi-frame images.

Table C.8-25c. SC Multi-frame Vector Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Time Vector	(0018,1065)	1C	An array that contains the real time increments (in msec) between frames for a Multi-frame image. See Section C.7.6.5.1.2 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Frame Time Vector (0018,1065). Note Frame Time Vector arrays may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
Page Number Vector	(0018,2001)	1C	An array that contains, for each of the image frames, the corresponding page numbers of the original document. Required if Frame Increment Pointer (0028,0009) points to Page Number Vector (0018,2001).
Frame Label Vector	(0018,2002)	1C	An array that contains, for each of the image frames, a descriptive label. Required if Frame Increment Pointer (0028,0009) points to Frame Label Vector (0018,2002).
Frame Primary Angle Vector	(0018,2003)	1C	An array that contains, for each of the image frames, the primary angle of rotation about an undefined axis, in degrees. May be used for annotative purposes for "cine loops" of 3D reprojected images Required if Frame Increment Pointer (0028,0009) points to Frame Primary Angle Vector (0018,2003).
Frame Secondary Angle Vector	(0018,2004)	1C	An array that contains, for each of the image frames, the secondary angle of rotation about an undefined axis that is orthogonal to that used for Frame Primary Angle Vector (0018,2003), in degrees. May be used for annotative purposes for "cine loops" of 3D reprojected images Required if Frame Increment Pointer (0028,0009) points to Frame Secondary Angle Vector (0018,2004).
Slice Location Vector	(0018,2005)	1C	An array that contains, for each of the image frames, the relative position of the image plane expressed in mm, as defined for Slice Location (0020,1041). See Section C.7.6.2.1.2 for further explanation. Required if Frame Increment Pointer (0028,0009) points to Slice Location Vector (0018,2005).
Display Window Label Vector	(0018,2006)	1C	An array that contains, for each of the image frames, a label or number of the display window of a graphical user interface from which the frame was captured. Required if Frame Increment Pointer (0028,0009) points to Display Window Label Vector (0018,2006).

C.8.7 X-Ray Modules

This Section describes Modules used in one or more X-Ray IODs. These Modules contain Attributes that are specific to X-Ray images.

C.8.7.1 X-Ray Image Module

Table C.8-26. X-Ray Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Increment Pointer	(0028,0009)	1C	Required if Multi-frame Image. Contains the Data Element Tag of the Attribute that is used as the Frame increment in Multi-frame image pixel data (see Section C.7.6.6). Enumerated Values: **00181063H** Frame Time (0018,1063) **00181065H** Frame Time Vector (0018,1065)
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5 Required if Lossy Compression has been performed on the Image. May be present otherwise.
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.7.1.1.1 for specialization.
Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel sample values and the X-Ray beam intensity. See Section C.8.7.1.1.2.
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image shall have a value of 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. ~~Only MONOCHROME2 may be used.~~ Enumerated Values: **MONOCHROME2**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.7.1.1.6.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. See Section C.8.7.1.1.7.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. See Section C.8.7.1.1.8.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Shall have the value: 0000H = Unsigned Integer.

Attribute Name	Tag	Type	Attribute Description
Scan Options	(0018,0022)	3	Parameters of scanning sequence. See Section C.8.7.1.1.4.
Include Table 10-7 "General Anatomy Optional Macro Attributes"			*No CID for the Anatomic Region Sequence is defined.*
R Wave Pointer	(0028,6040)	3	Marks the location(s) of the R Wave in the cardiac cycles by referencing frame numbers; frame numbers begin with 1.
Referenced Image Sequence	(0008,1140)	1C	Other images significantly related to this image. Shall be present if Image Type (0008,0008) Value 3 is BIPLANE A or BIPLANE B. May be present otherwise. One or more Items shall be included in this Sequence. See Section C.8.7.1.1.13.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7201 "Referenced Image Purposes of Reference".*
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See Section C.8.7.1.1.5 for further explanation.
Acquisition Device Processing Description	(0018,1400)	3	Indicates any visual processing performed on the images prior to exchange. See Section C.8.7.1.1.3.
Frame Label Vector	(0018,2002)	3	A multi-valued Attribute that contains a descriptive label for each of the image frames. The number of values shall equal the number of frames.
Frame Dimension Pointer	(0028,000A)	3	Contains the Data Element Tags of one or more Attributes that vary or increment for the frames of a multi-frame image. See Section C.8.7.1.1.12. Shall not be present if it would contain only one value and that value would be Frame Time (0018,1063) or Frame Time Vector (0018,1065).
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: **YES** **NO** Device is identified using the Device Module. See Section C.7.6.12.

C.8.7.1.1 X-Ray Image Attribute Descriptions

C.8.7.1.1.1 Image Type

The Image Type Attribute identifies important image characteristics in a multiple valued Data Element. For X-Ray, Image Type is specialized as follows:

- Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2

Enumerated Values:
ORIGINAL
DERIVED

Note

X-Ray images generally use PRIMARY value for images captured from patient exposure.

- Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2

Enumerated Values:
PRIMARY
SECONDARY

- Value 3 shall identify the image set in terms of the imaging planes.

Enumerated Values:
SINGLE PLANE Image is a single plane acquisition
BIPLANE A Image is the first plane (e.g., Frontal) of a Bi-plane acquisition
BIPLANE B Image is the second plane (e.g., Lateral) of a Bi-plane acquisition

- Other Values are implementation specific (optional).

C.8.7.1.1.2 Pixel Intensity Relationship

Pixel Intensity Relationship (0028,1040) shall identify the relationship of the pixel values to the X-Ray beam intensity.

Defined Terms:

LIN Approximately proportional to X-Ray beam intensity;
LOG Non-linear "Log Function"; A Modality LUT shall be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity;
DISP Ready to be displayed; A Modality LUT may be included with the image to allow it to be scaled back to its proportional value to X-Ray beam intensity. The Attribute Acquisition Device Processing Description may be used to provide some indication on the pre-processing performed to create the ready to be displayed image.

C.8.7.1.1.3 Acquisition Device Processing Description

Acquisition Device Processing Description (0018,1400) provides some indication in human readable text of the digital processing on the images before exchange. Examples of this processing are: edge enhanced, subtracted, time filtered, gamma corrected, convolved (spatially filtered).

C.8.7.1.1.4 Scan Options

The Scan Options Attribute identifies any acquisition technique that was used during the acquisition of the image.

Defined Terms:

EKG EKG Event Trigger
PHY Physiological Event Trigger
TOMO Tomography
CHASE Bolus Chasing
ROTA Rotation

C.8.7.1.1.5 Derivation Description

If an Image is identified to be a Derived image (see Section C.8.7.1.1.1), Derivation Description (0008,2111) is an optional and implementation specific text description of the way the image was derived from an original image. As applied to X-Ray images, it may be used to describe derivation operations such as edge enhancement, temporal filtering, digital subtraction, or other linear and non-linear transformations.

C.8.7.1.1.6 Bits Allocated

Enumerated Values:

8
16

C.8.7.1.1.7 Bits Stored

Enumerated Values:

8
10
12
16

C.8.7.1.1.8 High Bit

For X-Ray Images, High Bit (0028,0102) shall be one less than the value in Bit Stored.

C.8.7.1.1.9 Synchronization of Frame and Waveform Times

The synchronization of a multi-frame X-Ray image with a waveform (e.g., ECG, pressure, or respiration) encoded in a different SOP Instance is managed through the Attributes of the Synchronization Module (see Section C.7.4.2) of the Frame of Reference IE.

Note

The use of a Curve IE within the X-Ray IODs was previously defined in DICOM (see PS3.3-2004). That use has been retired in favor of encoding waveform data in a separate IOD.

C.8.7.1.1.12 Frame Dimension Pointer

Frame Dimension Pointer (0028,000A) identifies Attributes that vary or increment with each frame, and are clinically significant for viewing or processing the image. This is intended for SOP Instances whose preferred clinical presentation is dependent on frame relationships other than simply time.

Defined Terms for multi-frame cine from the Cine Module (see Section C.7.6.5) are:

00181063H Frame Time (0018,1063)
00181065H Frame Time Vector (0018,1065)

Defined Terms for rotational acquisition from the XA Positioner Module (see Section C.8.7.5) are:

00181520H Positioner Primary Angle Increment (0018,1520)
00181521H Positioner Secondary Angle Increment (0018,1521)

Defined Terms for stepped acquisition from the X-Ray Table Module (see Section C.8.7.4) are:

00181135H Table Vertical Increment (0018,1135)
00181137H Table Longitudinal Increment (0018,1137)
00181136H Table Lateral Increment (0018,1136)

Defined Terms for an arbitrary labeled increment:

00182002H Frame Label Vector (0018,2002)

Note

1. Previous editions of the Standard did not include the optional Frame Dimension Pointer (0028,000A), but instead depended entirely on the mandatory Frame Increment Pointer (0028,0009), and envisaged that only time and no other dimension would relate frames. Image creators that add the Frame Dimension Pointer (0028,000A) must anticipate that many implementations will ignore or discard this Attribute when displaying or storing images and continue to assume that frames are temporally related.

2. Frame Time (0018,1063) or Frame Time Vector (0018,1065) will also be present and will contain appropriate values consistent with the times of acquisition of the frames.

C.8.7.1.1.13 Referenced Image Sequence

When Image Type (0008,0008) Value 3 is BIPLANE A or BIPLANE B, Referenced Image Sequence (0008,1140) shall be used to identify the corresponding SOP Instance of the Biplane acquisition. In this case, either:

- only a single Item shall be present, or
- multiple Items may be present, each with the Purpose of Reference Code Sequence (0040,A170) present, and only the first Item having the Purpose of Reference value (121314, DCM, "Other image of biplane pair").

The Referenced Frame Number (0008,1160) Attribute shall not be present in the Item that references the corresponding SOP Instance of the Biplane acquisition.

C.8.7.2 X-Ray Acquisition Module

Table C.8-27. X-Ray Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	2	Peak kilo voltage output of the X-Ray generator used.
Radiation Setting	(0018,1155)	1	Identify the general level of X-Ray dose exposure. Enumerated Values: **SC** low dose exposure generally corresponding to fluoroscopic settings (e.g., preparation for diagnostic quality image acquisition) **GR** high dose for diagnostic quality image acquisition (also called digital spot or cine)
X-Ray Tube Current	(0018,1151)	2C	X-Ray Tube Current in mA. Required if Exposure (0018,1152) is not present. May be present otherwise.
X-Ray Tube Current in µA	(0018,8151)	3	X-Ray Tube Current in µA.
Exposure Time	(0018,1150)	2C	Duration of X-Ray exposure in msec. See Section C.8.7.2.1.1. Required if Exposure (0018,1152) is not present. May be present otherwise.
Exposure Time in µS	(0018,8150)	3	Duration of X-Ray exposure in µsec.
Exposure	(0018,1152)	2C	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current. Required if either Exposure Time (0018,1150) or X-Ray Tube Current (0018,1151) are not present. May be present otherwise.
Exposure in µAs	(0018,1153)	3	The exposure expressed in µAs, for example calculated from Exposure Time and X-Ray Tube Current.
Grid	(0018,1166)	3	Identify the grid. Only a single value shall be present. Defined Terms: **IN** A Grid is positioned; **NONE** No Grid is used.
Average Pulse Width	(0018,1154)	3	Average width of X-Ray pulse in msec.
Radiation Mode	(0018,115A)	3	Specifies X-Ray radiation mode. Defined Terms: **CONTINUOUS** **PULSED**
Type of Filters	(0018,1161)	3	Type of filter(s) inserted into the X-Ray beam (e.g., wedges).
Intensifier Size	(0018,1162)	3	Diameter of X-Ray intensifier in mm

Attribute Name	Tag	Type	Attribute Description
Field of View Shape	(0018,1147)	3	Shape of the Image Intensifier Field of View. See Section C.8.7.2.1.2. Defined Terms: **ROUND** **RECTANGLE**
Field of View Dimension(s)	(0018,1149)	3	Dimensions of the Image Intensifier Field of View in mm. If Rectangle, row dimension followed by column; if Round, diameter.
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm. See Section 10.7.1.3 for further explanation of the value order. The value of this Attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.
Include Table 10-10 "Basic Pixel Spacing Calibration Macro Attributes"			
Focal Spot(s)	(0018,1190)	3	Nominal focal spot size in mm used to acquire this image.
Image and Fluoroscopy Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of this image plus any non-digitally recorded fluoroscopy that may have been performed to prepare for the acquisition of this image. Note The sum of the area dose product of all images of a Series or a Study may not result in the total area dose product to which the patient was exposed.

C.8.7.2.1 X-Ray Acquisition Attribute Descriptions

C.8.7.2.1.1 Exposure Time

Exposure time is the cumulative time the patient received X-Ray exposure during this image (Multi-frame image acquisition). Calculation is pulse width * number of frames.

C.8.7.2.1.2 Field of View

The Field of View Attribute describes the shape and dimensions of the Image Receptor Field of View, applicable to both Image Intensifier and Digital Detector. This could be further restricted by the Collimator. See Section C.8.7.3.

C.8.7.3 X-Ray Collimator Module

An X-Ray Collimator is a device placed close to the X-Ray Source to restrict the span of the X-Ray beam. It is often made of lead shutters. Figure C.8-9 presents in a graphical form its relationship with the Field Of View Dimensions (0018,1149).

Geometry of the collimator is specified with respect to a row and column coordinate system where the origin is the upper left hand pixel. This origin is specified by the values 1,1 for row/column. A row coordinate represent a number of raw spacing (vertical) and a column coordinate represents a column spacing (horizontal). Up to three different collimator shapes may be used and superimposed.

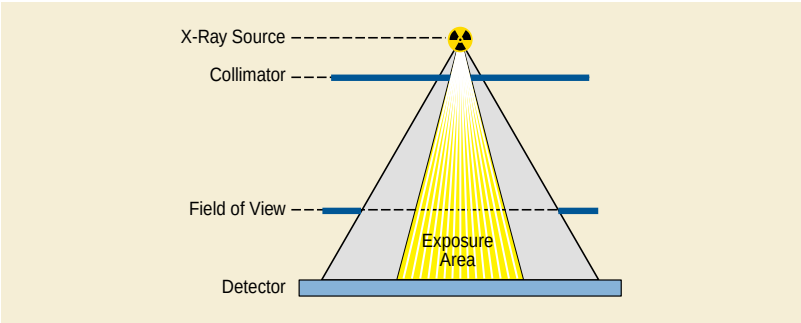


Figure C.8-9. Relationships of X-Ray Collimator

Table C.8-28. X-Ray Collimator Module Attributes

Attribute Name	Tag	Type	Attribute Description
Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL** This multi-valued Attribute shall contain at most one of each Enumerated Value.
Include Table C.8-28b "X-Ray Collimator Dimensions Macro Attributes"			

Table C.8-28b. X-Ray Collimator Dimensions Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Collimator Left Vertical Edge	(0018,1702)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the left edge of the rectangular collimator with respect to pixels in the image given as column. See Section C.8.7.3.1.1.
Collimator Right Vertical Edge	(0018,1704)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the right edge of the rectangular collimator with respect to pixels in the image given as column. See Section C.8.7.3.1.1.
Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the upper edge of the rectangular collimator with respect to pixels in the image given as row. See Section C.8.7.3.1.1.
Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if a value of Collimator Shape (0018,1700) is RECTANGULAR. Location of the lower edge of the rectangular collimator with respect to pixels in the image given as row. See Section C.8.7.3.1.1.
Center of Circular Collimator	(0018,1710)	1C	Required if a value of Collimator Shape (0018,1700) is CIRCULAR. Location of the center of the circular collimator with respect to pixels in the image given as row and column. See Section C.8.7.3.1.1.
Radius of Circular Collimator	(0018,1712)	1C	Required if a value of Collimator Shape (0018,1700) is CIRCULAR. Radius of the circular collimator with respect to pixels in the image given as a number of pixels along the row direction. See Section C.8.7.3.1.1.

Attribute Name	Tag	Type	Attribute Description
Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if a value of Collimator Shape (0018,1700) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex; column of the origin vertex. Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon collimator. Polygon collimators are implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices.

C.8.7.3.1 X-Ray Collimator Attribute Descriptions

C.8.7.3.1.1 Collimator Vertical and Horizontal Edges

These Attributes specify the pixel row or column where the X-Ray beam is fully obscured by a rectangular collimator:

- if the left edge of the collimator is not visible, Collimator Left Vertical Edge (0018,1702) shall have a value of 0;
- if the right edge of the collimator is not visible, Collimator Right Vertical Edge (0018,1704) value shall be 1 greater than the value of Columns (0028,0011) Attribute;
- if the top edge of the collimator is not visible, Collimator Upper Horizontal Edge (0018,1706) shall have a value of 0;
- if the bottom edge of the collimator is not visible, Collimator Lower Horizontal Edge (0018,1708) value shall be 1 greater than the value of Rows (0028,0010) Attribute.

C.8.7.4 X-Ray Table Module

Table C.8-29 contains Attributes that describe X-Ray images acquired with movement of the patient imaging table.

Table C.8-29. X-Ray Table Module Attributes

Attribute Name	Tag	Type	Attribute Description
Table Motion	(0018,1134)	2	Defined Terms: **STATIC** **DYNAMIC**
Table Vertical Increment	(0018,1135)	2C	Incremental change in Vertical position of the table relative to first frame of Multi-frame image given in mm. Required if Table Motion is DYNAMIC.
Table Longitudinal Increment	(0018,1137)	2C	Incremental change in Longitudinal position of the table relative to first frame of Multi-frame image in mm. Table motion towards +90°position of the primary angle of the positioner is positive. See Section C.8.7.4.1.2. Required if Table Motion is DYNAMIC.
Table Lateral Increment	(0018,1136)	2C	Incremental change in Lateral position of the table relative to first frame of Multi-frame image given in mm. Table motion towards +90°position of the secondary angle of the positioner is positive. See Section C.8.7.4.1.3. Required if Table Motion is DYNAMIC.
Table Angle	(0018,1138)	3	Angle of table plane in degrees relative to horizontal plane [Gravity plane]. Positive values indicate that the head of the table is upwards.

C.8.7.4.1 X-Ray Table Attribute Descriptions

C.8.7.4.1.1 Table Motion Increments

This section is replaced by Section C.8.7.4.1.4

C.8.7.4.1.2 Table Longitudinal Increment

The direction of the longitudinal movement is perpendicular to the primary axis of rotation of the positioner. A positive value of Table Longitudinal Increment (0018,1137) Attributes indicates a movement towards the +90° position of the positioner, see Figure C.8-9a.

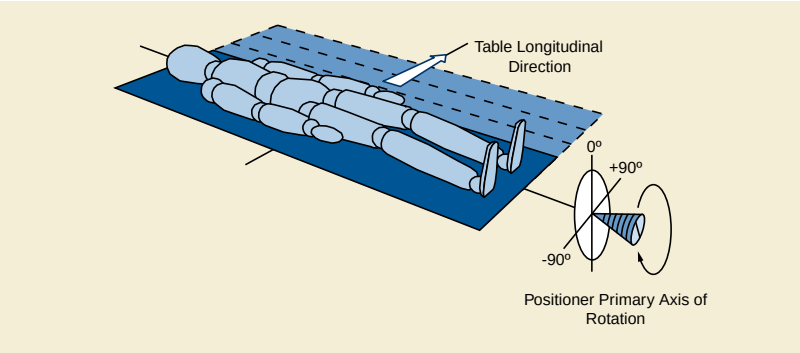


Figure C.8-9a. Table Longitudinal Movement

C.8.7.4.1.3 Table Lateral Increment

The direction of the lateral movement is perpendicular to the secondary axis of rotation of the positioner. A positive value of Table Lateral Increment (0018,1136) Attributes indicates a movement towards the +90° position of the positioner, see Figure C.8-9b.

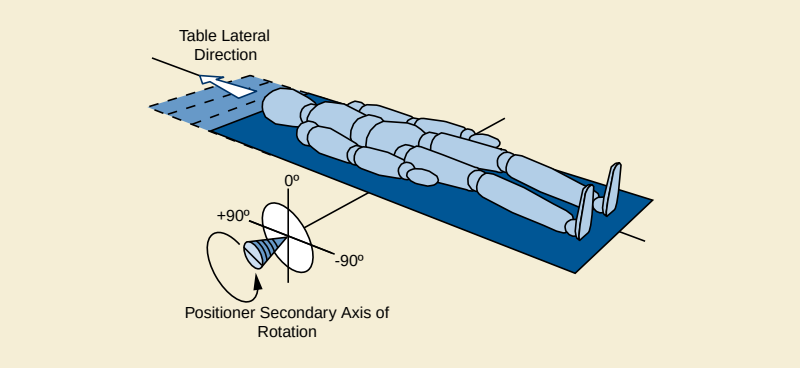


Figure C.8-9b. Table Lateral Movement

Note

The terms "longitudinal" and "lateral" are relative to an operator standing tableside, and facing the patient. Thus lateral movement is to the left and right of the operator, and longitudinal movement is towards or away from the operator.

C.8.7.4.1.4 Table Motion With Patient in Relation to Imaging Chain

The table moves the patient with respect to the imaging chain. This is being tracked as a motion of the imaging chain with respect to a coordinate system (X, Y, Z) attached to the patient (assumption is that the patient does not move with respect to the table). The coordinate system origin is fixed with respect to the patient at the time of the first frame. The X-axis is increasing to the left hand side of the patient. The Y-axis is increasing to the posterior side of the patient. The Z-axis is increasing toward the head of the patient (see Section C.7.6.2.1.1). The Patient Plane is then defined by the X and Z-axes as drawn in Figure C.8-10).

Note

1. Table motion causes the apparent locus of imaging to move in the opposite direction. For instance, with the patient supine and the table motion towards +90°of the primary axis of rotation of the positioner, the area of the patient imaged moves toward the right hand side of the patient.

2. When the patient is positioned prone or supine (Figure C.8-2 showing the supine position) the Table Longitudinal Increment (0018,1137) table motion takes place along the patient X-axis and the Table Lateral Increment (0018,0036) along the Z-axis. For patient positioned left or right decubitus, the Table Longitudinal Increment takes place along the Y-axis, the other direction is not changed.

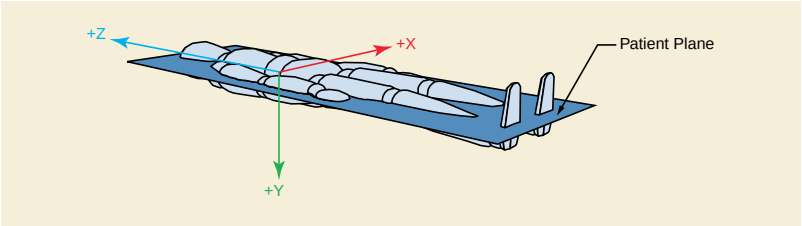


Figure C.8-10. Table Motion Vector Coordinates

C.8.7.5 XA Positioner Module

Table C.8-30 contains IOD Attributes that describe a c-arm positioner typically used in acquiring X-Ray Angiographic Images. The coordinate system used to track the positioner is defined in reference to the patient. The definition of coordinates with respect to the equipment is not supported. Furthermore, this Module does not describe the movement of the patient.

Note

The scope of the XA IOD is to address images produced on acquisition equipment equipped with an X-Ray source and an image Receptor positioned by what is general called a c-arm. For clinical areas other than Angiography that are using a c-arm to position the X-Ray source and image receptor (e.g., Interventional Procedures and Myelography and Biopsy/Localization), the X-Ray Angiography Image Object should be also used. Although the object is optimized for c-arm systems, it may also be used by other systems that support a similar coordinate system, such as some RF systems.

Table C.8-30. XA Positioner Module Attributes

Attribute Name	Tag	Type	Attribute Description
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to center of field of view. Note 1. This value is traditionally referred to as Source Object Distance (SOD). 2. For cardiovascular image equipment the SOD value typically is the distance from source to isocenter.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID).
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of Source Image Receptor Distance (SID) over Source Object Distance (SOD).

Attribute Name	Tag	Type	Attribute Description
Positioner Motion	(0018,1500)	2C	Used to describe the activity of the imaging devices. Defined Terms: **DYNAMIC** **STATIC** See Section C.8.7.5.1.1. Required if Pixel Data (7FE0,0010) contains more than one frame. May be present otherwise.
Positioner Primary Angle	(0018,1510)	2	Position of the X-Ray Image Intensifier about the patient from the RAO to LAO direction where movement from RAO to vertical is positive. See Section C.8.7.5.1.2.
Positioner Secondary Angle	(0018,1511)	2	Position of the X-Ray Image Intensifier about the patient from the CAU to CRA direction where movement from CAU to vertical is positive. See Section C.8.7.5.1.2
Positioner Primary Angle Increment	(0018,1520)	2C	Incremental change in primary positioner angle for each frame. See Section C.8.7.5.1.3. Required if Positioner Motion (0018,1500) equals DYNAMIC.
Positioner Secondary Angle Increment	(0018,1521)	2C	Incremental change in secondary positioner angle for each frame. See Section C.8.7.5.1.3. Required if Positioner Motion (0018,1500) equals DYNAMIC.
Detector Primary Angle	(0018,1530)	3	Angle of the X-Ray beam in the row direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards higher numbered columns. Negative values indicate that the X-Ray beam is tilted towards lower numbered columns. See Section C.8.7.5.1.4.
Detector Secondary Angle	(0018,1531)	3	Angle of the X-Ray beam in the column direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted towards lower numbered rows. Negative values indicate that the X-Ray beam is tilted towards higher numbered rows. See Section C.8.7.5.1.4.

C.8.7.5.1 XA Positioner Attribute Descriptions

C.8.7.5.1.1 Positioner Motion

Positioner Motion (0018,1500) Attribute is STATIC if the imaging table moves during a multi-frame acquisition, but the X-Ray positioner do not move.

If Pixel Data (7FE0,0010) contains a single frame and a value of Positioner Motion (0018,1500) is provided, the value shall be STATIC.

Note

If the positioner undergoes translation (non-rotational movement) during the acquisition, then that motion shall be described by an opposite table motion (see Section C.8.7.4).

C.8.7.5.1.2 Positioner Primary and Secondary Angles

The definitions of Positioner Angles shall be with respect to the patient as illustrated in Figure C.8-11 and Figure C.8-12. Zero degree is referenced to the origin perpendicular to the patient's chest. The Positioner Primary Angle definition is like longitude (in the equatorial plan); the Positioner Secondary Angle definition is like latitude (in the sagittal plane). The Positioner Angle Attributes apply to the first frame of a multi-frame image. The valid range of Primary Positioner Angle is -180 to +180 degrees and the Secondary Positioner Angle range is -90 to + 90 degrees.

The Patient Plane is defined by the isocenter of the imaging device and slices through the patient such that it is perpendicular to the sagittal plane of the body. The Primary Axis of rotation is defined at the intersection of the Patient Plane and of the Sagittal Plane. The Positioner Primary Angle is defined in the transaxial plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest and + 90 degrees at the patient left hand side (LAO) and -90 at the patient right hand side (RAO). The valid range of Primary Positioner Angle is -180 to +180 degrees.

The Secondary Axis is in the Patient Plane and is perpendicular to the Primary Axis at the isocenter. The Positioner Secondary Angle is defined in the Sagittal Plane at the isocenter with zero degrees in the direction perpendicular to the patient's chest. +90 degrees corresponds to the cranial direction. The Secondary Positioner Angle range is -90 to + 90 degrees.

At a 0 angle for both Primary Angle (0018,1510) and Secondary Angle (0018,1511), the patient faces the Image Intensifier or digital detector.

The Positioner Primary Angle (0018,1510) and Secondary Angle (0018,1511) apply to the first frame of a multi-frame image.

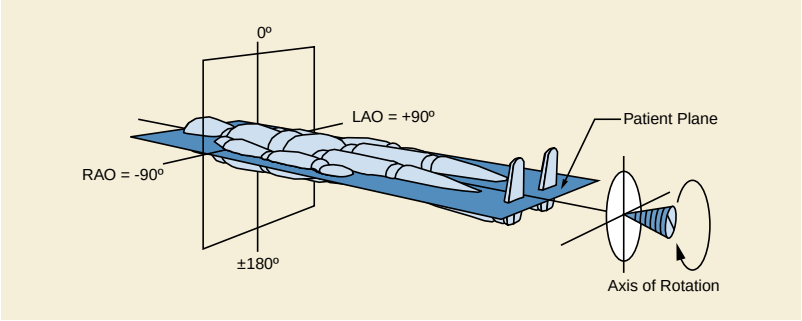


Figure C.8-11. Positioner Primary Angle

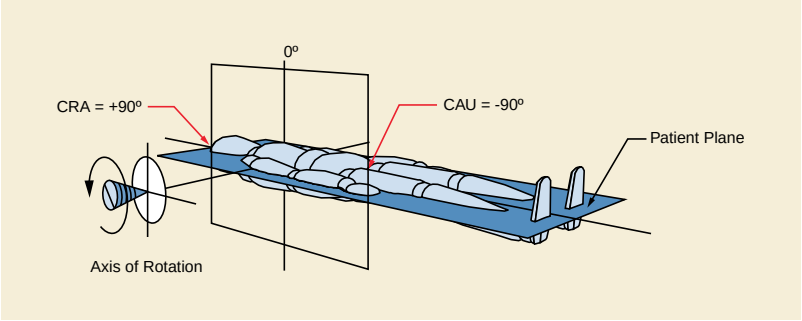


Figure C.8-12. Positioner Secondary Angle

C.8.7.5.1.3 Positioner Angle Increments

If the positioner angles change during acquisition of a multi-frame image, the Positioner Angle Increment Attributes describe the angular change per frame.

If the change in positioner angle is nominally constant for each frame, these fields may contain a single value of the average angular change per frame. Alternatively, the fields may contain a vector of offsets from the (initial) Positioner Angle Attributes, with one value for each frame in the multi-frame image. The number of values in the Positioner Angle Increment Attributes must be one, or must be equal to Number of Frames (0028,0008) in the Multi-frame Module (see Section C.7.6.6).

Note

It is permissible to generate a vector of the absolute positioner angles in the Positioner Angle Increment Attributes, and set the Positioner Primary and Secondary Angle Attributes to value 0.

C.8.7.5.1.4 Detector Primary and Secondary Angles

Detector Angles are defined in a fashion similar to the positioner angles, except that the angle of the central X-Ray beam vector is relative to the Detector Plane rather than the Patient Plane. The central X-Ray beam vector is defined as the vector from the X-Ray source through the isocenter to the detector plane. Zero degree is referenced to the normal to the detector plane pointing away from the X-Ray source. The Detector Angle Attributes apply to the first frame of a multi-frame image. The valid range of the Detector Angles is -90 to + 90 degrees.

The Primary Axis of rotation is defined along the line in the column direction of the detector plane that intersects the central X-Ray beam vector. The Detector Primary Angle is defined in the plane perpendicular to the Primary Axis of rotation at the point where the central X-Ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane and -90 degrees at the left hand side of the image (i.e., toward column 1) and +90 at the right hand side of the image (i.e., toward the highest numbered column). The valid range of Primary Detector Angle is -90 to +90 degrees.

The Secondary Axis is in the detector plane and is perpendicular to the Primary Axis at the intersection of the beam vector with the detector plane (i.e., it is along the row direction). The Detector Secondary Angle is defined in the plane perpendicular to the Secondary Axis at the point where the central X-Ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane. +90 degrees corresponds to the direction toward the top of the image. The Secondary Detector Angle range is -90 to + 90 degrees.

C.8.7.6 XRF Positioner Module

Table C.8-31. XRF Positioner Module Attributes

Attribute Name	Tag	Type	Attribute Description
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID).
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to center of field of view. Note This value is traditionally referred to as Source Object Distance (SOD).
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of SID (Source Image Receptor Distance) over SOD (Source Object Distance).
Column Angulation	(0018,1450)	3	Angle of the X-Ray beam in degree relative to an orthogonal axis to the detector plane. Positive values indicate that the tilt is towards the head of the table. Note The detector plane is assumed to be parallel to the table plane.

C.8.7.7 X-Ray Tomography Acquisition Module

This Module describes the Attributes of a Tomography acquisition (translation of X-Ray source during the acquisition of a single-frame image).

Table C.8-32. X-Ray Tomography Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Tomo Layer Height	(0018,1460)	1	Distance in mm between the table surface and the sharp image plane.
Tomo Angle	(0018,1470)	3	Angle span in degrees of rotation of X-Ray Source during X-Ray acquisition.
Tomo Time	(0018,1480)	3	Time in seconds the source has taken to rotate the Tomo Angle during X-Ray acquisition.
Tomo Type	(0018,1490)	3	Type of tomography. Defined Terms: **LINEAR** **SPIRAL** **POLYCYCLOIDAL** **CIRCULAR**
Tomo Class	(0018,1491)	3	Form of tomography: Defined Terms: **MOTION** **TOMOSYNTHESIS**
Number of Tomosynthesis Source Images	(0018,1495)	3	The number of source images used to construct this tomosynthetic image. Only meaningful if Tomo Class (0018,1491) is TOMOSYNTHESIS. These may be listed in Source Image Sequence (0008,2112) of the General Image Module.

C.8.7.8 X-Ray Acquisition Dose Module

This Module describes the Attributes related to dose delivery from an X-Ray source during the acquisition of an X-Ray image.

Table C.8-33. X-Ray Acquisition Dose Module Attributes

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	3	Peak kilo voltage output of the X-Ray generator used.
X-Ray Tube Current	(0018,1151)	3	X-Ray Tube Current in mA.
X-Ray Tube Current in µA	(0018,8151)	3	X-Ray Tube Current in µA.
Exposure Time	(0018,1150)	3	Duration of X-Ray exposure in msec.
Exposure Time in µS	(0018,8150)	3	Duration of X-Ray exposure in µsec.
Exposure	(0018,1152)	3	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current.
Exposure in µAs	(0018,1153)	3	The exposure expressed in µAs, for example calculated from Exposure Time and X-Ray Tube Current.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID).

Attribute Name	Tag	Type	Attribute Description
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to the table, support or bucky side that is closest to the Imaging Subject, as measured along the central ray of the X-Ray beam. Note 1. This definition is less useful in terms of estimating geometric magnification than a measurement to a defined point within the Imaging Subject, but accounts for what is realistically measurable in an automated fashion in a clinical setting. 2. This measurement does not take into account any air gap between the Imaging Subject and the "front" of the table or bucky. 3. If the detector is not mounted in a table or bucky, then the actual position relative to the patient is implementation or operator defined. 4. This value is traditionally referred to as Source Object Distance (SOD).
Image and Fluoroscopy Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of this image plus any non-digitally recorded fluoroscopy that may have been performed to prepare for the acquisition of this image. Note 1. The sum of the area dose product of all images of a Series or a Study may not result in the total area dose product to which the patient was exposed. 2. This may be an estimated value based on assumptions about the patient's body size and habitus.
Body Part Thickness	(0018,11A0)	3	The average thickness in mm of the body part examined when compressed, if compression has been applied during exposure.
Relative X-Ray Exposure	(0018,1405)	3	Indication of the applied dose, in manufacturer specific units. Note 1. This value is intended to provide a single location where manufacturer specific information can be found for annotation on a display or film, that has meaning to a knowledgeable observer. 2. This may be a calculated or measured value. Examples are the detector entrance dose (K_B), the CR sensitivity value (S), or the logarithmic median (lgM). 3. DICOM specifies Standard Attributes in Table 10-23 'Exposure Index Macro', which are recommended.
Entrance Dose	(0040,0302)	3	Average entrance dose value measured in dGy at the surface of the patient during the acquisition of this image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.

Attribute Name	Tag	Type	Attribute Description
Entrance Dose in mGy	(0040,8302)	3	Average entrance dose value measured in mGy at the surface of the patient during the acquisition of this image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
Entrance Dose Derivation	(0040,8303)	3	Describes what type of dose is represented by the values of Entrance Dose (0040,0302) and Entrance Dose in mGy (0040,8302). Enumerated Values: **IAK** Represents air kerma at the entrance surface, no backscatter included, no air kerma to tissue dose conversion applied. **ESAK** Represents air kerma at the entrance surface, with backscatter included, no air kerma to tissue dose conversion applied. **ESDBS** Represents absorbed dose in tissue at the entrance surface, with backscatter included. **ESDNOBS** Represents absorbed dose in tissue at the entrance surface, without backscatter included. Only meaningful if Entrance Dose (0040,0302) or Entrance Dose in mGy (0040,8302) is present.
Exposed Area	(0040,0303)	3	Typical dimension of the exposed area at the detector plane. If Rectangular: row dimension followed by column; if Round: diameter. Measured in cm. Note 1. The exposed area should be consistent with values specified in the X-Ray Collimator Module, if present. 2. This may be an estimated value based on assumptions about the patient's body size and habitus. 3. This Attribute was previously used in the Radiation Dose Module with units in mm. This use has been retired. See PS3.3 2017c.
Distance Source to Entrance	(0040,0306)	3	Distance in mm from the source to the surface of the patient closest to the source during the acquisition of this image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
Comments on Radiation Dose	(0040,0310)	3	User-defined comments on any special conditions related to radiation dose encountered during the acquisition of this image.
X-Ray Output	(0040,0312)	3	The X-Ray output at the patient entrance surface and kVp used to acquire the image, measured in mGy/mAs. Note This value may be a calibrated value rather than measured during the exposure.

Attribute Name	Tag	Type	Attribute Description
Half Value Layer	(0040,0314)	3	The thickness of Aluminum in mm required to reduce the X-Ray Output (0040,0312) by a factor of two. Note This value may be a calibrated value rather than measured during the exposure.
Organ Dose	(0040,0316)	3	Average organ dose value measured in dGy during the acquisition of this image. Note This may be an estimated value.
Organ Exposed	(0040,0318)	3	Organ to which Organ Dose (0040,0316) applies. Defined Terms: **BREAST** **GONADS** **BONE** **MARROW** **FETUS** **LENS** Note The anatomic regions described by these terms are those that are particularly radiosensitive and for which it is conventional to obtain organ specific dose parameters.
Anode Target Material	(0018,1191)	3	The primary material in the anode of the X-Ray source. Defined Terms: **TUNGSTEN** **MOLYBDENUM** **RHODIUM**
Include Table C.8-35a "X-Ray Filtration Macro Attributes"			
Rectification Type	(0018,1156)	3	Type of rectification used in the X-Ray generator. Defined Terms: **SINGLE PHASE** **THREE PHASE** **CONST POTENTIAL**
Include Table 10-23 "Exposure Index Macro Attributes"			

C.8.7.9 X-Ray Generation Module

This Module describes the Attributes related to generation of X-Rays during the acquisition of an X-Ray image.

Table C.8-34. X-Ray Generation Module Attributes

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	3	Peak kilo voltage output of the X-Ray generator used.
X-Ray Tube Current	(0018,1151)	3	X-Ray Tube Current in mA.

Attribute Name	Tag	Type	Attribute Description
X-Ray Tube Current in µA	(0018,8151)	3	X-Ray Tube Current in µA.
Exposure Time	(0018,1150)	3	Duration of X-Ray exposure in msec.
Exposure Time in µS	(0018,8150)	3	Duration of X-Ray exposure in µsec.
Exposure	(0018,1152)	3	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current.
Exposure in µAs	(0018,1153)	3	The exposure expressed in µAs, for example calculated from Exposure Time and X-Ray Tube Current.
Exposure Control Mode	(0018,7060)	3	Type of exposure control. Defined Terms: **MANUAL** **AUTOMATIC**
Exposure Control Mode Description	(0018,7062)	3	Text description of the mechanism of exposure control. May describe the number and type of exposure sensors or position of the sensitive area of the imaging detector.
Exposure Status	(0018,7064)	3	Whether the exposure was normally completed or not. Defined Terms: **NORMAL** **ABORTED**
Phototimer Setting	(0018,7065)	3	Nominal percentage phototimer setting, where a more positive value indicates greater exposure and a more negative value indicates less exposure.
Focal Spot(s)	(0018,1190)	3	Nominal focal spot size in mm used to acquire this image.
Anode Target Material	(0018,1191)	3	The primary material in the anode of the X-Ray source. Defined Terms: **TUNGSTEN** **MOLYBDENUM** **RHODIUM**
Rectification Type	(0018,1156)	3	Type of rectification used in the X-Ray generator. Defined Terms: **SINGLE PHASE** **THREE PHASE** **CONST POTENTIAL**
Generator ID	(0018,1005)	3	Identifier of the generator

C.8.7.10 X-Ray Filtration Module

This Module describes the Attributes related to the filtration of X-Rays during the acquisition of an X-Ray image.

Table C.8-35. X-Ray Filtration Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-35a "X-Ray Filtration Macro Attributes"			

Table C.8-35a. X-Ray Filtration Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Filter Type	(0018,1160)	3	Type of filter(s) inserted into the X-Ray beam (e.g., wedges). Defined Terms: **STRIP** **WEDGE** **BUTTERFLY** **MULTIPLE** **FLAT** **NONE** Note Multiple type of filters can be expressed by a combination, e.g., BUTTERFLY+WEDGE.
Filter Material	(0018,7050)	3	The X-Ray absorbing material used in the filter. May be multi-valued. Defined Terms: **MOLYBDENUM** **ALUMINUM** **COPPER** **RHODIUM** **NIOBIUM** **EUROPIUM** **LEAD**
Filter Thickness Minimum	(0018,7052)	3	The minimum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).
Filter Thickness Maximum	(0018,7054)	3	The maximum thickness in mm of the X-Ray absorbing material used in the filters. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).
Filter Beam Path Length Minimum	(0018,7056)	3	The minimum length (in mm) of the X-Ray beam path in the Filter Material that is not blocked by collimation. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).
Filter Beam Path Length Maximum	(0018,7058)	3	The maximum length (in mm) of the X-Ray beam path in the Filter Material that is not blocked by collimation. May be multi-valued, with values corresponding to the respective values in Filter Material (0018,7050).

C.8.7.11 X-Ray Grid Module

This Module describes the Attributes related to the use of a grid to reduce scatter of X-Rays during the acquisition of an X-Ray image.

Table C.8-36. X-Ray Grid Module Attributes

Attribute Name	Tag	Type	Attribute Description
Grid	(0018,1166)	3	Identifies the grid. May be multi-valued. Defined Terms: **FIXED** **FOCUSED** **RECIPROCATING** **PARALLEL** **CROSSED** **NONE**
Include Table C.8-36b "X-Ray Grid Description Macro Attributes"			

Table C.8-36b. X-Ray Grid Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Grid Absorbing Material	(0018,7040)	3	The X-Ray absorbing material used in the grid.
Grid Spacing Material	(0018,7041)	3	The spacing material used in the grid.
Grid Thickness	(0018,7042)	3	The thickness in mm of the X-Ray absorbing material used in the grid.
Grid Pitch	(0018,7044)	3	The pitch in mm of the X-Ray absorbing material used in the grid.
Grid Aspect Ratio	(0018,7046)	3	Ratio of the vertical spacing and horizontal spacing of the X-Ray absorbing material used in the grid. Specified by a pair of integer values where the first value is the vertical size, and the second value is the horizontal size.
Grid Period	(0018,7048)	3	Period in mSec of reciprocation cycle. Only meaningful if a value of Grid (0018,1166) is RECIPROCATING.
Grid Focal Distance	(0018,704C)	3	Focal distance in mm of a FOCUSED grid.
Grid ID	(0018,1006)	3	Identifier of the grid

C.8.8 Radiotherapy Modules

This Section describes Radiotherapy-specific Modules.

Modules defined here make reference to "IEC" coordinate systems and standards. These standards are defined in IEC Standard 61217, "Radiotherapy Equipment - Coordinates, Movements and Scales" (Reference CEI/IEC 61217: 1996).

Note

IEC document 62C/269/CDV "Amendment to IEC 61217: Radiotherapy Equipment - Coordinates, movements and scales" also defines a Patient-Based Coordinate System, and specifies the relationship between the DICOM Patient-Based Coordinate System (see Section C.7.6.2.1.1) and the IEC PATIENT Coordinate System. Rotating the IEC PATIENT Coordinate System described in IEC 62C/269/CDV (1999) by 90 degrees counter-clockwise (in the negative direction) about the x-axis yields the DICOM Patient-Based Coordinate System, i.e., $(X_{DICOM}, Y_{DICOM}, Z_{DICOM}) = (X_{IEC}, -Z_{IEC}, Y_{IEC})$. Refer to the latest IEC documentation for the current definition of the IEC PATIENT Coordinate System.

Many of the dosimetry concepts referred to in this document can be found in [ICRU Report 50].

C.8.8.1 RT Series Module

There exist significant differences in the manner in which RT objects as compared to diagnostic objects. An RT object can be one of several types, and a series of a given object type may be created over a temporal span of several weeks. The RT Series Module has been created to satisfy the requirements of the standard DICOM Query/Retrieve model while including only those Attributes relevant to the identification and selection of radiotherapy objects.

Table C.8-37. RT Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data. Enumerated Values: **RTIMAGE** RT Image **RTDOSE** RT Dose **RTSTRUCT** RT Structure Set **RTPLAN** RT Plan **RTRECORD** RT Treatment Record See Section C.8.8.1.1.
Series Instance UID	(0020,000E)	1	Unique identifier of the Series.
Series Number	(0020,0011)	2	A number that identifies this Series.
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Series Description	(0008,103E)	3	Description of the Series.
Series Description Code Sequence	(0008,103F)	3	A coded description of the Series. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Operators' Name	(0008,1070)	2	Name(s) of the operator(s) supporting the Series.
Operator Identification Sequence	(0008,1072)	3	Identification of the operator(s) supporting the Series. One or more Items may be present in this Sequence. If more than one Item, the number and order shall correspond to the value of Operators' Name (0008,1070), if present.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Referenced Performed Procedure Step Sequence	(0008,1111)	3	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.
>Include Table 10-9 “Request Attributes Macro Attributes”			*No Baseline CID is defined.*
Include Table 10-16 “Performed Procedure Step Summary Macro Attributes”			*No Baseline CID is defined.*

C.8.8.1.1 Modality

The Enumerated Value for Modality (0008,0060) shall determined by the IOD.

Enumerated Values if RT Image IOD:

RTIMAGE

Enumerated Values if RT Dose IOD:

RTDOSE

Enumerated Values if RT Structure Set IOD:

RTSTRUCT

Enumerated Values if RT Plan IOD or RT Ion Plan IOD:

RTPLAN

Enumerated Values if RT Beams Treatment Record IOD, RT Ion Beams Treatment Record IOD, RT Brachy Treatment Record IOD, or RT Treatment Summary Record IOD:

RTRECORD

Note

DICOM specifies that a given Series shall contain objects of only one Modality, and shall be created by a single device (described in the General Equipment Module). However, in general there may be many Series defined for a given modality/device pair. Note that a radiotherapy Series is generally created over an extended time interval (unlike in radiology, where all images in an image Series are generally created together).

C.8.8.2 RT Image Module

Table C.8-38 contains Attributes that describe RT-specific characteristics of a projection image. The image described by these Attributes must be a radiotherapy image acquired or calculated using a conical imaging geometry.

Table C.8-38. RT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.8.8.2.6.1 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.8.2.6.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.8.2.6.3 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.8.2.6.4 for specialization.
High Bit	(0028,0102)	1	Most significant bit for each pixel sample. Each sample shall have the same high bit. See Section C.8.8.2.6.5 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. See Section C.8.8.2.6.6 for specialization.
Pixel Intensity Relationship	(0028,1040)	3	The relationship between the Pixel sample values and the X-Ray beam intensity. See Section C.8.19.6.4.1.1.

Attribute Name	Tag	Type	Attribute Description
Pixel Intensity Relationship Sign	(0028,1041)	1C	The sign of the relationship between the Pixel sample values stored in Pixel Data (7FE0,0010) and the X-Ray beam intensity. Required if Pixel Intensity Relationship (0028,1040) is present. Enumerated Values: **+1** Lower pixel values correspond to less X-Ray beam intensity **-1** Higher pixel values correspond to less X-Ray beam intensity See Section C.8.11.3.1.2 for further explanation.
RT Image Label	(3002,0002)	1	User-defined label for RT Image.
RT Image Name	(3002,0003)	3	User-defined name for RT Image.
RT Image Description	(3002,0004)	3	User-defined description of RT Image.
Image Type	(0008,0008)	1	Image identification characteristics (see Section C.7.6.1.1.2). Defined Terms for Value 3: **DRR** digitally reconstructed radiograph **PORTAL** digital portal image or portal film image **SIMULATOR** conventional simulator image **RADIOGRAPH** radiographic image **BLANK** image pixels set to background value **FLUENCE** fluence map
Conversion Type	(0008,0064)	2	Describes the kind of image conversion. Defined Terms: **DV** Digitized Video **DI** Digital Interface **DF** Digitized Film **WSD** Workstation
Reported Values Origin	(3002,000A)	2C	Describes the origin of the parameter values reported in the image. Required if Value 3 of Image Type (0008,0008) is SIMULATOR or PORTAL. Enumerated Values: **OPERATOR** manually entered by operator **PLAN** planned parameter values **ACTUAL** electronically recorded
RT Image Plane	(3002,000C)	1	Describes whether or not image plane is normal to beam axis. Enumerated Values: **NORMAL** image plane normal to beam axis **NON_NORMAL** image plane non-normal to beam axis
X-Ray Image Receptor Translation	(3002,000D)	3	Position in (x,y,z) coordinates of origin of IEC X-RAY IMAGE RECEPTOR System in the IEC GANTRY coordinate system (mm). See Note 2.
X-Ray Image Receptor Angle	(3002,000E)	2	X-Ray Image Receptor Angle i.e., orientation of IEC X-RAY IMAGE RECEPTOR coordinate system with respect to IEC GANTRY coordinate system (degrees). See Section C.8.8.2.2.
RT Image Orientation	(3002,0010)	2C	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system. Required if RT Image Plane (3002,000C) is NON_NORMAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Image Plane Pixel Spacing	(3002,0011)	2	Physical distance (in mm) between the center of each image pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. See Section C.8.8.2.3 and Section 10.7.1.3 for further explanation.
RT Image Position	(3002,0012)	2	The x and y coordinates (in mm) of the upper left hand corner of the image, in the IEC X-RAY IMAGE RECEPTOR coordinate system. This is the center of the first pixel transmitted. See Section C.8.8.2.7.
Radiation Machine Name	(3002,0020)	2	User-defined name identifying radiation machine used in acquiring or computing image (i.e., name of conventional simulator, electron accelerator, X-Ray device, or machine modeled when calculating DRR).
Primary Dosimeter Unit	(300A,00B3)	2	Measurement unit of machine dosimeter. Enumerated Values: **MU** Monitor Unit **MINUTE** minute
Radiation Machine SAD	(3002,0022)	2	Radiation source to Gantry rotation axis distance of radiation machine used in acquiring or computing image (mm).
Radiation Machine SSD	(3002,0024)	3	Source to Patient surface distance (in mm) of radiation machine used in acquiring or computing image.
RT Image SID	(3002,0026)	2	Distance from radiation machine source to image plane (in mm) along radiation beam axis. See Section C.8.8.2.3.
Source to Reference Object Distance	(3002,0028)	3	Source to reference object distance (in mm), as used for magnification calculation of RADIOGRAPH and SIMULATOR images.
Referenced RT Plan Sequence	(300C,0002)	3	Sequence of one Class/Instance pair describing RT Plan associated with image. Only a single Item is permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Referenced Beam Number	(300C,0006)	3	Uniquely identifies the corresponding N-segment treatment beam specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module within the RT Plan referenced in Referenced RT Plan Sequence (300C,0002) or the Ion Beam Sequence (300A,03A2) in the RT Ion Beams Module within the RT Ion Plan referenced in Referenced RT Plan Sequence (300C,0002).
Referenced Fraction Group Number	(300C,0022)	3	Identifier of Fraction Group within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Fraction Number	(3002,0029)	3	Fraction Number of fraction during which image was acquired, within Fraction Group referenced by Referenced Fraction Group Number (300C,0022) within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition starts.
End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number (300C,0006) at which image acquisition ends.
Exposure Sequence	(3002,0030)	3	Sequence of Exposure parameter sets, corresponding to exposures used in generating the image. One or more Items are permitted in this Sequence. See Section C.8.8.2.4.

Attribute Name	Tag	Type	Attribute Description
>Referenced Frame Number	(0008,1160)	1C	Identifies corresponding image frame in multi-frame image. Required if there is more than one Item in Exposure Sequence (3002,0030), and image is a multi-frame image.
>KVP	(0018,0060)	2C	Peak kilo voltage output (kV) of X-Ray generator used to acquire image. Required if Value 3 of Image Type (0008,0008) is PORTAL, SIMULATOR or RADIOGRAPH.
>Primary Fluence Mode Sequence	(3002,0050)	3	Sequence defining whether the primary fluence of the treatment beam uses a non-standard fluence-shaping. Only a single Item is permitted in this Sequence.
>>Fluence Mode	(3002,0051)	1	Describes whether the fluence shaping is the standard mode for the beam or an alternate. Enumerated Values: **STANDARD** Uses standard fluence-shaping **NON_STANDARD** Uses a non-standard fluence-shaping mode
>>Fluence Mode ID	(3002,0052)	1C	Identifier for the specific fluence-shaping mode. Required if Fluence Mode (3002,0051) has value NON_STANDARD.
>X-Ray Tube Current	(0018,1151)	2C	Imaging device X-Ray Tube Current (mA). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH. May be present otherwise.
>X-Ray Tube Current in mA	(0018,9330)	3	X-Ray Tube Current in mA. An average in the case of fluoroscopy (continuous radiation mode).
>Exposure Time	(0018,1150)	2C	Time of X-Ray exposure (msec). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH. May be present otherwise. See Section C.8.8.2.8.
>Exposure Time in ms	(0018,9328)	3	Duration of X-Ray exposure in msec. See Section C.8.8.2.8.
>Meterset Exposure	(3002,0032)	2C	Treatment machine Meterset duration over which image has been acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3). Required if Value 3 of Image Type (0008,0008) is PORTAL. See Section C.8.8.2.8.
>Diaphragm Position	(3002,0034)	3	Positions of diaphragm jaw pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis in the IEC order X1, X2, Y1, Y2.
>Beam Limiting Device Sequence	(300A,00B6)	3	Sequence of beam limiting device (collimator) jaw or leaf (element) positions for given exposure. One or more Items are permitted in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction

Attribute Name	Tag	Type	Attribute Description
>>Source to Beam Limiting Device Distance	(300A,00BA)	3	Radiation source to beam limiting device (collimator) distance (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries (in mm) of beam limiting device (collimator) leaves (elements) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e., X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY. May be present otherwise.
>>Leaf/Jaw Positions	(300A,011C)	1	Positions of beam limiting device (collimator) leaf or jaw (element) pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY). Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), in IEC leaf (element) subscript order 101, 102, … 1N, 201, 202, … 2N.
>Gantry Angle	(300A,011E)	3	Treatment machine gantry angle, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
>Gantry Pitch Angle	(300A,014A)	3	Gantry Pitch Angle. i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). See Section C.8.8.25.6.5.
>Beam Limiting Device Angle	(300A,0120)	3	Treatment machine beam limiting device (collimator) angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).
>Patient Support Angle	(300A,0122)	3	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
>Table Top Pitch Angle	(300A,0140)	3	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
>Table Top Roll Angle	(300A,0144)	3	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
>Table Top Vertical Position	(300A,0128)	3	Table Top Vertical position in IEC TABLE TOP coordinate system (mm).
>Table Top Longitudinal Position	(300A,0129)	3	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm).
>Table Top Lateral Position	(300A,012A)	3	Table Top Lateral position in IEC TABLE TOP coordinate system (mm).
>Applicator Sequence	(300A,0107)	3	Sequence of Applicators associated with Beam. Only a single Item is permitted in this Sequence.
>>Applicator ID	(300A,0108)	1	User or machine supplied identifier for Applicator.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.

Attribute Name	Tag	Type	Attribute Description
>>Applicator Type	(300A,0109)	1	Type of Applicator. Defined Terms: **ELECTRON_SQUARE** square electron applicator **ELECTRON_RECT** rectangular electron applicator **ELECTRON_CIRC** circular electron applicator **ELECTRON_SHORT** short electron applicator **ELECTRON_OPEN** open (dummy) electron applicator **PHOTON_SQUARE** square photon applicator **PHOTON_RECT** rectangular photon applicator **PHOTON_CIRC** circular photon applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator (deprecated)
>>Applicator Geometry Sequence	(300A,0431)	3	Describes the applicator aperture geometry. Only a single Item is permitted in this Sequence.
>>>Applicator Aperture Shape	(300A,0432)	1	Aperture shape of the applicator. Defined Terms: **SYM_SQUARE** A square-shaped aperture symmetrical to the central axis. **SYM_RECTANGLE** A rectangular-shaped aperture symmetrical to the central axis. **SYM_CIRCULAR** A circular-shaped aperture symmetrical to the central axis.
>>>Applicator Opening	(300A,0433)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system. In case of square-shaped applicator contains the length of the sides of the square. In case of circular-shaped applicators, contains the diameter of the circular aperture. Required if Applicator Aperture Shape (300A,0432) is SYM_SQUARE or SYM_CIRCULAR.
>>>Applicator Opening X	(300A,0434)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in X-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.
>>>Applicator Opening Y	(300A,0435)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in Y-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.
>> Source to Applicator Mounting Position Distance	(300A,0436)	3	Radiation source to applicator mounting position distance (in mm) for current applicator.
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>General Accessory Sequence	(300A,0420)	3	Sequence of General Accessories associated with the beam producing this image. One or more Items are permitted in this Sequence.
>>General Accessory Number	(300A,0424)	1	Identification Number of the General Accessory. The value shall be unique within the Sequence.
>>General Accessory ID	(300A,0421)	1	User or machine supplied identifier for General Accessory.

Attribute Name	Tag	Type	Attribute Description
>>General Accessory Description	(300A,0422)	3	User supplied description of General Accessory.
>>General Accessory Type	(300A,0423)	3	Specifies the type of accessory. Defined Terms: **GRATICULE** Accessory tray with a radio-opaque grid **IMAGE_DETECTOR** Image acquisition device positioned in the beam line **RETICLE** Accessory tray with radio-transparent markers or grid
>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory
>>Source to General Accessory Distance	(300A,0425)	3	Radiation source to general accessory distance (in mm) for current accessory.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Block Sequence	(300A,00F4)	2C	Sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. Zero or more Items shall be included in this Sequence.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Tray Accessory Code	(300A,0355)	3	An identifier for the Tray intended to be read by a device such as a bar-code reader.
>>Accessory Code	(300A,00F9)	3	An identifier for the Block intended to be read by a device such as a bar-code reader.
>>Source to Block Tray Distance	(300A,00F6)	2	Radiation Source to attachment edge of block tray assembly (mm).
>>Block Type	(300A,00F8)	1	Type of block. Enumerated Values: **SHIELDING** blocking material is inside contour **APERTURE** blocking material is outside contour
>>Block Divergence	(300A,00FA)	2	Indicates presence or otherwise of geometrical divergence Enumerated Values: **PRESENT** block edges are shaped for beam divergence **ABSENT** block edges are not shaped for beam divergence
>>Block Mounting Position	(300A,00FB)	3	Indicates on which side of the Block Tray the block is mounted. Enumerated Values: **PATIENT_SIDE** the block is mounted on the side of the Block Tray that is towards the patient. **SOURCE_SIDE** the block is mounted on the side of the Block Tray that is towards the radiation source.
>>Block Number	(300A,00FC)	1	Identification Number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created.
>>Block Name	(300A,00FE)	3	User-defined name for block.
>>Material ID	(300A,00E1)	2	User-supplied identifier for material used to manufacture Block.
>>Block Thickness	(300A,0100)	3	Physical thickness of block (in mm) parallel to radiation beam axis.
>>Block Number of Points	(300A,0104)	2	Number of (x,y) pairs defining the block edge.

Attribute Name	Tag	Type	Attribute Description
>>Block Data	(300A,0106)	2	A data stream of (x,y) pairs that comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm).
Fluence Map Sequence	(3002,0040)	1C	A Sequence of data describing the fluence map Attributes for a radiotherapy beam. Only a single Item shall be included in this Sequence. Required if the third value of Image Type (0008,0008) is FLUENCE.
>Fluence Data Source	(3002,0041)	1	Source of fluence data. Enumerated Values: **CALCULATED** Calculated by a workstation **MEASURED** Measured by exposure to a film or detector.
>Fluence Data Scale	(3002,0042)	3	The Meterset corresponding with a fluence map cell value of 1.0 expressed in units specified by Primary Dosimeter Units (300A,00B3). This is the Meterset value used for treatment, not the Meterset used to expose the film as defined by Meterset Exposure (3002,0032).
Gantry Angle	(300A,011E)	3	Treatment machine gantry angle, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
Gantry Pitch Angle	(300A,014A)	3	Gantry Pitch Angle. i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). See Section C.8.8.25.6.5.
Beam Limiting Device Angle	(300A,0120)	3	Treatment machine beam limiting device (collimator) angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees).
Patient Support Angle	(300A,0122)	3	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).
Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
Table Top Eccentric Angle	(300A,0125)	3	Table Top (non-isocentric) angle, i.e., orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT system (degrees).
Table Top Pitch Angle	(300A,0140)	3	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
Table Top Roll Angle	(300A,0144)	3	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system (degrees). See Section C.8.8.25.6.2.
Table Top Vertical Position	(300A,0128)	3	Table Top Vertical position in IEC TABLE TOP coordinate system (mm).
Table Top Longitudinal Position	(300A,0129)	3	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm).
Table Top Lateral Position	(300A,012A)	3	Table Top Lateral position in IEC TABLE TOP coordinate system (mm).
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the equipment-based IEC coordinate system to the Patient-Based Coordinate System.

Attribute Name	Tag	Type	Attribute Description
Patient Position	(0018,5100)	1C	Patient position descriptor relative to the patient support device. Required if Isocenter Position (300A,012C) is present. May be present otherwise. See Section C.8.8.12.1.2 for Defined Terms and further explanation. Note The orientation of the patient relative to the patient support device is denoted in the same manner as in the RT Patient Setup Module. It defines the relation of the DICOM Patient-Based Coordinate System identified by the Frame of Reference Module of the RT Image to the IEC coordinate system and together with Isocenter Position (300A,012C) allows the RT Image to be placed into the Patient Frame of Reference. It also allows a system using an RT Image to verify that the patient is setup in a similar position relative to the patient support device.
Exposure Time	(0018,1150)	3	Time of X-Ray exposure (msec). Required if Value 3 of Image Type (0008,0008) is SIMULATOR or RADIOGRAPH. May be present otherwise. See Section C.8.8.2.8.
Exposure Time in ms	(0018,9328)	3	Duration of X-Ray exposure in msec. See Section C.8.8.2.8.
Meterset Exposure	(3002,0032)	3	Treatment machine Meterset duration over which image has been acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3). See Section C.8.8.2.8.

Note

1. The numeric beam data parameters recorded with the RT Image correspond to the parameters as they were known at the time the image was created or taken. The parameters may or may not correspond to an actual RT Plan Instance that is created for a patient. If the Reported Values Origin (3002,000A) has an Enumerated Value of OPERATOR or ACTUAL and there is an RT Plan reference present, the numeric beam data parameters may or may not be the same in the two objects.

2. The Z coordinate of the X-Ray Image Receptor Translation (3002,000D) will be equal to the Radiation Machine SAD (3002,0022) minus the RT Image SID (3002,0026). If the image receptor is further from the beam source than the machine isocenter, the Z coordinate will be negative (see IEC 61217).

C.8.8.2.1 Multi-frame Image Data

In either multiple exposure multi-frame images or cine images, only the Attributes inside Exposure Sequence (3002,0030) shall differ between frames. For example, Attributes such as beam limiting device (collimator) leaf (element) positions and block information may change, whereas Attributes such as gantry and beam limiting device (collimator) angle shall not change.

C.8.8.2.2 X-Ray Image Receptor Angle

The X-Ray Image Receptor Angle (3002,000E) specifies the rotation of the image receptor device in the IEC X-RAY IMAGE RECEPTOR PLANE. A positive angle corresponds to a counter-clockwise rotation of the X-Ray Image Receptor as viewed from the radiation source in the IEC GANTRY coordinate system. The normal (non-rotated) value for this parameter is zero degrees.

C.8.8.2.3 Image Plane Pixel Spacing and RT Image SID

The Image Plane Pixel Spacing (3002,0011) Attribute shall always be defined on the image plane, i.e., at the radiation machine source to image plane distance specified by RT Image SID (3002,0026). For images where the source-image distance is undefined or unknown (e.g., DRR images), RT Image SID (3002,0026) shall equal Radiation Machine SAD (3002,0022) and Image Plane Pixel Spacing (3002,0011) shall be defined on this common plane.

C.8.8.2.4 Exposure Sequence

Exposure Sequence (3002,0030) allows specification of imaging parameters and aperture definitions for single exposure images (single Item Sequence), integrated images (multiple Item Sequence) or multiple exposures (multiple Item Sequence). An integrated image is a single-frame image (no Cine Module or Multi-frame Module present) with multiple Items in the Exposure Sequence. A Referenced Frame Number (0008,1160) is not provided. A multiple exposure image can be expressed as a multi-frame image containing either a single frame, or more than one frame. Referenced Frame Number (0008,1160) shall be specified for each Exposure Sequence (3002,0030) Item for multiple exposure images expressed using more than one frame.

Many of the Attributes referring to beam parameters can be present both inside Exposure Sequence (3002,0030) and outside the Sequence. When a specific Attribute is present inside the Sequence, that Attribute shall supersede the Attribute found outside Exposure Sequence (3002,0030). For any Item in the Sequence, if the Attribute is not present, the value of the Attribute (if specified) outside the Sequence shall be used.

C.8.8.2.5 Single-Frame and Multi-frame Images

If the Multi-frame Module is present and the Cine Module is not present then the Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 00200013 (Instance Number). If the Multi-frame Module and Cine Module are both present then the Frame Increment Pointer (0028,0009) shall have an Enumerated Value of either 00181063 (Frame Time) or 00181065 (Frame Time Vector).

C.8.8.2.6 Image Pixel Module Attributes

C.8.8.2.6.1 Samples Per Pixel

Enumerated Values:

1

C.8.8.2.6.2 Photometric Interpretation

Enumerated Values:

MONOCHROME2

C.8.8.2.6.3 Bits Allocated

Enumerated Values:

8
16

C.8.8.2.6.4 Bits Stored

Enumerated Values when Bits Allocated (0028,0100) is 8:

8

Enumerated Values when Bits Allocated (0028,0100) is 16:

12
13
14
15
16

C.8.8.2.6.5 High Bit

For RT Images, High Bit (0028,0102) shall be one less than the value of Bits Stored (0028,0101).

C.8.8.2.6.6 Pixel Representation

Enumerated Values when Bits Allocated (0028,0100) is 8:

0000H unsigned integer

C.8.8.2.7 RT Image Plane, Position and Orientation

When RT Image Plane (3002,000C) is NORMAL and RT Image Orientation (3002,0010) is not provided, the orientation is defined as follows: The image viewing direction shall be from the radiation source to the image (i.e., in the sense of a beam's eye view, or along the negative Zr direction of the IEC X-RAY IMAGE RECEPTOR coordinate system).

If RT Image Plane is NON_NORMAL, any rotation defined by RT Image Orientation is performed about the origin of the IEC X-RAY IMAGE RECEPTOR coordinate system. The definitions of the x and y coordinates of the RT Image Position (3002,0012) are defined before any rotation of the image plane is taken into account, see Figure C.8.8.2.7-1.

The direction of rows shall be along the positive Xr direction and the direction of the columns shall be along the negative Yr direction of the IEC X-RAY IMAGE RECEPTOR coordinate system.

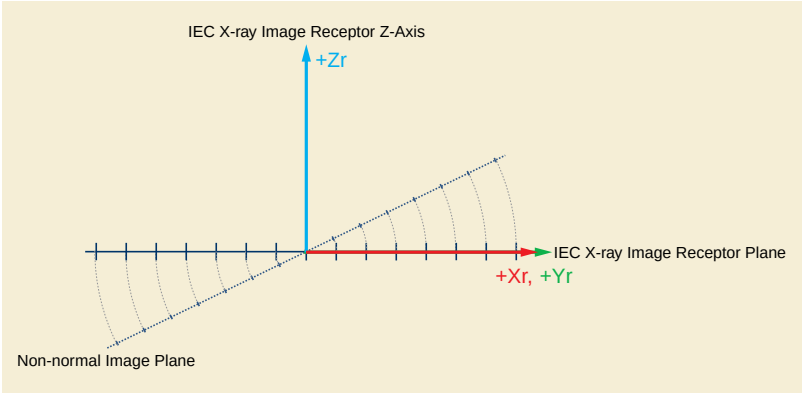


Figure C.8.8.2.7-1. Non-normal Image Plane

C.8.8.2.8 Exposure Time and Meterset Exposure

Multi-frame RT Images may encode a continuous acquisition. In this case, the Exposure Sequence (3002,0030) may not reference all frames.

The Attributes Exposure Time (00018,1150), Exposure Time in ms (0018,9328) and Meterset Exposure (3002,0032) Attributes in the Exposure Sequence (3002,0030), if present with values, contain the exposure values encompassing the X-Ray exposure during the acquisition of the single frame referenced by the Referenced Frame Number (0008,1160). Note that not all frames may be referenced in this Sequence and therefore the sum of these values may not equal the total exposure value.

The Attributes Exposure Time (00018,1150), Exposure Time in ms (0018,9328) and Meterset Exposure (3002,0032) Attributes outside the Exposure Sequence (3002,0030) may be used to record the total exposure values.

C.8.8.3 RT Dose Module

The RT Dose Module is used to convey 2D or 3D radiation dose data generated from treatment planning systems or similar devices. The Attributes defined within the Module support dose for a single radiation beam (potentially comprised of multiple segments, as delivered in a dynamic treatment) or a group of beams comprising either a fraction group (see Section C.8.8.13) or a complete treatment plan (potentially the sum of multiple fraction groups).

The RT Dose Module provides the mechanism to transmit a 3D array of dose data as a set of 2D dose planes that may or may not be related to CT or MR image planes. This mechanism works via the DICOM Multi-frame Module that is required if multi-frame pixel data are present.

Table C.8-39. RT Dose Module Attributes

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1C	Number of samples (planes) in this image. See Section C.8.8.3.4.1 for specialization. Required if Pixel Data (7FE0,0010) is present.
Photometric Interpretation	(0028,0004)	1C	Specifies the intended interpretation of the pixel data. See Section C.8.8.3.4.2 for specialization. Required if Pixel Data (7FE0,0010) is present.
Bits Allocated	(0028,0100)	1C	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.8.3.4.3 for specialization. Required Pixel Data (7FE0,0010) is present.
Bits Stored	(0028,0101)	1C	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.8.3.4.4 for specialization. Required if Pixel Data (7FE0,0010) is present.
High Bit	(0028,0102)	1C	Most significant bit for each pixel sample. Each sample shall have the same high bit. See Section C.8.8.3.4.5 for specialization. Required if Pixel Data (7FE0,0010) is present.
Pixel Representation	(0028,0103)	1C	Data representation of the pixel samples. Each sample shall have the same pixel representation. See Section C.8.8.3.4.6 for specialization. Required Pixel Data (7FE0,0010) is present.
Content Date	(0008,0023)	3	The date the content of this Module was created.
Content Time	(0008,0033)	3	The time the content of this Module was created.
Dose Units	(3004,0002)	1	Units used to describe dose. Enumerated Values: **GY** Gray **RELATIVE** dose relative to implicit reference value
Dose Type	(3004,0004)	1	Type of dose. Defined Terms: **PHYSICAL** physical dose **EFFECTIVE** physical dose after correction for biological effect using user-defined modeling technique **ERROR** difference between desired and planned dose
Spatial Transform of Dose	(3004,0005)	3	The use of transformation in the calculation of the combined dose. Defined Terms: **NONE** No transformation. Calculated on the original image set **RIGID** Only Rigid transform used (see definition in Section C.20.2.1.2) **NON_RIGID** Any other transform used
Referenced Spatial Registration Sequence	(0070,0404)	2C	A reference to a Spatial Registration SOP Instance or a Deformable Spatial Registration SOP Instance, which defines the transformation used to transform the dose. Required, if Spatial Transform of Dose (3004,0005) is provided and has a value of RIGID or NON_RIGID. Zero or more Items shall be included in this Sequence. See Section C.8.8.3.5
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	3	A number that identifies this object Instance.
Dose Comment	(3004,0006)	3	User-defined comments for dose data.
Normalization Point	(3004,0008)	3	Coordinates (x, y, z) of normalization point in the patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). See Section C.8.8.3.1.
Dose Summation Type	(3004,000A)	1	Type of dose summation. Defined Terms: **PLAN** dose calculated for entire delivery of all fraction groups of RT Plan **MULTI_PLAN** dose calculated for entire delivery of 2 or more RT Plans **FRACTION** dose calculated for entire delivery of a single Fraction Group within RT Plan **BEAM** dose calculated for entire delivery of one or more Beams within RT Plan **BRACHY** dose calculated for entire delivery of one or more Brachy Application Setups within RT Plan **FRACTION_SESSION** dose calculated for a single session ("fraction") of a single Fraction Group within RT Plan **BEAM_SESSION** dose calculated for a single session ("fraction") of one or more Beams within RT Plan **BRACHY_SESSION** dose calculated for a single session ("fraction") of one or more Brachy Application Setups within RT Plan **CONTROL_POINT** dose calculated for one or more Control Points within a Beam for a single fraction **RECORD** dose calculated for RT Beams Treatment Record
Referenced RT Plan Sequence	(300C,0002)	1C	Sequence describing RT Plan associated with dose. Required if Dose Summation Type (3004,000A) is PLAN, MULTI_PLAN, FRACTION, BEAM, BRACHY, FRACTION_SESSION, BEAM_SESSION, BRACHY_SESSION or CONTROL_POINT. Only a single Item shall be included in this Sequence, unless Dose Summation Type (3004,000A) is MULTI_PLAN, in which case two or more Items shall be included in this Sequence. See Note 1.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Referenced Fraction Group Sequence	(300C,0020)	1C	Sequence of one Fraction Group containing beams or brachy application setups contributing to dose. Required if Dose Summation Type (3004,000A) is FRACTION, BEAM, BRACHY, FRACTION_SESSION, BEAM_SESSION, BRACHY_SESSION or CONTROL_POINT. Only a single Item shall be included in this Sequence. See Note 1.
>>Referenced Fraction Group Number	(300C,0022)	1	Uniquely identifies Fraction Group specified by Fraction Group Number (300A,0071) in Fraction Group Sequence of RT Fraction Scheme Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
>>Referenced Beam Sequence	(300C,0004)	1C	Sequence of Beams in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BEAM, BEAM_SESSION or CONTROL_POINT. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>>Referenced Beam Number	(300C,0006)	1	Uniquely identifies Beam specified by Beam Number (300A,00C0) in Beam Sequence (300A,00B0) of RT Beams Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002) or in Ion Beam Sequence (300A,03A2) of RT Ion Beams Module within RT Ion Plan referenced in Referenced RT Plan Sequence (300C,0002).
>>>Referenced Control Point Sequence	(300C,00F2)	1C	Sequence defining the Control Points in current Beam contributing to dose. Required if Dose Summation Type (3004,000A) is CONTROL_POINT. Only a single Item shall be included in this Sequence.
>>>>Referenced Start Control Point Index	(300C,00F4)	1	Identifies Control Point specified by Control Point Index (300A,0112) within Beam referenced by Referenced Beam Number (300C,0006). This is the first of the two Control Points from which the Dose contribution to the Control Point can be calculated.
>>>>Referenced Stop Control Point Index	(300C,00F6)	1	Identifies Control Point specified by Control Point Index (300A,0112) within Beam referenced by Referenced Beam Number (300C,0006). This is the second of the two Control Points from which the Dose contribution to the Control Point can be calculated. The Control Point Index (300A,0112) referenced by Referenced Stop Control Point Index (300C,00F6) shall be the Control Point Index (300A,0112) immediately following the Control Point Index (300A,0112) referenced by Referenced Start Control Point Index (300C,00F4) within the Referenced Beam Number (300C,0006).
>>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Sequence of Brachy Application Setups in current Fraction Group contributing to dose. Required if Dose Summation Type (3004,000A) is BRACHY or BRACHY_SESSION. One or more Items shall be included in this Sequence.
>>>Referenced Brachy Application Setup Number	(300C,000C)	1	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) in Brachy Application Setup Sequence (300A,0230) of RT Brachy Application Setups Module within RT Plan referenced in Referenced RT Plan Sequence (300C,0002).
Referenced Treatment Record Sequence	(3008,0030)	1C	Sequence describing RT Beams Treatment Record associated with dose. One or more Items shall be included in this Sequence. Required if Dose Summation Type (3004,000A) is RECORD.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Beam Sequence	(300C,0004)	1C	Sequence of Beams contributing to dose. One or more Items shall be included in this Sequence. Required, if the dose does not apply to the complete RT Beams Treatment Record referenced in the Referenced Treatment Record Sequence (3008,0030).
>>Referenced Beam Number	(300C,0006)	1	Uniquely identifies Beam specified by Referenced Beam Number (300C,0006) in Treatment Session Beam Sequence (3008,0020) of RT Beams Session Record Module within RT Beams Treatment Record referenced in the Referenced Treatment Record Sequence (3008,0030) or in Treatment Session Ion Beam Sequence (3008,0021) of RT Ion Beams Session Record Module within RT Ion Beams Treatment Record referenced in the Referenced Treatment Record Sequence (3008,0030).

Attribute Name	Tag	Type	Attribute Description
Grid Frame Offset Vector	(3004,000C)	1C	An array that contains the dose image plane offsets (in mm) of the dose image frames in a multi-frame dose. Required if multi-frame pixel data are present and Frame Increment Pointer (0028,0009) points to Grid Frame Offset Vector (3004,000C). See Section C.8.8.3.2.
Dose Grid Scaling	(3004,000E)	1C	Scaling factor that when multiplied by the dose grid data found in Pixel Data (7FE0,0010) Attribute of the Image Pixel Module, yields grid doses in the dose units as specified by Dose Units (3004,0002). Required if Pixel Data (7FE0,0010) is present.
Tissue Heterogeneity Correction	(3004,0014)	3	Specifies a list of patient heterogeneity characteristics used for calculating dose. This Attribute shall be multi-valued if beams used to compute the dose have differing correction techniques. Enumerated Values: **IMAGE** image data **ROI_OVERRIDE** one or more ROI densities override image or water values where they exist **WATER** entire volume treated as water equivalent
Derivation Code Sequence	(0008,9215)	3	A coded description of how this dose was derived from other RT Dose and/or RT Plan objects. One or more Items are permitted in this Sequence. More than one Item indicates that successive derivation steps have been applied.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7220 “RT Dose Derivation”.*
Referenced Instance Sequence	(0008,114A)	3	The set of SOP Instances used to derive this RT Dose SOP Instance. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the Instance(s). Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7221 “RT Dose Purpose of Reference”.*

Note

In order to prevent misrepresentation of the dose summation:

a. If the Dose Summation Type (3004,000A) is PLAN, then only a single Instance of RT Plan is referenced and the dose will be for the entire plan (i.e., it is not viable to combine only certain fraction groups of different plans).

b. If the Dose Summation Type (3004,000A) is MULTI_PLAN, then 2 or more Instances of RT Plan may be referenced. As above, each reference will be for the entire plan.

c. If the Dose Summation Type (3004,000A) is FRACTION or FRACTION_SESSION, then only a single Instance of RT PLAN and a single Fraction Group are referenced (i.e., component beams or brachy application setups are not referenced).

C.8.8.3.1 Normalization Point

Normalization Point (3004,0008) aids in the interpretation and subsequent use of the transmitted data. If used, it shall be a point receiving dose contributions from all referenced components of the dose summation.

C.8.8.3.2 Grid Frame Offset Vector

Grid Frame Offset Vector (3004,000C) shall be provided if a dose distribution is encoded as a multi-frame image. Values of the Grid Frame Offset Vector (3004,000C) shall vary monotonically and are to be interpreted as follows:

a. If Grid Frame Offset Vector (3004,000C) is present and its first element is zero, this Attribute contains an array of n elements indicating the plane location of the data in the right-handed image coordinate system, relative to the position of the first dose plane transmitted, i.e., the point at which Image Position (patient) (0020,0032) is defined, with positive offsets in the direction of the cross product of the row and column directions.

b. If Grid Frame Offset Vector (3004,000C) is present, its first element is equal to the third element of Image Position (patient) (0020,0032), and Image Orientation (patient) (0020,0037) has the value (1,0,0,0,1,0), then Grid Frame Offset Vector contains an array of n elements indicating the plane location (patient z coordinate) of the data in the Patient-Based Coordinate System.

In future implementations, use of option a) is strongly recommended.

This Attribute is conditional since the RT Dose Module may be included even if pixel doses are not being transmitted, or the image may be a single-frame image. If the Multi-frame Module is present, Frame Increment Pointer (0028,0009) shall have the Enumerated Value of 3004000C (Grid Frame Offset Vector).

Note

Option (a) can represent a rectangular-parallelepiped dose grid with any orientation with respect to the patient, while option (b) can only represent a rectangular-parallelepiped dose grid whose planes are in the transverse patient dimension and whose x- and y-axes are parallel to the patient x- and y-axes.

Example: Figure C.8.8.3-1 shows an example of plane positions for a dose grid with transverse planes.

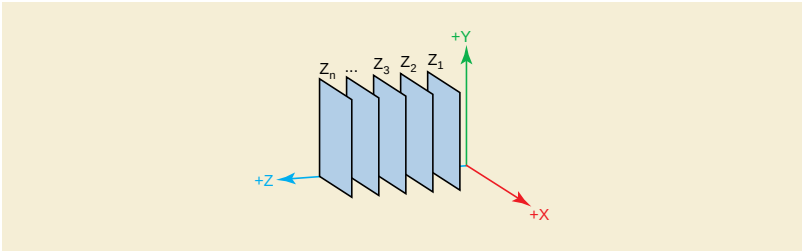


Figure C.8.8.3-1. Dose Grid Frame Example

For this example, Table C.8-39b gives the values of elements in the Grid Frame Offset Vector (3004,000C) for both relative (option (a)) and absolute (option (b)) interpretations, under the following conditions:

1. The value of Image Orientation (Patient) (0020,0037) is (1,0,0,0,1,0). I.e., the dose grid is transverse with x- and y-axes parallel to the patient x- and y-axes;

2. The value of Image Position (Patient) (0020,0032), i.e., the position of the first element of the dose grid, is (4, 5, 6); and

3. The spacing between adjacent dose grid planes is 2mm (uniform).

Table C.8-39b. Values of Dose Grid Frame Offset Vector Under Relative (A) and Absolute (B) Interpretations

Grid Frame Offset Vector Element	Option (a) Relative Coordinates	Option (b) Absolute Coordinates
Z1	0	6
Z2	2	8
Z3	4	10
ZN	2(N-1)	6 + 2(N-1)

C.8.8.3.3 Dose Units

Dose Units are specified in both the RT Dose Module and RT Dose ROI Module. The Attribute Dose Type present in the RT Dose Module shall apply to all doses present in the RT Dose IOD.

C.8.8.3.4 Image Pixel Module Attributes

C.8.8.3.4.1 Samples Per Pixel

Enumerated Values:

1

C.8.8.3.4.2 Photometric Interpretation

Enumerated Values:

MONOCHROME2

C.8.8.3.4.3 Bits Allocated

Enumerated Values:

16
32

C.8.8.3.4.4 Bits Stored

For RT Doses, Bits Stored (0028,0101) shall be equal to Bits Allocated (0028,0100).

C.8.8.3.4.5 High Bit

For RT Doses, High Bit (0028,0102) shall be one less than the value of Bits Stored (0028,0101).

C.8.8.3.4.6 Pixel Representation

Enumerated Values when Dose Type (3004,0004) = ERROR:

0001H two's complement integer,

Enumerated Values when Dose Type (3004,0004) not ERROR:

0000H unsigned integer, otherwise.

C.8.8.3.5 Referenced Spatial Registration Sequence

This Sequence lists the registrations used to create the dose. It is important to note, that this Sequence does not make any statement about how the dose was calculated or about the scope of objects contributing to a summed dose.

C.8.8.4 RT DVH Module

The RT DVH Module provides for the inclusion of differential or cumulative dose volume histogram data. The data contained within this Module may supplement dose data in the RT Dose Module and/or RT Dose ROI Module, or it may be present in the absence of other dose data.

Table C.8-40. RT DVH Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Structure Set Sequence	(300C,0060)	1	Sequence of one Class/Instance pair describing Structure Set containing structures that are used to calculate Dose-Volume Histograms (DVHs). Only a single Item shall be included in this Sequence. See Section C.8.8.4.1.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
DVH Normalization Point	(3004,0040)	3	Coordinates (x, y, z) of common DVH normalization point in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm).

Attribute Name	Tag	Type	Attribute Description
DVH Normalization Dose Value	(3004,0042)	3	Dose Value at DVH Normalization Point (3004,0040) used as reference for individual DVHs when Dose Units (3004,0002) is RELATIVE.
DVH Sequence	(3004,0050)	1	Sequence of DVHs. One or more Items shall be included in this Sequence.
>DVH Referenced ROI Sequence	(3004,0060)	1	Sequence of referenced ROIs used to calculate DVH. One or more Items shall be included in this Sequence.
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI used to calculate DVH specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by referenced RT Plan in Referenced RT Plan Sequence (300C,0002) in RT Dose Module.
>>DVH ROI Contribution Type	(3004,0062)	1	Specifies whether volume within ROI is included or excluded in DVH. See Section C.8.8.4.2. Enumerated Values: **INCLUDED** **EXCLUDED**
>DVH Type	(3004,0001)	1	Type of DVH. Enumerated Values: **DIFFERENTIAL** differential dose-volume histogram **CUMULATIVE** cumulative dose-volume histogram **NATURAL** natural dose volume histogram
>Dose Units	(3004,0002)	1	Dose axis units. Enumerated Values: **GY** Gray **RELATIVE** dose relative to reference value specified in DVH Normalization Dose Value (3004,0042)
>Dose Type	(3004,0004)	1	Type of dose. Defined Terms: **PHYSICAL** physical dose **EFFECTIVE** physical dose after correction for biological effect using user-defined modeling technique **ERROR** difference between desired and planned dose
>DVH Dose Scaling	(3004,0052)	1	Scaling factor that when multiplied by the dose bin widths found in DVH Data (3004,0058), yields dose bin widths in the dose units as specified by Dose Units (3004,0002).
>DVH Volume Units	(3004,0054)	1	Volume axis units. Defined Terms: **CM3** cubic centimeters **PERCENT** percent **PER_U** volume per u with u(dose)=dose$^{-3/2}$. See Section C.8.8.4.3.
>DVH Number of Bins	(3004,0056)	1	Number of bins n used to store DVH Data (3004,0058).

Attribute Name	Tag	Type	Attribute Description
>DVH Data	(3004,0058)	1	A data stream describing the dose bin widths ~~Dnand~~Dn and associated volumes ~~Vnin~~Vn in DVH Volume Units (3004,0054) in the order D1V1, D2V2, … DnVn. Note DVH Data arrays may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
>DVH Minimum Dose	(3004,0070)	3	Minimum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060) in units specified by Dose Units (3004,0002) of the current Sequence Item.
>DVH Maximum Dose	(3004,0072)	3	Maximum calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060) in units specified by Dose Units (3004,0002) of the current Sequence Item.
>DVH Mean Dose	(3004,0074)	3	Mean calculated dose to ROI(s) described by DVH Referenced ROI Sequence (3004,0060) in units specified by Dose Units (3004,0002) of the current Sequence Item.

C.8.8.4.1 Referenced Structure Set Sequence

The Referenced Structure Set Sequence (300C,0060) is required for direct cross-reference of the dose bin data with the corresponding ROI(s) from which they were derived. ROIs referenced by the DVH Referenced ROI Sequence (3004,0050) shall only contain contours with a Contour Geometric Type (3006,0042) of POINT or CLOSED_PLANAR.

C.8.8.4.2 DVH ROI Contribution Type

The volume used to calculate the DVH shall be the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is INCLUDED, minus the geometric union of ROIs where DVH ROI Contribution Type (3004,0062) is EXCLUDED.

C.8.8.4.3 DVH Volume Units

The unit PER_U is defined in: Anderson, LL: "A "natural" volume-dose histogram for brachytherapy", Medical Physics 13(6) pp 898-903, 1986.

C.8.8.5 Structure Set Module

A structure set defines a set of areas of significance. Each area can be associated with a Frame of Reference and zero or more images. Information that can be transferred with each region of interest (ROI) includes geometrical and display parameters, and generation technique.

Table C.8-41. Structure Set Module Attributes

Attribute Name	Tag	Type	Attribute Description
Structure Set Label	(3006,0002)	1	User-defined label for Structure Set.
Structure Set Name	(3006,0004)	3	User-defined name for Structure Set.
Structure Set Description	(3006,0006)	3	User-defined description for Structure Set.
Instance Number	(0020,0013)	3	A number that identifies this object Instance.
Structure Set Date	(3006,0008)	2	Date at which Structure Set was last modified.
Structure Set Time	(3006,0009)	2	Time at which Structure Set was last modified.
Referenced Frame of Reference Sequence	(3006,0010)	3	Sequence describing Frames of Reference in which the ROIs are defined. One or more Items are permitted in this Sequence. See Section C.8.8.5.1.

Attribute Name	Tag	Type	Attribute Description
>Frame of Reference UID	(0020,0052)	1	Uniquely identifies Frame of Reference within Structure Set.
>RT Referenced Study Sequence	(3006,0012)	3	Sequence of Studies containing Series to be referenced. One or more Items are permitted in this Sequence. See Section C.8.8.5.4.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>>RT Referenced Series Sequence	(3006,0014)	1	Sequence describing Series of images within the referenced Study that are used in defining the Structure Set. One or more Items shall be included in this Sequence.
>>>Series Instance UID	(0020,000E)	1	Unique identifier for the Series containing the images.
>>>Contour Image Sequence	(3006,0016)	1	Sequence of Items describing images in a given Series used in defining the Structure Set (typically CT or MR images). One or more Items shall be included in this Sequence.
>>>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
Structure Set ROI Sequence	(3006,0020)	1	ROIs for current Structure Set. One or more Items shall be included in this Sequence.
>ROI Number	(3006,0022)	1	Identification number of the ROI. The value of ROI Number (3006,0022) shall be unique within the Structure Set in which it is created.
>Referenced Frame of Reference UID	(3006,0024)	1	Uniquely identifies Frame of Reference in which ROI is defined, specified by Frame of Reference UID (0020,0052) in Referenced Frame of Reference Sequence (3006,0010).
>ROI Name	(3006,0026)	2	User-defined name for ROI.
>ROI Description	(3006,0028)	3	User-defined description for ROI.
>ROI Volume	(3006,002C)	3	Volume of ROI (cubic centimeters).
>ROI Generation Algorithm	(3006,0036)	2	Type of algorithm used to generate ROI. Defined Terms: **AUTOMATIC** calculated ROI **SEMIAUTOMATIC** ROI calculated with user assistance **MANUAL** user-entered ROI
>ROI Generation Description	(3006,0038)	3	User-defined description of technique used to generate ROI.
>ROI Derivation Algorithm Identification Sequence	(3006,0037)	3	Software algorithm that derived the ROI. Only a single Item is permitted in this Sequence.
>>Include Table 10-19 “Algorithm Identification Macro Attributes”.			
>Derivation Code Sequence	(0008,9215)	3	A coded description of how this ROI was derived. One or more Items are permitted in this Sequence. See Section C.8.8.5.3 for further explanation.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*Enumerated Value (113085, DCM, "Spatial resampling").*

Attribute Name	Tag	Type	Attribute Description
>Definition Source Sequence	(0008,1156)	3	Instances containing the source of the ROI Contour information. Only a single Item is permitted in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”.			
>>Referenced Segment Number	(0062,000B)	1C	The value of Segment Number (0062,0004) in the referenced SOP Instance that identifies the segment that is the source of the ROI Contour information. Required if Referenced SOP Class UID (0008,1150) is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4").
>>Referenced Fiducial UID	(0070,031B)	1C	The value of Fiducials UID (0070,031A) in the referenced SOP Instance that identifies the fiducial that is the source of the ROI Contour information. Required if Referenced SOP Class UID (0008,1150) is Spatial Fiducials Storage ("1.2.840.10008.5.1.4.1.1.66.2").
Predecessor Structure Set Sequence	(3006,0018)	3	The Structure Set that has been used to derive the current Structure Set. Only a single Item is permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.8.5.1 Frames of Reference

The Referenced Frame of Reference Sequence (3006,0010) describes a set of frames of reference in which some or all of the ROIs are expressed. Since the Referenced Frame of Reference UID (3006,0024) is required for each ROI, each Frame of Reference used to express the coordinates of an ROI shall be listed in the Referenced Frame of Reference Sequence (3006,0010) once and only once.

Note

As an example, a set of ROIs defined using a single image Series would list the image Series in a single Referenced Frame of Reference Sequence (3006,0010) Item, providing the UID for this referenced Frame of Reference (obtained from the source images), and listing all pertinent images in the Contour Image Sequence (3006,0016).

C.8.8.5.2 Frame of Reference Relationship Sequence and Transformation Matrix

Retired. See PS3.3-2011.

The concept of definition of registered Frame of References using the Frame of Reference Relationship Sequence (3006,00C0) formerly present in the Standard is retired. The use of Registration IODs is advised since the introduction of Spatial Registration IOD, which is a much stronger and more general concept, and independent from the specifics of RT Structure Sets. Additionally it is of importance that registrations are decoupled from image and segmentation objects.

C.8.8.5.3 ROI Derivation Sequence

If an ROI is created by re-sampling an existing ROI that is either (a) present in a different Frame of Reference (FoR) and has been resampled to align with the image Series referenced by the current structure set, or (b) present in the same FoR, but its contours are referenced to a different image Series, it is useful to be able to identify that the ROI is resampled. The Derivation Code Sequence (0008,9215) shall be used with code (113085, DCM, "Spatial resampling") to indicate the resampled ROI.

C.8.8.5.4 SOP Class UID in RT Referenced Study Sequence

Since RT Referenced Study Sequence (3006,0012) is Type 3, the Attribute may be omitted.

If RT Referenced Study Sequence (3006,0012) is present with an Item, the SOP Class UID of the Detached Study Management SOP Class (Retired) may be used in Referenced SOP Class UID (0008,1150).

C.8.8.6 ROI Contour Module

In general, a ROI can be defined by either a sequence of overlays or a sequence of contours. This Module, if present, is used to define the ROI as a set of contours. Each ROI contains a sequence of one or more contours, where a contour is either a single point (for a point ROI) or more than one point (representing an open or closed polygon).

Table C.8-42. ROI Contour Module Attributes

Attribute Name	Tag	Type	Attribute Description
ROI Contour Sequence	(3006,0039)	1	Sequence of Contour Sequences defining ROIs. One or more Items shall be included in this Sequence.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Display Color	(3006,002A)	3	RGB triplet color representation for ROI, specified using the range 0-255.
>Recommended Display Grayscale Value	(0062,000C)	3	A default single gray unsigned value in which it is recommended that the contour be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Recommended Display CIELab Value	(0062,000D)	3	A default triplet value in which it is recommended that the contour be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Contour Sequence	(3006,0040)	3	Sequence of Contours defining ROI. One or more Items are permitted in this Sequence.
>>Contour Number	(3006,0048)	3	Identification number of the contour. The value of Contour Number (3006,0048) shall be unique within the Contour Sequence (3006,0040) in which it is defined. No semantics or ordering shall be inferred from this Attribute.
>>Attached Contours	(3006,0049)	3	List of Contour Number (3006,0048) defining lower-numbered contour(s) to which the current contour is connected.
>>Contour Image Sequence	(3006,0016)	3	Sequence of images containing the contour. One or more Items are permitted in this Sequence.
>>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>>Contour Geometric Type	(3006,0042)	1	Geometric type of contour. See Section C.8.8.6.1. Enumerated Values: **POINT** single point **OPEN_PLANAR** open contour containing coplanar points **OPEN_NONPLANAR** open contour containing non-coplanar points **CLOSED_PLANAR** closed contour (polygon) containing coplanar points
>>Contour Slab Thickness	(3006,0044)	3	Thickness of slab (in mm) represented by contour, where Contour Data (3006,0050) defines a plane in the center of the slab, offset by the Contour Offset Vector (3006,0045) if it is present. See Section C.8.8.6.2.

Attribute Name	Tag	Type	Attribute Description
>>Contour Offset Vector	(3006,0045)	3	Vector (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 that is normal to plane of Contour Data (3006,0050), describing direction and magnitude of the offset (in mm) of each point of the central plane of a contour slab from the corresponding original point of Contour Data (3006,0050). See Section C.8.8.6.2.
>>Number of Contour Points	(3006,0046)	1	Number of points (triplets) in Contour Data (3006,0050).
>>Contour Data	(3006,0050)	1	Sequence of (x,y,z) triplets defining a contour in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). See Section C.8.8.6.1 and Section C.8.8.6.3. Note Contour Data may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.

C.8.8.6.1 Contour Geometric Type

A contour can be one of the following geometric types:

- A Contour Geometric Type (3006,0042) of POINT indicates that the contour is a single point, defining a specific location of significance.
- A Contour Geometric Type (3006,0042) of OPEN_PLANAR indicates that the last vertex shall not be connected to the first point, and that all points in Contour Data (3006,0050) shall be coplanar.
- A Contour Geometric Type (3006,0042) of OPEN_NONPLANAR indicates that the last vertex shall not be connected to the first point, and that the points in Contour Data (3006,0050) may be non-coplanar. Contours having a Geometric Type (3006,0042) of OPEN_NONPLANAR can be used to represent objects best described by a single, possibly non-coplanar curve, such as a brachy-therapy applicator.
- A Contour Geometric Type (3006,0042) of CLOSED_PLANAR indicates that the last point shall be connected to the first point, where the first point is not repeated in Contour Data (3006,0050). All points in Contour Data (3006,0050) shall be coplanar.

C.8.8.6.2 Contour Slab Thickness

A set of Contour slabs may define a multi-slab Volume of Interest. Contour Slab Thickness (3006,0044) shall specify the thickness of a slab, the central plane of which shall be defined by the set of points offset from Contour Data (3006,0050) by the value of Contour Offset Vector (3006,0045). One contour slab may contain one to many sets of Contour Data (3006,0050) that may define regions of one complex Volume of Interest. If no valid value of Contour Slab Thickness (3006,0044) is present, then the offset value shall be (0,0,0) and the original Contour Data (3006,0050) shall define the central plane of the Contour slab.

C.8.8.6.3 Representing Inner and Outer Contours on an Image

When a single ROI describes an excluded inner volume, this can be encoded with a single contour, using a "keyhole" technique. In this method, an arbitrarily narrow channel is used to connect the outer contour to the inner contour, so that it is drawn as a single contour. An example of such a structure is shown in Figure C.8.8.6-1

Points in space lying along the path defined by the contour are considered to be inside the ROI.

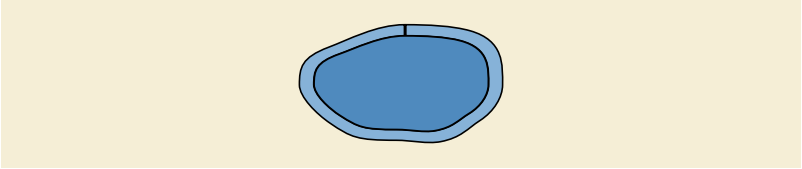


Figure C.8.8.6-1. Example of ROI with excluded inner volume

C.8.8.7 RT Dose ROI Module

RT Dose ROI provides ancillary dose-related information to the ROI data defined within the Structure Set Module and ROI Contour Module, which may be included in the RT Dose IOD composite object. These Modules in combination provide for the definition of dose data in the form of *isodose curves* or named or unnamed dose points. Isodose curves in radiation oncology are simply contours identifying a set of points with the same dose value.

Table C.8-43. RT Dose ROI Module Attributes

Attribute Name	Tag	Type	Attribute Description
RT Dose ROI Sequence	(3004,0010)	1	Sequence specifying dose levels for isodose curves or dose points described in the ROI Module. One or more Items shall be included in this Sequence. See Section C.8.8.7.1.
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI within the current RT Dose. See Note 1 and Section C.8.8.7.2.
>Dose Units	(3004,0002)	1	Units used for ROI Dose. Enumerated Values: **GY** Gray **RELATIVE** dose relative to implicit reference value
>Dose Value	(3004,0012)	1	Dose value for ROI, in units defined by Dose Units (3004,0002). See Section C.8.8.7.3.

Note

1. The Structure Set ROI Sequence (3006,0020) defining the dose point and surfaces is defined in the Structure Set Module. ROI Number (3006,0022) is unique within the Structure Set ROI Sequence, and is referenced from the RT Dose ROI Module using Referenced ROI Number (3006,0084).

2. The RT Dose ROI Module defines the Attributes that describe references to ROIs contained within the associated Structure Set Module and ROI Contour Module. Note that the RT Dose IOD Module table specifies that either all or none of the Structure Set Module, ROI Contour Module, and RT Dose ROI Module must be present in the RT Dose IOD.

C.8.8.7.1 Contour Geometric Type of Referenced ROI

ROIs referenced in the RT Dose ROI Module shall have a Contour Geometric Type (3006,0042) of POINT, OPEN_PLANAR or CLOSED_PLANAR.

C.8.8.7.2 Referenced ROI Number

There shall be a one-to-one correspondence between Referenced ROI Number (3006,0084) and the Sequence of ROIs defined in the Structure Set Module and ROI Contour Module. The RT Dose ROI Module shall only contain references to structures that are dose-related (i.e., dose points and isodose curves).

C.8.8.7.3 Dose Value

Dose Value (3004,0012) shall be the dose value corresponding to the referenced isodose curve, named dose point, or unnamed dose point.

C.8.8.8 RT ROI Observations Module

The RT ROI Observations Module specifies the identification and interpretation of an ROI specified in the Structure Set Module and ROI Contour Module.

Table C.8-44. RT ROI Observations Module Attributes

Attribute Name	Tag	Type	Attribute Description
RT ROI Observations Sequence	(3006,0080)	1	Sequence of observations related to ROIs defined in the ROI Module. One or more Items shall be included in this Sequence.
>Observation Number	(3006,0082)	1	Identification number of the Observation. The value of Observation Number (3006,0082) shall be unique within the RT ROI Observations Sequence (3006,0080).
>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the referenced ROI described in the Structure Set ROI Sequence (3006,0020).
>ROI Observation Label	(3006,0085)	3	User-defined label for ROI Observation.
>ROI Observation Description	(3006,0088)	3	User-defined description for ROI Observation.
>RT Related ROI Sequence	(3006,0030)	3	Sequence of significantly related ROIs, e.g., CTVs contained within a PTV. One or more Items are permitted in this Sequence.
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies the related ROI described in the Structure Set ROI Sequence (3006,0020).
>>RT ROI Relationship	(3006,0033)	3	Relationship of referenced ROI with respect to referencing ROI. Defined Terms: **SAME** ROIs represent the same entity **ENCLOSED** referenced ROI completely encloses referencing ROI **ENCLOSING** referencing ROI completely encloses referenced ROI
>Include Table 10-7b "Multiple Site General Anatomy Optional Macro Attributes"			*May not be necessary if the anatomy is implicit in the RT ROI Identification Code Sequence (3006,0086).* *More than one item in Anatomic Region Sequence (0008,2218) may be used when a region of interest spans multiple anatomical locations and there is not a single pre-coordinated code describing the combination of locations. There is no requirement that the multiple locations be contiguous.*
>Segmented Property Category Code Sequence	(0062,0003)	3	Sequence defining the general category of the property this ROI represents. Only a single Item is permitted in this Sequence. See Note 1.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>RT ROI Identification Code Sequence	(3006,0086)	3	Sequence containing Code used to identify ROI. Only a single Item is permitted in this Sequence. See Note 2.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*For dose measurement devices BCID 7026 "Radiotherapeutic Dose Measurement Devices".* *No Baseline CID is defined otherwise.*
>>Segmented Property Type Modifier Code Sequence	(0062,0011)	3	Sequence defining the modifier of the property type of this segment. One or more Items are permitted in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 244 "Laterality".*

Attribute Name	Tag	Type	Attribute Description
>Related RT ROI Observations Sequence	(3006,00A0)	3	Sequence of related ROI Observations. One or more Items are permitted in this Sequence.
>>Observation Number	(3006,0082)	1	Uniquely identifies a related ROI Observation.
>RT ROI Interpreted Type	(3006,00A4)	2	Type of ROI. See Section C.8.8.8.1. Defined Terms: **EXTERNAL** external patient contour **PTV** Planning Target Volume (as defined in [ICRU Report 50]) **CTV** Clinical Target Volume (as defined in [ICRU Report 50]) **GTV** Gross Tumor Volume (as defined in [ICRU Report 50]) **TREATED_VOLUME** Treated Volume (as defined in [ICRU Report 50]) **IRRAD_VOLUME** Irradiated Volume (as defined in [ICRU Report 50]) **BOLUS** patient bolus to be used for external beam therapy **AVOIDANCE** region in which dose is to be minimized **ORGAN** patient organ **MARKER** patient marker or marker on a localizer **REGISTRATION** registration ROI **ISOCENTER** treatment isocenter to be used for external beam therapy **CONTRAST_AGENT** volume into which a contrast agent has been injected **CAVITY** patient anatomical cavity **BRACHY_CHANNEL** brachytherapy channel **BRACHY_ACCESSORY** brachytherapy accessory device **BRACHY_SRC_APP** brachytherapy source applicator **BRACHY_CHNL_SHLD** brachytherapy channel shield **SUPPORT** external patient support device **FIXATION** external patient fixation or immobilization device **DOSE_REGION** ROI to be used as a dose reference **CONTROL** ROI to be used in control of dose optimization and calculation **DOSE_MEASUREMENT** ROI representing a dose measurement device, such as a chamber or TLD
>ROI Interpreter	(3006,00A6)	2	Name of person performing the interpretation.
>Material ID	(300A,00E1)	3	User-supplied identifier for ROI material.
>ROI Physical Properties Sequence	(3006,00B0)	3	Sequence describing physical properties associated with current ROI interpretation. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>ROI Physical Property	(3006,00B2)	1	Physical property specified by ROI Physical Property Value (3006,00B4). Defined Terms: **REL_MASS_DENSITY** mass density relative to water **REL_ELEC_DENSITY** electron density relative to water **EFFECTIVE_Z** effective atomic number **EFF_Z_PER_A** ratio of effective atomic number to mass (AMU^{-1}) **REL_STOP_RATIO** ratio of linear stopping power of material relative to linear stopping power of water **ELEM_FRACTION** elemental composition of the material **MEAN_EXCI_ENERGY** Mean Excitation Energy of the material (eV)
>>ROI Elemental Composition Sequence	(3006,00B6)	1C	The elemental composition of the ROI and the atomic mass fraction of the elements in the ROI. Required if ROI Physical Property (3006,00B2) equals ELEM_FRACTION. One or more Items shall be included in this Sequence.
>>>ROI Elemental Composition Atomic Number	(3006,00B7)	1	The atomic number of the element for which the ROI Elemental Composition Sequence (3006,00B6) is present.
>>>ROI Elemental Composition Atomic Mass Fraction	(3006,00B8)	1	The fractional weight of the element for which the ROI Elemental Composition Sequence (3006,00B6) is present. The sum of all ROI Elemental Composition Atomic Mass Fractions (3006,00B8) within the ROI Elemental Composition Sequence (3006,00B6) shall equal 1.0 within acceptable limits of floating point precision.
>>ROI Physical Property Value	(3006,00B4)	1	User-assigned value for physical property. Note The value has no meaning when ROI Physical Property (3006,00B2) has the value ELEM_FRACTION. Therefore this Attribute may contain any value and receivers may ignore that value.

Note

1. This Attribute allows preserving information by copying the content of Segmented Property Category Code Sequence (0062,0003) in case a Segmentation object is re-encoded as an RT Structure Set or vice-versa.

2. In case of re-encoding a Segmentation object as an RT Structure Set or vice-versa it is suggested, that the Segmented Property Type Code Sequence (0062,000F) is mapped to RT ROI Identification Code Sequence (3006,0086).

C.8.8.8.1 RT ROI Interpreted Type

RT ROI Interpreted Type (3006,00A4) shall describe the class of ROI (e.g., CTV, PTV). Individual instances of each class of structure (e.g., CTV1, CTV2) can be distinguished using ROI Observation Label (3006,0085).

C.8.8.8.2 Additional RT ROI Identification Code Sequence

Retired. See DICOM PS3.3 2016c.

C.8.8.9 RT General Plan Module

Table C.8-45. RT General Plan Module Attributes

Attribute Name	Tag	Type	Attribute Description
RT Plan Label	(300A,0002)	1	User-defined label for treatment plan.
RT Plan Name	(300A,0003)	3	User-defined name for treatment plan.
RT Plan Description	(300A,0004)	3	User-defined description of treatment plan.
Instance Number	(0020,0013)	3	A number that identifies this object Instance.
RT Plan Date	(300A,0006)	2	Date treatment plan was last modified.
RT Plan Time	(300A,0007)	2	Time treatment plan was last modified.
Treatment Protocols	(300A,0009)	3	Planned treatment protocols.
Plan Intent	(300A,000A)	3	Intent of this plan. Defined Terms: **CURATIVE** Curative therapy on patient **PALLIATIVE** Palliative therapy on patient **PROPHYLACTIC** Preventative therapy on patient **VERIFICATION** Verification of patient plan using phantom **MACHINE_QA** Quality assurance of the delivery machine (independently of a specific patient) **RESEARCH** Research project **SERVICE** Machine repair or maintenance operation
Treatment Sites	(300A,000B)	3	Planned treatment sites.
RT Plan Geometry	(300A,000C)	1	Describes whether RT Plan is based on patient or treatment device geometry. See Section C.8.8.9.1. Defined Terms: **PATIENT** RT Structure Set exists **TREATMENT_DEVICE** RT Structure Set does not exist
Referenced Structure Set Sequence	(300C,0060)	1C	The RT Structure Set on which the RT Plan is based. Only a single Item shall be included in this Sequence. Required if RT Plan Geometry (300A,000C) is PATIENT.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Referenced Dose Sequence	(300C,0080)	3	Related Instances of RT Dose (for grids and named/unnamed point doses). One or more Items are permitted in this Sequence. See Note 1.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Referenced RT Plan Sequence	(300C,0002)	3	Related Instances of RT Plan. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>RT Plan Relationship	(300A,0055)	1	Relationship of referenced plan with respect to current plan. Defined Terms: **PRIOR** plan delivered prior to current treatment **ALTERNATIVE** alternative plan prepared for current treatment **PREDECESSOR** plan used in derivation of current plan **VERIFIED_PLAN** plan that is verified using the current plan. This value shall only be used if Plan Intent (300A,000A) is present and has a value of VERIFICATION **CONCURRENT** plan that forms part of a set of two or more RT Plan Instances representing a single conceptual 'plan', applied in parallel in one treatment phase
Frame of Reference to Displayed Coordinate System Transformation Matrix	(0070,030B)	3	A 4x4 transformation matrix that transforms a coordinate of the Frame of Reference to a displayed coordinate system. Only rigid transformation matrices are permitted (see definition in Section C.20.2.1.2). Matrix elements shall be listed in row major order.

Note

An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, individual dose points (with optional dose point names), isodose curves, and DVHs.

C.8.8.9.1 Referenced Structure Set Sequence

An RT Plan Geometry (300A,000C) of PATIENT shall signify that an RT Structure Set has been defined upon which the plan geometry is based, and this RT Structure Set shall be specified in the Referenced Structure Set Sequence (300C,0060). An RT Plan Geometry (300A,000C) of TREATMENT_DEVICE shall indicate that no patient geometry is available, and that the RT Plan is being defined with respect to the IEC FIXED Coordinate System.

C.8.8.10 RT Prescription Module

Table C.8-46. RT Prescription Module Attributes

Attribute Name	Tag	Type	Attribute Description
Prescription Description	(300A,000E)	3	User-defined description of treatment prescription.
Dose Reference Sequence	(300A,0010)	3	Sequence of Dose References. One or more Items are permitted in this Sequence.
>Dose Reference Number	(300A,0012)	1	Identification number of the Dose Reference. The value of Dose Reference Number (300A,0012) shall be unique within the RT Plan in which it is created.
>Dose Reference UID	(300A,0013)	3	A unique identifier for a Dose Reference that can be used to link the same entity across multiple RT Plan objects.

Attribute Name	Tag	Type	Attribute Description
>Dose Reference Structure Type	(300A,0014)	1	Structure type of Dose Reference. Defined Terms: **POINT** dose reference point specified as ROI **VOLUME** dose reference volume specified as ROI **COORDINATES** point specified by Dose Reference Point Coordinates (300A,0018) **SITE** dose reference clinical site
>Dose Reference Description	(300A,0016)	3	User-defined description of Dose Reference.
>Referenced ROI Number	(3006,0084)	1C	Uniquely identifies ROI representing the dose reference specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Dose Reference Structure Type (300A,0014) is POINT or VOLUME.
>Dose Reference Point Coordinates	(300A,0018)	1C	Coordinates (x,y,z) of Reference Point in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). Required if Dose Reference Structure Type (300A,0014) is COORDINATES.
>Nominal Prior Dose	(300A,001A)	3	Dose (in Gy) from prior treatment to this Dose Reference (e.g., from a previous course of treatment).
>Dose Reference Type	(300A,0020)	1	Type of Dose Reference. Defined Terms: **TARGET** treatment target (corresponding to GTV, PTV, or CTV in [ICRU Report 50]) **ORGAN_AT_RISK** Organ at Risk (as defined in [ICRU Report 50])
>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) that when reached or exceeded should cause some action to be taken.
>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) that can be delivered to the dose reference.
>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) is TARGET.
>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in percent) of Target to receive less than the Target Prescription Dose if Dose Reference Type (300A,0020) is TARGET and Dose Reference Structure Type (300A,0014) is VOLUME. See Section C.8.8.10.1.
>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.
>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.

Attribute Name	Tag	Type	Attribute Description
>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in percent) of the Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) is VOLUME.

C.8.8.10.1 Target Underdose Volume Fraction

If the Target Underdose Volume Fraction (300A,0028) is not present, it shall be interpreted as zero.

C.8.8.11 RT Tolerance Tables Module

Table C.8-47. RT Tolerance Tables Module Attributes

Attribute Name	Tag	Type	Attribute Description
Tolerance Table Sequence	(300A,0040)	3	Sequence of tolerance tables to be used for delivery of treatment plan. One or more Items are permitted in this Sequence. See Note 1.
>Tolerance Table Number	(300A,0042)	1	Identification number of the Tolerance Table. The value of Tolerance Table Number (300A,0042) shall be unique within the RT Plan in which it is created.
>Tolerance Table Label	(300A,0043)	3	User-defined label for Tolerance Table.
>Gantry Angle Tolerance	(300A,0044)	3	Maximum permitted difference (in degrees) between planned and delivered Gantry Angle.
>Gantry Pitch Angle Tolerance	(300A,014E)	3	Maximum permitted difference (in degrees) between planned and delivered Gantry Pitch Angle.
>Beam Limiting Device Angle Tolerance	(300A,0046)	3	Maximum permitted difference (in degrees) between planned and delivered Beam Limiting Device Angle.
>Beam Limiting Device Tolerance Sequence	(300A,0048)	3	Sequence of beam limiting device (collimator) tolerances. One or more Items are permitted in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Beam Limiting Device Position Tolerance	(300A,004A)	1	Maximum permitted difference (in mm) between planned and delivered leaf (element) or jaw positions for current beam limiting device (collimator).
>Patient Support Angle Tolerance	(300A,004C)	3	Maximum permitted difference (in degrees) between planned and delivered Patient Support Angle.
>Table Top Eccentric Angle Tolerance	(300A,004E)	3	Maximum permitted difference (in degrees) between planned and delivered Table Top Eccentric Angle.
>Table Top Pitch Angle Tolerance	(300A,004F)	3	Maximum permitted difference (in degrees) between the planned and delivered Table Top Pitch Angle.
>Table Top Roll Angle Tolerance	(300A,0050)	3	Maximum permitted difference (in degrees) between the planned and delivered Table Top Roll Angle.

Attribute Name	Tag	Type	Attribute Description
>Table Top Vertical Position Tolerance	(300A,0051)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Vertical Position.
>Table Top Longitudinal Position Tolerance	(300A,0052)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Longitudinal Position.
>Table Top Lateral Position Tolerance	(300A,0053)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Lateral Position.

Note

Tolerance Tables may be used to compare planned with delivered machine parameters. If the absolute difference between the planned and delivered values exceeds the Tolerance Table value, treatment may be inhibited or the operator may be warned.

C.8.8.12 RT Patient Setup Module

The RT Patient Setup Module contains information describing the positioning of the patient with respect to the treatment machine, along with any fixation devices used. It also describes the shielding devices applied to the patient. The Module contains a Sequence of patient setup descriptions, each of which may be referenced by one of more beams or brachy application setups.

Table C.8-48. RT Patient Setup Module Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Setup Sequence	(300A,0180)	1	Sequence of patient setup data for current plan. One or more Items shall be included in this Sequence.
>Patient Setup Number	(300A,0182)	1	Identification number of the Patient Setup. The value of Patient Setup Number (300A,0182) shall be unique within the RT Plan in which it is created.
>Patient Setup Label	(300A,0183)	3	The user-defined label for the Patient Setup.
>Patient Position	(0018,5100)	1C	Patient position descriptor relative to the equipment. Required if Patient Additional Position (300A,0184) is not present. See Section C.8.8.12.1.2 for Defined Terms and further explanation.
>Patient Additional Position	(300A,0184)	1C	User-defined additional description of patient position. Required if Patient Position (0018,5100) is not present.
>Referenced Setup Image Sequence	(300A,0401)	3	Sequence of setup verification images for this patient setup. One or more Items are permitted in this Sequence. See Section C.8.8.12.1.1
>>Setup Image Comment	(300A,0402)	3	Comment on the Setup Image.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Fixation Device Sequence	(300A,0190)	3	Sequence of Fixation Devices used in Patient Setup. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Fixation Device Type	(300A,0192)	1	Type of Fixation Device used during in Patient Setup. Defined Terms: **BITEBLOCK** **HEADFRAME** **MASK** **MOLD** **CAST** **HEADREST** **BREAST_BOARD** **BODY_FRAME** **VACUUM_MOLD** **WHOLE_BODY_POD** **RECTAL_BALLOON**
>>Fixation Device Label	(300A,0194)	2	User-defined label identifier for Fixation Device.
>>Fixation Device Description	(300A,0196)	3	User-defined description of Fixation Device.
>>Fixation Device Position	(300A,0198)	3	Position/Notch number of Fixation Device.
>>Fixation Device Pitch Angle	(300A,0199)	3	The Fixation Device Pitch Angle, i.e., orientation of PITCHED FIXATION DEVICE coordinate system with respect to IEC PATIENT SUPPORT coordinate system (degrees). Pitching is the rotation around IEC PATIENT SUPPORT X-axis.
>>Fixation Device Roll Angle	(300A,019A)	3	The Fixation Device Roll Angle, i.e., orientation of ROLLED FIXATION DEVICE coordinate system with respect to IEC PITCHED FIXATION DEVICE coordinate system (degrees). Rolling is the rotation around IEC PATIENT SUPPORT Y-axis.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Shielding Device Sequence	(300A,01A0)	3	Sequence of Shielding Devices used in Patient Setup. One or more Items are permitted in this Sequence.
>>Shielding Device Type	(300A,01A2)	1	Type of Shielding Device used in Patient Setup. Defined Terms: **GUM** **EYE** **GONAD**
>>Shielding Device Label	(300A,01A4)	2	User-defined label for Shielding Device.
>>Shielding Device Description	(300A,01A6)	3	User-defined description of Shielding Device.
>>Shielding Device Position	(300A,01A8)	3	Position/Notch number of Shielding Device.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Setup Technique	(300A,01B0)	3	Setup Technique used in Patient Setup. Defined Terms: **ISOCENTRIC** **FIXED_SSD** **TBI** **BREAST_BRIDGE** **SKIN_APPOSITION**
>Setup Technique Description	(300A,01B2)	3	User-defined description of Setup Technique.

Attribute Name	Tag	Type	Attribute Description
>Setup Device Sequence	(300A,01B4)	3	Sequence of devices used for patient alignment in Patient Setup. One or more Items are permitted in this Sequence.
>>Setup Device Type	(300A,01B6)	1	Type of Setup Device used for patient alignment. Defined Terms: **LASER_POINTER** **DISTANCE_METER** **TABLE_HEIGHT** **MECHANICAL_PTR** **ARC**
>>Setup Device Label	(300A,01B8)	2	User-defined label for Setup Device used for patient alignment.
>>Setup Device Description	(300A,01BA)	3	User-defined description for Setup Device used for patient alignment.
>>Setup Device Parameter	(300A,01BC)	2	Setup Parameter for Setup Device in appropriate IEC 61217 coordinate system. Units shall be mm for distances and degrees for angles.
>>Setup Reference Description	(300A,01D0)	3	User-defined description of Setup Reference used for patient alignment.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Table Top Vertical Setup Displacement	(300A,01D2)	3	Vertical Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e., vertical offset between patient positioning performed using setup and treatment position.
>Table Top Longitudinal Setup Displacement	(300A,01D4)	3	Longitudinal Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e., longitudinal offset between patient positioning performed using setup and treatment position.
>Table Top Lateral Setup Displacement	(300A,01D6)	3	Lateral Displacement in IEC TABLE TOP coordinate system (in mm) relative to initial Setup Position, i.e., lateral offset between patient positioning performed using setup and treatment position.
>Motion Synchronization Sequence	(300A,0410)	3	Sequence of Motion Synchronization. One or more Items are permitted in this Sequence.
>>Respiratory Motion Compensation Technique	(0018,9170)	1	Technique applied to reduce respiratory motion artifacts. Defined Terms: **NONE** **BREATH_HOLD** **REALTIME** image acquisition shorter than respiratory cycle **GATING** Prospective gating **TRACKING** prospective through-plane or in-plane motion tracking **PHASE_ORDERING** prospective phase ordering **PHASE_RESCANNING** prospective techniques, such as real-time averaging, diminishing variance and motion adaptive gating **RETROSPECTIVE** retrospective gating **CORRECTION** retrospective image correction **UNKNOWN** technique not known

Attribute Name	Tag	Type	Attribute Description
>>Respiratory Signal Source	(0018,9171)	1	Signal source from which respiratory motion is derived. Defined Terms: **NONE** **BELT** **NASAL_PROBE** **CO2_SENSOR** **NAVIGATOR** MR navigator and organ edge detection **MR_PHASE** phase (of center k-space line) **ECG** baseline demodulation of the ECG **SPIROMETER** Signal derived from flow sensor **EXTERNAL_MARKER** Signal determined from external motion surrogate **INTERNAL_MARKER** Signal determined from internal motion surrogate **IMAGE** Signal derived from an image **UNKNOWN** Signal source not known
>>Respiratory Motion Compensation Technique Description	(0018,9185)	3	Description of respiratory motion compensation technique.
>>Respiratory Signal Source ID	(0018,9186)	3	Identifies the device providing the respiratory signal.

C.8.8.12.1 RT Patient Setup Module Attributes

C.8.8.12.1.1 Referenced Setup Image Sequence

Images with modality SC or VL serve as visible light photos for visual setup control. Images with modality RTIMAGE serve as reference images on plan level. RT Images present in this Sequence shall not be referenced in the Referenced Reference Image Sequence (300C,0042) of the RT Beams Module.

C.8.8.12.1.2 Patient Position

Defined Terms for Patient Position shall be those specified in Section C.7.3.1.1.2, plus the following:

Defined Terms:

SITTING In the sitting position, the patient's face is towards the front of the chair

C.8.8.13 RT Fraction Scheme Module

The RT Fraction Scheme Module contains Attributes that describe a single or multiple scheme of dose descriptions. Each Sequence Item contains dose specification information, fractionation patterns, and either beam or brachytherapy application setup specifications. The design of the RT Fraction Scheme Module allows a beam or brachytherapy application setup to be used in multiple fraction schemes.

Table C.8-49. RT Fraction Scheme Module Attributes

Attribute Name	Tag	Type	Attribute Description
Fraction Group Sequence	(300A,0070)	1	Sequence of Fraction Groups in current Fraction Scheme. One or more Items shall be included in this Sequence.
>Fraction Group Number	(300A,0071)	1	Identification number of the Fraction Group. The value of Fraction Group Number (300A,0071) shall be unique within the RT Plan in which it is created.
>Fraction Group Description	(300A,0072)	3	The user defined description for the fraction group.

Attribute Name	Tag	Type	Attribute Description
>Referenced Dose Sequence	(300C,0080)	3	Related Instances of RT Dose (for grids, isodose curves and named/unnamed point doses). One or more Items are permitted in this Sequence. See Note 1.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Dose Reference Sequence	(300C,0050)	3	Sequence of Dose References for the current Fraction Group. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) within Dose Reference Sequence (300A,0010) in RT Prescription Module.
>>Constraint Weight	(300A,0021)	3	Relative importance of satisfying constraint, where high values represent more important constraints.
>>Delivery Warning Dose	(300A,0022)	3	The dose (in Gy) that when reached or exceeded should cause some action to be taken.
>>Delivery Maximum Dose	(300A,0023)	3	The maximum dose (in Gy) that can be delivered to the dose reference.
>>Target Minimum Dose	(300A,0025)	3	Minimum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Prescription Dose	(300A,0026)	3	Prescribed dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Maximum Dose	(300A,0027)	3	Maximum permitted dose (in Gy) to Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET.
>>Target Underdose Volume Fraction	(300A,0028)	3	Maximum permitted fraction (in percent) of Target to receive less than the Target Prescription Dose (300A,0027) if Dose Reference Type (300A,0020) of referenced Dose Reference is TARGET and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Full-volume Dose	(300A,002A)	3	Maximum dose (in Gy) to entire Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Limit Dose	(300A,002B)	3	Maximum permitted dose (in Gy) to any part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Maximum Dose	(300A,002C)	3	Maximum dose (in Gy) to non-overdosed part of Dose Reference if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>>Organ at Risk Overdose Volume Fraction	(300A,002D)	3	Maximum permitted fraction (in percent) of Organ at Risk to receive more than the Organ at Risk Maximum Dose if Dose Reference Type (300A,0020) of referenced Dose Reference is ORGAN_AT_RISK and Dose Reference Structure Type (300A,0014) of referenced Dose Reference is VOLUME.
>Number of Fractions Planned	(300A,0078)	2	Total number of treatments (Fractions) prescribed for current Fraction Group.
>Number of Fraction Pattern Digits Per Day	(300A,0079)	3	Number of digits in Fraction Pattern (300A,007B) used to represent one day. See Note 2.

Attribute Name	Tag	Type	Attribute Description
>Repeat Fraction Cycle Length	(300A,007A)	3	Number of weeks needed to describe treatment pattern. See Note 2.
>Fraction Pattern	(300A,007B)	3	String of 0's (no treatment) and 1's (treatment) describing treatment pattern. Length of string is 7 x Number of Fraction Pattern Digits Per Day x Repeat Fraction Cycle Length. Pattern shall start on a Monday. See Note 2.
>Beam Dose Meaning	(300A,008B)	3	Indicates the meaning of Beam Dose (300A,0084). Enumerated Values: **BEAM_LEVEL** Beam Dose value is individually calculated for this Beam **FRACTION_LEVEL** Dose is calculated on the Fraction level, and the value of Beam Dose (300A,0084) is assigned to the Beam to carry a nominally distributed dose only.
>Number of Beams	(300A,0080)	1	Number of Beams in current Fraction Group. If Number of Beams is greater then zero, Number of Brachy Application Setups (300A,00A0) shall equal zero.
>Referenced Beam Sequence	(300C,0004)	1C	Sequence of treatment beams in current Fraction Group. One or more Items shall be included in this Sequence. Required if Number of Beams (300A,0080) is greater than zero.
>>Referenced Beam Number	(300C,0006)	1	Uniquely identifies Beam specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module or within Ion Beam Sequence (300A,03A2) in RT Ion Beams Module.
>>Referenced Dose Reference UID	(300A,0083)	3	Identifies the Dose Reference specified by Dose Reference UID (300A,0013) in the Dose Reference Sequence (300A,0010) in the RT Prescription Module which specifies the primary target for the current Beam. If present shall have a value that is present in the Dose Reference Sequence.
>>Beam Dose	(300A,0084)	3	Dose (in Gy) due to current Beam for one treatment fraction. See Note 9.
>>Beam Dose Type	(300A,0090)	1C	Type of Dose of the Beam Dose (300A,0084). Enumerated Values: **PHYSICAL** **EFFECTIVE** Shall not have the same value as Alternate Beam Dose Type (300A,0092). Required if Alternate Beam Dose (300A,0091) is present. May be present otherwise.
>>Alternate Beam Dose	(300A,0091)	3	Alternate Dose (in Gy) according to the Alternate Beam Dose Type (300A,0092). See Note 9.

Attribute Name	Tag	Type	Attribute Description
>>Alternate Beam Dose Type	(300A,0092)	1C	Type of Dose of the Alternate Beam Dose (300A,0091). Enumerated Values: **PHYSICAL** **EFFECTIVE** Shall not have the same value as Beam Dose Type (300A,0090). Required if Alternate Beam Dose (300A,0091) is present.
>>Beam Meterset	(300A,0086)	3	Machine setting to be delivered for current Beam, specified in Monitor Units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3) (in RT Beams Module) for referenced Beam. See Note 4.
>>Beam Delivery Duration Limit	(300A,00C5)	3	The expected maximum delivery time in sec. See Note 7.
>Number of Brachy Application Setups	(300A,00A0)	1	Number of Brachy Application Setups in current Fraction Group. If Number of Brachy Application Setups is greater then zero, Number of Beams (300A,0080) shall equal zero.
>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	Sequence of treatment Brachy Application Setups in current Fraction Group. Required if Number of Brachy Application Setups (300A,00A0) is greater than zero. One or more Items shall be included in this Sequence.
>>Referenced Brachy Application Setup Number	(300C,000C)	1	Uniquely identifies Brachy Application Setup specified by Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in RT Brachy Application Setups Module.
>>Brachy Application Setup Dose Specification Point	(300A,00A2)	3	Coordinates (x,y,z) of point in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 at which Brachy Application Setup Dose (300A,00A4) is specified (mm).
>>Brachy Application Setup Dose	(300A,00A4)	3	Dose (in Gy) at Brachy Application Setup Dose Specification Point (300A,00A2) due to current Brachy Application Setup.
>>Referenced Dose Reference UID	(300A,0083)	3	Identifies the Dose Reference specified by Dose Reference UID (300A,0013) in the Dose Reference Sequence (300A,0010) in the RT Prescription Module that specifies the primary target for the current Brachy Application Setup. If present, shall have a value that is present in the Dose Reference Sequence (300A,0010).

Note

1. An RT Dose IOD referenced within the Referenced Dose Sequence (300C,0080) can be used for storing grid-based (pixel) data, isodose curves, and/or individual dose points (with optional dose point names) for the current Fraction Group.

2. The fractionation pattern does not indicate the actual start of treatment, or the order or timing of fraction delivery. If treatment does not commence as outlined in the pattern, it is the application's responsibility to make any necessary adjustments.

   Examples of Fractionation Pattern Schemes:

   a. 1 fraction group, 1 fraction per day (Monday to Friday):

      - Number of Fraction Pattern Digits per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1111100

   b. 2 fraction groups, 1 fraction per day, first fraction group Monday, Wednesday, and Friday, second fraction group Tuesday and Thursday:

- Fraction Group 1: Number of Fraction Pattern Digits Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1010100
- Fraction Group 2: Number of Fraction Pattern Digits Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 0101000

c. 2 fraction groups, 1 fraction per day, alternating fraction groups every day of treatment (Monday to Friday):

- Fraction Group 1: Number of Fraction Pattern Digits Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 10101000101000
- Fraction Group 2: Number of Fraction Pattern Digits Per Day = 1, Repeat Fraction Cycle Length = 2, Fraction Pattern = 01010001010100

d. 1 fraction group, 2 fractions per day (Monday to Friday):

- Fraction Group 1: Number of Fraction Pattern Digits Per Day = 2, Repeat Fraction Cycle Length = 1, Fraction Pattern = 11111111110000

e. 2 fraction groups, 2 fractions per day, alternating fraction groups every treatment (Monday to Friday):

- Fraction Group 1: Number of Fraction Pattern Digits Per Day = 1, Repeat Fraction Cycle Length = 1, Fraction Pattern = 1111100
- Fraction Group 2: Number of Fraction Pattern Digits Per Day = 2, Repeat Fraction Cycle Length = 1, Fraction Pattern = 11111111110000

3. The Brachy Application Setup Dose Specification Point (300A,00A2) contains the coordinates of the single point used for dose normalization. This point is distinct from the Brachy Referenced Dose Reference Sequence (300C,0055) in the RT Brachy Application Setups Module, which are used for plan evaluation and dose tracking.

4. The Meterset at a given Control Point (see RT Beams Module) is equal to Beam Meterset (300A,0086) multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E).

5. Attribute Referenced Patient Setup Number (300C,006A) was previously defined. Its use in this Module is now retired (see PS3.3-2004).

6. Attributes Beam Dose Point Depth, Beam Dose Point Equivalent Depth and Beam Dose Point SSD were previously included in this Module as optional Attributes but have been retired. See PS3.3-2011.

7. The Beam Delivery Duration Limit (300A,00C5) is the maximum time span allowed to deliver a single fraction of a beam to prevent significant over-treatments. Treatment is expected to be terminated upon reaching the Beam Delivery Duration Limit independent of the Meterset. This limit represents the expected time span including some increase by a factor greater than 1 to accommodate normal variations in delivery.

8. The Beam Dose Verification Control Point Sequence was previously included and has been retired. See PS 3.3 2017c. The information is now described in the Referenced Dose Reference Sequence (300C,0050) in the Section C.8.8.14 RT Beams Module.

9. The Beam Dose Specification Point (300A,0082) was previously included in this module as a means to specify a single point at which dose contributions of different beams could be specified. This attribute has been retired as it no longer reflects clinical practice. Along with this, the semantics of the Beam Dose (300A,0084) and Alternate Beam Dose (300A,0091) have been adapted to reflect the absence of the Beam Dose Specification Point. In order to refer to an Item in the Dose Reference Sequence (300A,0010) it is recommended to utilize the Referenced Dose Reference UID (300A,0083) and the Dose Reference UID (300A,0013) respectively.

C.8.8.13.1 Beam Dose Verification Parameters

Retired. See PS3.3 2017c.

C.8.8.14 RT Beams Module

The RT Beams Module contains information defining equipment parameters for delivery of external radiation beams.

Table C.8-50. RT Beams Module Attributes

Attribute Name	Tag	Type	Attribute Description
Beam Sequence	(300A,00B0)	1	Sequence of treatment beams for current RT Plan. One or more Items shall be included in this Sequence.
>Beam Number	(300A,00C0)	1	Identification number of the Beam. The value of Beam Number (300A,00C0) shall be unique within the RT Plan in which it is created. See Note 1.
>Beam Name	(300A,00C2)	3	User-defined name for Beam. See Note 1.
>Beam Description	(300A,00C3)	3	User-defined description for Beam. See Note 1.
>Beam Type	(300A,00C4)	1	Motion characteristic of Beam. See Note 5. Enumerated Values: **STATIC** All Control Point Sequence (300A,0111) Attributes remain unchanged between consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134). **DYNAMIC** One or more Control Point Sequence (300A,0111) Attributes change between one or more consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134).
>Radiation Type	(300A,00C6)	2	Particle type of Beam. Defined Terms: **PHOTON** **ELECTRON** **NEUTRON** **PROTON**
>Primary Fluence Mode Sequence	(3002,0050)	3	Sequence defining whether the primary fluence of the treatment beam uses a non-standard fluence-shaping. Only a single Item is permitted in this Sequence.
>>Fluence Mode	(3002,0051)	1	Describes whether the fluence shaping is the standard mode for the beam or an alternate. Enumerated Values: **STANDARD** Uses standard fluence-shaping **NON_STANDARD** Uses a non-standard fluence-shaping mode
>>Fluence Mode ID	(3002,0052)	1C	Identifier for the specific fluence-shaping mode. Required if Fluence Mode (3002,0051) has value NON_STANDARD.
>High-Dose Technique Type	(300A,00C7)	1C	Type of high-dose treatment technique. Defined Terms: **TBI** Total Body Irradiation **HDR** High Dose Rate Required if treatment technique requires a dose that would normally require overriding of treatment machine safety controls.

Attribute Name	Tag	Type	Attribute Description
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for beam delivery. See Note 2.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for beam delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for beam delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7030 "Institutional Departments, Units and Services".*
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for beam delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for beam delivery.
>Primary Dosimeter Unit	(300A,00B3)	3	Measurement unit of machine dosimeter. See Section C.8.8.14.1. Enumerated Values: **MU** Monitor Unit **MINUTE** minute
>Referenced Tolerance Table Number	(300C,00A0)	3	Uniquely identifies Tolerance Table specified by Tolerance Table Number (300A,0042) within Tolerance Table Sequence in RT Tolerance Tables Module. These tolerances are to be used for verification of treatment machine settings.
>Source-Axis Distance	(300A,00B4)	3	Radiation source to Gantry rotation axis distance of the equipment that is to be used for beam delivery (mm).
>Beam Limiting Device Sequence	(300A,00B6)	1	Sequence of beam limiting device (collimator) jaw or leaf (element) sets. One or more Items shall be included in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Source to Beam Limiting Device Distance	(300A,00BA)	3	Radiation source to beam limiting device (collimator) distance of the equipment that is to be used for beam delivery (mm).
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).

Attribute Name	Tag	Type	Attribute Description
>>Leaf Position Boundaries	(300A,00BE)	2C	Boundaries of beam limiting device (collimator) leaves (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e., X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY. May be present otherwise. See Note 3.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup to be used for current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence of RT Patient Setup Module.
>Referenced Reference Image Sequence	(300C,0042)	3	Reference images used for validation of current beam. One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Reference Image Number	(300A,00C8)	1	Uniquely identifies Reference Image within Referenced Reference Image Sequence (300C,0042).
>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition starts.
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition ends.
>Planned Verification Image Sequence	(300A,00CA)	3	Sequence of planned verification images to be acquired during current beam. One or more Items are permitted in this Sequence. See Section C.8.8.14.2.
>>Start Cumulative Meterset Weight	(300C,0008)	3	Cumulative Meterset Weight within current Beam at which image acquisition will start.
>>Meterset Exposure	(3002,0032)	3	Meterset duration over which image is to be acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3).
>>End Cumulative Meterset Weight	(300C,0009)	3	Cumulative Meterset Weight within current Beam at which image acquisition will end.
>>RT Image Plane	(3002,000C)	3	Describes whether or not image plane is normal to beam axis. Enumerated Values: **NORMAL** image plane normal to beam axis **NON_NORMAL** image plane non-normal to beam axis
>>X-Ray Image Receptor Angle	(3002,000E)	3	X-Ray Image Receptor Angle i.e., orientation of IEC X-RAY IMAGE RECEPTOR coordinate system with respect to IEC GANTRY coordinate system (degrees). See Section C.8.8.14.3.
>>RT Image Orientation	(3002,0010)	3	The direction cosines of the first row and the first column with respect to the IEC X-RAY IMAGE RECEPTOR coordinate system.
>>RT Image Position	(3002,0012)	3	The x and y coordinates (in mm) of the upper left hand corner of the image, in the IEC X-RAY IMAGE RECEPTOR coordinate system. This is the center of the first pixel transmitted.
>>RT Image SID	(3002,0026)	3	Radiation machine source to image plane distance (mm).
>>Imaging Device-Specific Acquisition Parameters	(300A,00CC)	3	User-specified device-specific parameters that describe how the imager will acquire the image.
>>Referenced Reference Image Number	(300C,0007)	3	Uniquely identifies Reference Image to which planned verification image is related, specified by Reference Image Number (300A,00C8) within Referenced Reference Image Sequence (300C,0042).

Attribute Name	Tag	Type	Attribute Description
>Treatment Delivery Type	(300A,00CE)	3	Delivery Type of treatment. Defined Terms: **TREATMENT** normal patient treatment **OPEN_PORTFILM** portal image acquisition with open field **TRMT_PORTFILM** portal image acquisition with treatment port **CONTINUATION** continuation of interrupted treatment **SETUP** no treatment beam is applied for this RT Beam. To be used for specifying the gantry, couch, and other machine positions where X-Ray set-up images or measurements are to be taken
>Referenced Dose Sequence	(300C,0080)	3	Related Instances of RT Dose (for grids, isodose curves, and named/unnamed point doses). One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current Beam.
>Wedge Sequence	(300A,00D1)	1C	Sequence of treatment wedges. Required if Number of Wedges (300A,00D0) is non-zero. One or more Items shall be included in this Sequence.
>>Wedge Number	(300A,00D2)	1	Identification number of the Wedge. The value of Wedge Number (300A,00D2) shall be unique within the Beam in which it is created.
>>Wedge Type	(300A,00D3)	2	Type of wedge (if any) defined for Beam. Defined Terms: **STANDARD** standard (static) wedge **DYNAMIC** moving beam limiting device (collimator) jaw simulating wedge **MOTORIZED** single wedge that can be removed from beam remotely
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for Wedge.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Wedge Angle	(300A,00D5)	2	Nominal wedge angle (degrees).
>>Wedge Factor	(300A,00D6)	2	Nominal wedge factor under machine calibration conditions at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).
>>Wedge Orientation	(300A,00D8)	2	Orientation of wedge, i.e., orientation of IEC WEDGE FILTER coordinate system with respect to IEC BEAM LIMITING DEVICE coordinate system (degrees).
>>Source to Wedge Tray Distance	(300A,00DA)	3	Radiation source to wedge tray attachment edge distance (in mm) for current wedge.
>>Effective Wedge Angle	(300A,00DE)	3	Effective wedge angle (degrees). See Section C.8.8.14.14.
>Number of Compensators	(300A,00E0)	1	Number of compensators associated with current Beam.
>Total Compensator Tray Factor	(300A,00E2)	3	Compensator Tray transmission factor (between 0 and 1), at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).

Attribute Name	Tag	Type	Attribute Description
>Compensator Sequence	(300A,00E3)	1C	Sequence of treatment compensators. One or more Items shall be included in this Sequence. Required if Number of Compensators (300A,00E0) is non-zero.
>>Compensator Description	(300A,02EB)	3	User defined description for the compensator.
>>Compensator Number	(300A,00E4)	1C	Identification number of the Compensator. The value of Compensator Number (300A,00E4) shall be unique within the Beam in which it is created. Required if Number of Compensators (300A,00E0) is non-zero.
>>Compensator Type	(300A,00EE)	3	Type of compensator (if any). Defined Terms: **STANDARD** physical (static) compensator **DYNAMIC** moving Beam Limiting Device (collimator) simulating physical compensator
>>Material ID	(300A,00E1)	2C	User-supplied identifier for material used to manufacture Compensator. Required if Number of Compensators (300A,00E0) is non-zero.
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for compensator.
>>Accessory Code	(300A,00F9)	3	An identifier for the Compensator intended to be read by a device such as a bar-code reader.
>>Compensator Tray ID	(300A,00EF)	3	User-supplied identifier for compensator tray.
>>Tray Accessory Code	(300A,0355)	3	An identifier for the Tray intended to be read by a device such as a bar-code reader.
>>Source to Compensator Tray Distance	(300A,00E6)	2	Radiation source to compensator tray attachment edge distance (in mm) for current compensator.
>>Compensator Divergence	(300A,02E0)	3	Indicates presence or absence of geometrical divergence of the compensator. Enumerated Values: **PRESENT** the compensator is shaped according to the beam geometrical divergence. **ABSENT** the compensator is not shaped according to the beam geometrical divergence.
>>Compensator Mounting Position	(300A,02E1)	3	Indicates on which side of the Compensator Tray the compensator is mounted. Enumerated Values: **PATIENT_SIDE** the compensator is mounted on the side of the Compensator Tray that is towards the patient. **SOURCE_SIDE** the compensator is mounted on the side of the Compensator Tray that is towards the radiation source. **DOUBLE_SIDED** the compensator has a shaped (i.e., non-flat) surface on both sides of the Compensator Tray.
>>Compensator Rows	(300A,00E7)	1	Number of rows in the compensator. A row is defined to be in the X direction of the IEC Beam Limiting Device Coordinate system.
>>Compensator Columns	(300A,00E8)	1	Number of columns in the compensator. A column is defined to be in the Y direction of the IEC Beam Limiting Device Coordinate system.

Attribute Name	Tag	Type	Attribute Description
>>Compensator Pixel Spacing	(300A,00E9)	1	Physical distance (in mm) between the center of each pixel projected onto machine isocentric plane. Specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing. See Section 10.7.1.3 for further explanation of the value order.
>>Compensator Position	(300A,00EA)	1	The x and y coordinates of the upper left hand corner (first pixel transmitted) of the compensator, projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm).
>>Compensator Transmission Data	(300A,00EB)	1C	A data stream of the pixel samples that comprise the compensator, expressed as broad-beam transmission values (between 0 and 1) along a ray line passing through the pixel, at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). The order of pixels encoded is left to right, top to bottom, i.e., the upper left pixel is encoded first followed by the remainder of the first row, followed by the first pixel of the 2nd row, then the remainder of the 2nd row and so on) when viewed from the radiation source. Required if Material ID (300A,00E1) is zero-length. May be present if Material ID (300A,00E1) is non-zero length. See Section C.8.8.14.10 and Section C.8.8.14.11. Note Compensator Transmission Data may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
>>Compensator Thickness Data	(300A,00EC)	1C	A data stream of the pixel samples that comprise the compensator, expressed as thicknesses (in mm). The order of pixels encoded is left to right, top to bottom, i.e., the upper left pixel is encoded first followed by the remainder of the first row, followed by the first pixel of the 2nd row, then the remainder of the 2nd row and so on) when viewed from the radiation source. Required if Material ID (300A,00E1) is non-zero length. May be present if Material ID (300A,00E1) is zero length. See Section C.8.8.14.9 and Section C.8.8.14.10 and Section C.8.8.14.11, “Block and Compensator Precedence for Dosimetric Calculations”. Note Compensator Thickness Data may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
>>Source to Compensator Distance	(300A,02E2)	1C	A data stream of the pixel samples that comprise the distance from the radiation source to the compensator surface closest to the radiation source (in mm). The order of pixels encoded is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the columns). Required if Material ID (300A,00E1) is non-zero length, and Compensator Mounting Position (300A,02E1) is DOUBLE_SIDED. May be present if Material ID (300A,00E1) is zero length and Compensator Mounting Position (300A,02E1) is DOUBLE_SIDED. See Section C.8.8.14.9 and Section C.8.8.14.11.
>Number of Boli	(300A,00ED)	1	Number of boli associated with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	1C	Sequence of boli associated with Beam. Required if Number of Boli (300A,00ED) is non-zero. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module.
>>Bolus ID	(300A,00DC)	3	User-supplied identifier for the Bolus.
>>Bolus Description	(300A,00DD)	3	User-defined description for the Bolus.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Total Block Tray Factor	(300A,00F2)	3	Total block tray transmission for all block trays (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111).
>Block Sequence	(300A,00F4)	1C	Sequence of blocks associated with Beam. One or more Items shall be included in this Sequence. Required if Number of Blocks (300A,00F0) is non-zero.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Tray Accessory Code	(300A,0355)	3	An identifier for the Tray intended to be read by a device such as a bar-code reader.
>>Accessory Code	(300A,00F9)	3	An identifier for the Block intended to be read by a device such as a bar-code reader.
>>Source to Block Tray Distance	(300A,00F6)	2	Radiation Source to attachment edge of block tray assembly (mm).
>>Block Type	(300A,00F8)	1	Type of block. Enumerated Values: **SHIELDING** blocking material is inside contour **APERTURE** blocking material is outside contour
>>Block Divergence	(300A,00FA)	2	Indicates presence or otherwise of geometrical divergence. Enumerated Values: **PRESENT** block edges are shaped for beam divergence **ABSENT** block edges are not shaped for beam divergence
>>Block Mounting Position	(300A,00FB)	3	Indicates on which side of the Block Tray the block is mounted. Enumerated Values: **PATIENT_SIDE** the block is mounted on the side of the Block Tray that is towards the patient. **SOURCE_SIDE** the block is mounted on the side of the Block Tray that is towards the radiation source.
>>Block Number	(300A,00FC)	1	Identification number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created.
>>Block Name	(300A,00FE)	3	User-defined name for block.
>>Material ID	(300A,00E1)	2	User-supplied identifier for material used to manufacture Block.
>>Block Thickness	(300A,0100)	2C	Physical thickness of block (in mm) parallel to radiation beam axis. Required if Material ID (300A,00E1) is non-zero length. May be present if Material ID (300A,00E1) is zero length. See Section C.8.8.14.4 and Section C.8.8.14.11.

Attribute Name	Tag	Type	Attribute Description
>>Block Transmission	(300A,0102)	2C	Transmission through the block (between 0 and 1) at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Control Point Sequence (300A,0111). Required if Material ID (300A,00E1) is zero length. May be present if Material ID (300A,00E1) is non-zero length. See Section C.8.8.14.4 and Section C.8.8.14.11.
>>Block Number of Points	(300A,0104)	2	Number of (x,y) pairs defining the block edge.
>>Block Data	(300A,0106)	2	A data stream of (x,y) pairs that comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). See Note 4.
>Applicator Sequence	(300A,0107)	3	Sequence of Applicators associated with Beam. Only a single Item is permitted in this Sequence.
>>Applicator ID	(300A,0108)	1	User or machine supplied identifier for Applicator.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Applicator Type	(300A,0109)	1	Type of Applicator. Defined Terms: **ELECTRON_SQUARE** square electron applicator **ELECTRON_RECT** rectangular electron applicator **ELECTRON_CIRC** circular electron applicator **ELECTRON_SHORT** short electron applicator **ELECTRON_OPEN** open (dummy) electron applicator **PHOTON_SQUARE** square photon applicator **PHOTON_RECT** rectangular photon applicator **PHOTON_CIRC** circular photon applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator (deprecated)
>>Applicator Geometry Sequence	(300A,0431)	3	Describes the applicator aperture geometry. Only a single Item is permitted in this Sequence.
>>>Applicator Aperture Shape	(300A,0432)	1	Aperture shape of the applicator. Defined Terms: **SYM_SQUARE** A square-shaped aperture symmetrical to the central axis. **SYM_RECTANGLE** A rectangular-shaped aperture symmetrical to the central axis. **SYM_CIRCULAR** A circular-shaped aperture symmetrical to the central axis.
>>>Applicator Opening	(300A,0433)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system. In case of square-shaped applicator contains the length of the sides of the square. In case of circular-shaped applicators, contains the diameter of the circular aperture. Required if Applicator Aperture Shape (300A,0432) is SYM_SQUARE or SYM_CIRCULAR.
>>>Applicator Opening X	(300A,0434)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in X-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.

Attribute Name	Tag	Type	Attribute Description
>>>Applicator Opening Y	(300A,0435)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in Y-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.
>> Source to Applicator Mounting Position Distance	(300A,0436)	3	Radiation source to applicator mounting position distance (in mm) for current applicator.
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>General Accessory Sequence	(300A,0420)	3	A Sequence of General Accessories associated with this Beam. One or more Items are permitted in this Sequence.
>>General Accessory Number	(300A,0424)	1	Identification Number of the General Accessory. The value shall be unique within the Sequence.
>>General Accessory ID	(300A,0421)	1	User or machine supplied identifier for General Accessory.
>>General Accessory Description	(300A,0422)	3	User supplied description of General Accessory.
>>General Accessory Type	(300A,0423)	3	Specifies the type of accessory. Defined Terms: **GRATICULE** Accessory tray with a radio-opaque grid **IMAGE_DETECTOR** Image acquisition device positioned in the beam line **RETICLE** Accessory tray with radio-transparent markers or grid
>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory
>>Source to General Accessory Distance	(300A,0425)	3	Radiation source to general accessory distance (in mm) for current accessory.
>Referenced Dose Reference Sequence	(300C,0050)	3	A Sequence of Dose References for which verification control points are defined. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module.
>>Depth Value Averaging Flag	(300A,0093)	1C	Whether or not the depth values have been averaged. Enumerated Values: **YES** The values represent average values from the current Verification Control Point to the next **NO** The values refer to a single location Required if the referenced beam describes an angular movement and the depth values change during movement.
>>Beam Dose Verification Control Point Sequence	(300A,008C)	1	Sequence of Items containing Beam Dose Coordinate Verification Control Points. Two or more Items shall be included in this Sequence.
>>>Cumulative Meterset Weight	(300A,0134)	1	The cumulative Meterset weight value, at which the beam dose point geometrical parameters apply.

Attribute Name	Tag	Type	Attribute Description
>>>Referenced Control Point Index	(300C,00F0)	1C	Uniquely identifies the Control Point specified by Control Point Index (300A,0112) within Beam referenced by Referenced Beam Number (300C,0006). See Section C.8.8.14.16. Required, if the Referenced Cumulative Meterset corresponds to a Control Point in the Control Point Sequence (300A,0111).
>>>Beam Dose Point Depth	(300A,0088)	1C	The depth (in mm) in the patient along a ray from the source to the dose point specified by the Dose Reference Point Coordinates (300A,0018) or the referenced ROI. Required for all but the last Item in this Sequence and for the last Item if Depth Value Averaging Flag (300A,0093) has a value of NO. See Note 6.
>>>Beam Dose Point Equivalent Depth	(300A,0089)	1C	The radiological depth in mm (water-equivalent depth, taking tissue heterogeneity into account) in the patient along a ray from the source to the dose point specified by the Dose Reference Point Coordinates (300A,0018) or the referenced ROI. Required for all but the last Item in this Sequence and for the last Item if Depth Value Averaging Flag (300A,0093) has a value of NO. See Note 6.
>>>Beam Dose Point SSD	(300A,008A)	1C	Source to patient surface (skin) distance in mm along a ray from the source to the dose point specified by the Dose Reference Point Coordinates (300A,0018) or the referenced ROI. Required for all but the last Item in this Sequence and for the last Item if Depth Value Averaging Flag (300A,0093) has a value of NO. See Note 6.
>>>Beam Dose Point Source to External Contour Distance	(300A,0094)	3	Source to External Contour distance in mm including devices associated with the patient anatomy model along a ray from the source to the dose point specified by the Dose Reference Point Coordinates (300A,0018) or the referenced ROI. May be present for all but the last Item in this Sequence and for the last Item if Depth Value Averaging Flag (300A,0093) has a value of NO. See Section C.8.8.14.15.
>Final Cumulative Meterset Weight	(300A,010E)	1C	Value of Cumulative Meterset Weight (300A,0134) for final Control Point in Control Point Sequence (300A,0111). Required if Cumulative Meterset Weight is non-null in Control Points specified within Control Point Sequence (300A,0111). See Section C.8.8.14.1.
>Number of Control Points	(300A,0110)	1	Number of control points in Beam. Value shall be greater than or equal to 2.
>Control Point Sequence	(300A,0111)	1	Sequence of machine configurations describing treatment beam. The number of Items in this Sequence shall equal the value of Number of Control Points (300A,0110). See Section C.8.8.14.5 and Section C.8.8.14.6.
>>Control Point Index	(300A,0112)	1	Index of current Control Point, starting at 0 for first Control Point.

Attribute Name	Tag	Type	Attribute Description
>>Cumulative Meterset Weight	(300A,0134)	2	Cumulative weight to current control point. Cumulative Meterset Weight for the first Item in Control Point Sequence shall always be zero. Cumulative Meterset Weight for the final Item in Control Point Sequence shall always be equal to Final Cumulative Meterset Weight. See Section C.8.8.14.1.
>>Referenced Dose Reference Sequence	(300C,0050)	3	A Sequence of Dose References for current Beam. One or more Items are permitted in this Sequence.
>>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module.
>>>Cumulative Dose Reference Coefficient	(300A,010C)	2	Coefficient used to calculate cumulative dose contribution from this Beam to the referenced Dose Reference at the current Control Point. See Section C.8.8.14.7.
>>Referenced Dose Sequence	(300C,0080)	1C	Sequence describing related Instances of RT Dose (for grids, isodose curves, and named/unnamed point doses). One or more Items shall be included in this Sequence. Required if RT Dose is being transmitted, and Dose Summation Type (3004,000A) equals CONTROL_POINT.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Nominal Beam Energy	(300A,0114)	3	Nominal Beam Energy at control point (MV/MeV).
>>Dose Rate Set	(300A,0115)	3	Dose Rate to be set on treatment machine for segment beginning at current control point (e.g., MU/min).
>>Wedge Position Sequence	(300A,0116)	1C	A Sequence of Items describing Wedge Positions for the current control point. Required for first Item of Control Point Sequence if Number of Wedges (300A,00D0) is non-zero, and in subsequent control points if Wedge Position (300A,0118) changes during Beam. See Section C.8.8.14.5. The number of Items in this Sequence shall equal the value of Number of Wedges (300A,00D0).
>>>Referenced Wedge Number	(300C,00C0)	1	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1).
>>>Wedge Position	(300A,0118)	1	Position of Wedge at current Control Point. Enumerated Values: **IN** **OUT**
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	Sequence of beam limiting device (collimator) jaw or leaf (element) positions. One or more Items shall be included in this Sequence. Required for first Item of Control Point Sequence, or if Beam Limiting Device changes during Beam.

Attribute Name	Tag	Type	Attribute Description
>>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). The value of this Attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an Item of Beam Limiting Device Sequence (300A,00B6). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>>Leaf/Jaw Positions	(300A,011C)	1	Positions of beam limiting device (collimator) leaf (element) or jaw pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) in Beam Limiting Device Sequence (300A,00B6). Values shall be listed in IEC leaf (element) subscript order 101, 102, … 1N, 201, 202, … 2N. See Note 3.
>>Gantry Angle	(300A,011E)	1C	Gantry angle of radiation source, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first Item of Control Point Sequence, or if Gantry Angle changes during Beam. See Section C.8.8.14.13.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. Required for first Item of Control Point Sequence, or if Gantry Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Gantry Pitch Angle	(300A,014A)	3	Gantry Pitch Angle. i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). If used, must be present for first Item of Control Point Sequence, or if used and Gantry Pitch Rotation Angle changes during Beam, must be present. See Section C.8.8.25.6.5. See Section C.8.8.14.13.
>>Gantry Pitch Rotation Direction	(300A,014C)	3	Direction of Gantry Pitch Angle when viewing along the positive X-axis of the IEC GANTRY coordinate system, for segment following Control Point. If used, must be present for first Item of Control Point Sequence, or if used and Gantry Pitch Rotation Direction changes during Beam, must be present. See Section C.8.8.14.8 and Section C.8.8.25.6.5. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation

Attribute Name	Tag	Type	Attribute Description
>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for first Item of Control Point Sequence, or if Beam Limiting Device Angle changes during Beam. See Section C.8.8.14.13.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. Required for first Item of Control Point Sequence, or if Beam Limiting Device Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first Item of Control Point Sequence, or if Patient Support Angle changes during Beam. See Section C.8.8.14.13.
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. Required for first Item of Control Point Sequence, or if Patient Support Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
>>Table Top Eccentric Angle	(300A,0125)	1C	Table Top (non-isocentric) angle, i.e., orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT coordinate system (degrees). Required for first Item of Control Point Sequence, or if Table Top Eccentric Angle changes during Beam. See Section C.8.8.14.13.
>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	Direction of Table Top Eccentric Rotation when viewing table from above, for segment following Control Point. Required for first Item of Control Point Sequence, or if Table Top Eccentric Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation

Attribute Name	Tag	Type	Attribute Description
>>Table Top Pitch Angle	(300A,0140)	1C	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Pitch Angle changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.12 and Section C.8.8.14.13.
>>Table Top Pitch Rotation Direction	(300A,0142)	1C	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Pitch Rotation Direction changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.8 and Section C.8.8.14.12. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	1C	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the IEC Y-axis of the IEC TABLE TOP coordinate system (degrees). If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Roll Angle changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.12 and Section C.8.8.14.13.
>>Table Top Roll Rotation Direction	(300A,0146)	1C	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Roll Rotation Direction changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.8 and Section C.8.8.14.12. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Vertical Position changes during Beam. See Section C.8.8.14.6.
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Longitudinal Position changes during Beam. See Section C.8.8.14.6.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Lateral Position changes during Beam. See Section C.8.8.14.6.
>>Isocenter Position	(300A,012C)	2C	Isocenter coordinates (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). Required for first Item of Segment Control Point Sequence, or if Segment Isocenter Position changes during Beam.
>>Surface Entry Point	(300A,012E)	3	Patient surface entry point coordinates (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm).

Attribute Name	Tag	Type	Attribute Description
>>External Contour Entry Point	(300A,0133)	3	External Contour entry point coordinates (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). See Section C.8.8.14.15.
>>Source to Surface Distance	(300A,0130)	3	Source to Patient Surface (skin) distance (mm).
>>Source to External Contour Distance	(300A,0132)	3	Source to External Contour distance (mm) including devices associated with the patient anatomy model. For dosimetric purposes this value may differ from the Source to Surface Distance (300A,0130). See Section C.8.8.14.15.

Note

1. Beam Number (300A,00C0) is provided to link related information across Modules, and its value should not be required to have any real-world interpretation. Beam Name (300A,00C2), a Type 3 Attribute, is intended to store the primary beam identifier (often referred to as "field identifier"). Beam Description (300A,00C3), a Type 3 Attribute, is intended to store additional beam identifying information (often referred to as "field name"). Equipment supporting both these Attributes should state this clearly in the Conformance Statement.

2. The DICOM Standard does not support the transmission of treatment unit modeling information such as depth doses and beam profiles.

3. Implementers should take note that Leaf Position Boundaries (300A,00BE) are the positions of the mechanical boundaries (projected to the isocentric plane) between beam limiting device (collimator) leaves, fixed for a given beam limiting device (collimator). Leaf/Jaw Positions (300A,011C) are values specific to a given beam control point, specifying the beam limiting device (collimator) leaf (element) openings.

4. Block coordinates may not be transmitted when such data is not available from the transmitting system. However, the receiving system may not have internal mechanisms to use or store such data. For example, a plan transmitted from an treatment planning system to a Record and Verify (R&V) system will contain the block data for blocked beams. Subsequent transfer of beam data from the R&V system may omit this data since the R&V system may not have stored it.

5. Refer to Section C.8.8.14.5 for examples of STATIC and DYNAMIC Beam Type. Note that beams having Wedge Type = DYNAMIC as the only moving parameter are not considered DYNAMIC according to the definition of Beam Type (300A,00C4).

6. Attributes Beam Dose Point Depth (300A,0088), Beam Dose Point Equivalent Depth (300A,0089), Beam Dose Point SSD (300A,008A) were previously included in this Module on the level of Beam Sequence (300A,00B0) > Control Points Beam Sequence (300A,0111) > Referenced Dose Reference Sequence (300C,0050). These Attributes have been retired at this location. See PS3.3-2011.

C.8.8.14.1 Meterset Calculations

The Meterset at a given Control Point is equal to Beam Meterset (300A,0086) specified in the Referenced Beam Sequence (300C,0004) of the RT Fraction Scheme Module, multiplied by the Cumulative Meterset Weight (300A,0134) for the Control Point, divided by the Final Cumulative Meterset Weight (300A,010E). The Meterset is specified in units defined by Primary Dosimeter Unit (300A,00B3). If the calculation for Meterset results in a Meterset value that is not an exact multiple of the primary Meterset resolution, then the result shall be rounded to the nearest allowed Meterset value (i.e., less than a half resolution unit shall be rounded down to the nearest resolution unit, and equal or greater than half a resolution unit shall be rounded up to the nearest resolution unit).

Note also that if Final Cumulative Meterset Weight (300A,010E) is equal to 100, then Cumulative Meterset Weight (300A,0134) becomes equivalent to the percentage of Beam Meterset (300A,0086) delivered at each control point. If Final Cumulative Meterset Weight (300A,010E) is equal to Beam Meterset (300A,0086), then the Cumulative Meterset Weight (300A,0134) at each control point becomes equal to the cumulative Meterset delivered at that control point.

C.8.8.14.2 Planned Verification Image Sequence

The Planned Verification Image Sequence (300A,00CA) contains Attributes that describe the planned verification images to be acquired during current beam. The Start Cumulative Meterset Weight (300C,0008) specifies the Cumulative Meterset Weight at which image acquisition is to begin. If Meterset Exposure (3002,0032) is present in a Sequence Item and End Cumulative Meterset Weight (300C,0009) is not present then a single image shall be acquired using the Meterset duration specified in Meterset Exposure (3002,0032). If End Cumulative Meterset Weight (300C,0009) is present in a Sequence Item and Meterset Exposure (3002,0032) is not present then a single image shall be acquired over the beam delivery from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). If both Meterset Exposure (3002,0032) and End Cumulative Meterset Weight (300C,0009) are present in a Sequence Item then images shall be acquired every Meterset Exposure (3002,0032) from Start Cumulative Meterset Weight (300C,0008) to End Cumulative Meterset Weight (300C,0009). No images shall extend past End Cumulative Meterset Weight (300C,0009).

C.8.8.14.3 X-Ray Image Receptor Angle

The X-Ray Image Receptor Angle (3002,000E) specifies the rotation of the image receptor device in the IEC X-RAY IMAGE RECEPTOR PLANE. A positive angle corresponds to a counter-clockwise rotation of the X-Ray Image Receptor as viewed from the radiation source in the IEC GANTRY coordinate system. The normal (non-rotated) value for this parameter is zero degrees.

C.8.8.14.4 Multiple Aperture Blocks

All blocks with Block Type (300A,00F8) of APERTURE for a given beam shall have equal values of Block Transmission (300A,0102) and/or Block Thickness (300A,0100) if they are specified. The composite aperture shall be evaluated as the union of the individual apertures within a single Block. Shielding block transmission(s) shall be applied multiplicatively after the (composite) aperture has been evaluated.

C.8.8.14.5 Control Point Sequence

The RT Beams Module uses a single beam model to handle static, arc, and dynamic delivery of external beam radiation by a medical accelerator or gamma beam therapy equipment (cobalt unit). All applicable parameters shall be specified at Control Point 0, with the exception of couch positions (see Section C.8.8.14.6). All parameters that change at any control point of a given beam shall be specified explicitly at all control points (including those preceding the change). No assumptions are made about the behavior of machine parameters between specified control points, and communicating devices shall agree on this behavior outside the current Standard.

The Cumulative Meterset Weight (300A,0134) values in a Control Point Sequence (300A,0111) shall be monotonically increasing in the order of increasing Control Point Index (300A,0112).

Gantry Rotation Direction (300A,011F), Beam Limiting Device Rotation Direction (300A,0121), Patient Support Rotation Direction (300A,0123), and Table Top Eccentric Rotation Direction (300A,0126) are defined as applying to the segment following the control point, and changes to these parameters during treatment may be specified without use of a "non-irradiation" segment. All other Control Point Sequence Attributes are defined only at the control point. To unambiguously encode changes in discrete-valued Attributes such as Wedge Position (300A,0118) and Nominal Beam Energy (300A,0114), a non-irradiation segment where Cumulative Meterset Weight (300A,0134) does not change, shall be used.

Some examples of beam specification using control points are as follows:

a) Static delivery:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: Cumulative Meterset Weight = 1, no other parameters defined

b) Arc delivery:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0, Gantry Rotation Direction = *rotation direction*, Gantry Angle = *initial angle*

Control Point 1: Cumulative Meterset Weight = 1, Gantry Rotation Direction = NONE, Gantry Angle = *final angle*

c) Dynamic delivery of two equally weighted segments:

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight = 0

Control Point 1: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 0.5

Control Point 2: All changing treatment parameters defined (including those which do not change at this control point), Cumulative Meterset Weight = 1

d) Dynamic Delivery of two unequally weighted segments with a step change in table angle:

Control Point 0: All applicable treatment parameters defined, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = NONE, Cumulative Meterset Weight = 0

Control Point 1: All changing parameters defined (including those that do not change at this control point), Cumulative Meterset Weight = 0.3, Patient Support Angle = *initial angle*, Patient Support Rotation Direction = *rotation direction*

Control Point 2: All changing parameters defined (although none should change at this control point), Cumulative Meterset Weight = 0.3, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE

Control Point 3: All changing parameters defined (including those that do not change at this control point), Cumulative Meterset Weight = 1, Patient Support Angle = *new angle*, Patient Support Rotation Direction = NONE

C.8.8.14.6 Absolute and Relative Machine Coordinates

All treatment machine parameters except couch translations are specified in absolute machine coordinates as defined by IEC 61217. For the Table Top Vertical Position (300A,0128), Table Top Longitudinal Position (300A,0129), and Table Top Lateral Position (300A,012A), if the first Control Point contains a value of non-zero length, all subsequent Control Point position values are absolute values in their respective coordinate system. If the first Control Point contains a zero-length value, all subsequent Control Point position values are specified relative to the (unknown) initial value.

C.8.8.14.7 Cumulative Dose Reference Coefficient

The Cumulative Dose Reference Coefficient (300A,010C) is the value by which Beam Dose (300A,0084) is multiplied to obtain the dose to the referenced dose reference site at the current control point (and after previous control points have been successfully administered). The Cumulative Dose Reference Coefficient (300A,010C) is by definition zero for the initial control point. The Cumulative Dose Reference Coefficient (300A,010C) of the final control point multiplied by Beam Dose (300A,0084) results in the final dose to the referenced dose reference site for the current beam. Dose calculation for dose reference sites other than points is not well defined.

C.8.8.14.8 Machine Rotations

For the machine rotation angles Gantry Angle (300A,011E), Beam Limiting Device Angle (300A,0120), Patient Support Angle (300A,0122), and Table Top Eccentric Angle (300A,0125), rotation direction is specified as clockwise (CW), counter-clockwise (CC), or NONE. The maximum permitted rotation between two Control Points is 360 degrees. Examples:

a. Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = NONE:

   No movement.

b. Gantry Angle moves from 5 degrees to 5 degrees, Gantry Rotation Direction = CW:

   Full clockwise rotation (360 degrees).

c. Table Angle moves from 170 degrees to 160 degrees, Table Rotation Direction = CC:

   Counter-clockwise rotation by 350 degrees (note direction of increasing table angle as defined by IEC 61217).

C.8.8.14.9 Compensator Thickness Data and Source to Compensator Distance

The values stored in Compensator Thickness Data (300A,00EC) and Source to Compensator Distance (300A,02E2) shall be parallel to the radiation beam axis if Compensator Divergence (300A,02E0) equals ABSENT, or divergent according to the beam geometrical divergence if Compensator Divergence (300A,02E0) equals PRESENT. If Compensator Divergence (300A,02E0) is not present, then the parallel or divergent nature of the thicknesses is as if ABSENT was specified for Compensator Divergence (300A,02E0).

C.8.8.14.10 Compensator Transmission and Thickness Data Direction

The direction of the rows and columns in Compensator Transmission Data (300A,00EB) and Compensator Thickness Data (300A,00EC) is defined as follows: The direction of rows goes along the positive Xb direction and the direction of the columns does along the negative Yb direction of the IEC X-BEAM LIMITING DEVICE coordinate system. Other interpretations shall be documented in an implementation's conformance statement.

C.8.8.14.11 Block and Compensator Precedence for Dosimetric Calculations

If Block Thickness (300A,0100) and Block Transmission (300A,0102) are present, Block Transmission shall have precedence for dosimetric calculations. If Compensator Transmission Data (300A,00EB) and Compensator Thickness Data (300A,00EC) are present, Compensator Transmission Data shall have precedence for dosimetric calculations.

C.8.8.14.12 Table Top Pitch and Table Top Roll

Pitch and Roll Coordinate Systems of the Table Top are defined in IEC 61217 Edition 1.2 2008-04. These angles are defined as rotations of the IEC Table Top System as indicated below.

The Table Top Pitch Angle is defined as the rotation of the coordinate axes Yt, Zt about axis Xt by an angle ψt; See Figure C.8.8.14-1. An increase in the value of angle ψt corresponds to the clockwise rotation of the Table Top as viewed from the Table Top coordinate system origin along the positive Xt axis.

The Table Top Roll Angle is defined as the rotation of the coordinate axes Xt, Zt about axis Yt by an angle ψt; See Figure C.8.8.14-2. An increase in the value of angle ψt corresponds to the clockwise rotation of the Table Top as viewed from the Table Top coordinate system origin along the positive Yt axis.

It is important to observe that the point of rotation is the origin of the table top system after the rotation of the PATIENT SUPPORT(s) system about Zs by θs after the rotation of the Table top eccentric rotation (e) system about Ze by θe and after the translation of Table top (t) system along Xe Ye Ze. This means that the rotation point of the Pitch and Roll angles is typically not the isocenter. The translational values Xt Yt Zt may need to be adjusted to preserve the patient position at the isocenter. e.g., a rotation of the Pitch angle by a positive angle at a position originally at Xt=0, Yt=100 and Zt=0 will lead to a negative Zt value and a slightly lower Yt if the patient position at isocenter is to be maintained.

The Pitch Angle rotation is applied before the Roll Angle rotation.

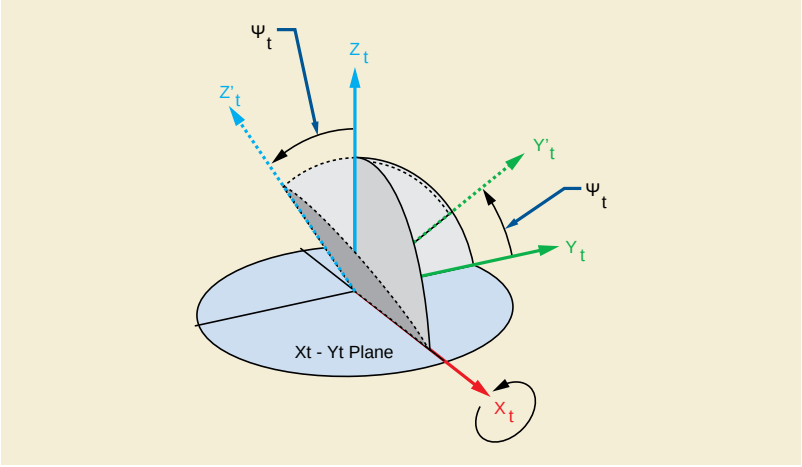


Figure C.8.8.14-1. Table Top Pitch Angle

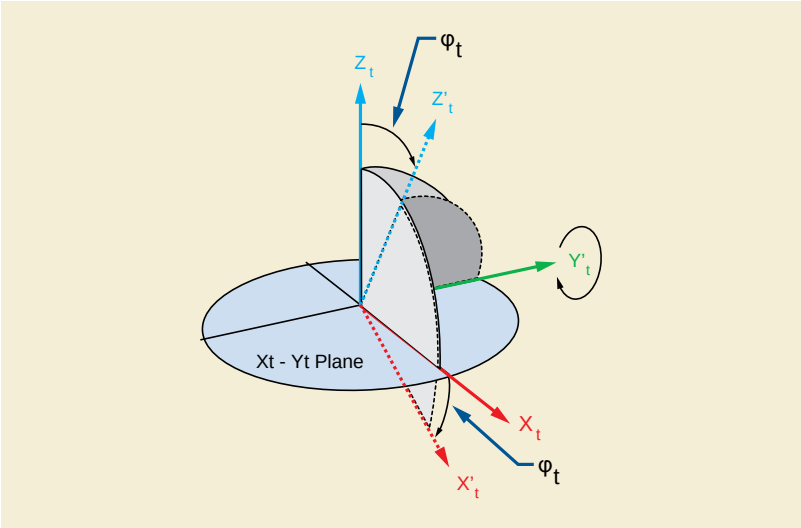


Figure C.8.8.14-2. Table Top Roll Angle

C.8.8.14.13 Angular Values in RT Beams Module

The Attributes that define angles refer to coordinate systems defined by IEC 61217. Where indicated in the DICOM Attribute definition, the angle uses the coordinate system (orientation of the rotation axis and the origin of the rotating coordinate system) defined in IEC 61217, however DICOM makes no restrictions on the range of values stored. IEC 61217 defines restrictions that only apply to user interface presentation.

C.8.8.14.14 Effective Wedge Angle

The Effective Wedge Angle (300A,00DE) and Radiation Beam Effective Wedge Angle (300A,0654) describe the dosimetric angle of a motorized wedge accounting for the partial presence of the wedge in the beam. The presence of the wedge in the beam is either specified by the Wedge Position (300A,0118) in the Wedge Position Sequence (300A,0116) included in the Control Point Sequence (300A,0111) of the current beam or the RT Control Point Sequence of the current Radiation. When the wedge is in the beam throughout all control points, the Effective Wedge Angle (300A,00DE) and Radiation Beam Effective Wedge Angle (300A,0654) will have the same value as the Wedge Angle (300A,00D5) or Radiation Beam Wedge Angle (300A,0652). Otherwise the Effective Wedge Angle (300A,00DE) or Radiation Beam Effective Wedge Angle (300A,0654) will have a lower value than the Wedge Angle (300A,00D5) or Radiation Beam Wedge Angle (300A,0652).

C.8.8.14.15 Source to External Contour Distance and External Contour Entry Point

The Source to External Contour Distance (300A,0132) is the distance to the beam entry point (External Contour Entry Point), which may include Bolus, Patient Positioning Devices, Patient Immobilization Devices or other devices. This value is useful for including the attenuation effects of external devices on the dose calculation and for patient setup.

C.8.8.14.16 Referenced Control Point

The number of Items in the Beam Dose Verification Control Point Sequence (300A,008C) is not required to be the same as in the Control Point Sequence (300A,0111). A different sampling can be chosen for the Beam Dose Verification Control Point Sequence, but where the Cumulative Meterset Weight of a Control Point Sequence (300A,008C) Item is the same it shall be referenced by the Referenced Control Point Index (300C,00F0).

C.8.8.15 RT Brachy Application Setups Module

The RT Brachy Application Setups Module describes the application of a brachytherapy radiotherapy treatment. It contains one or more sources, each associated with one or more Channels. A Channel is a device by which a source is placed in its intended treatment position or positions. A Channel may consist of a Source Applicator plus a Transfer Tube, a Source Applicator alone, a rigid or flexible linear source, or a seed. A number of Channels (for example applicators, sources or seeds) are generally arranged in an Application Setup, which may be considered a "logical" device. It is important not to confuse Application Setup with Applicator. The model used

here has been primarily built around the concept of remote afterloading, but extended to support other brachytherapy applications such as manual applicators and molds, seeds, and sources. Additional devices that are not Channels are described as Brachy Accessory Devices. Examples of Accessory Devices include shields that modify the dose distribution from all sources in the treatment. However, Channel shields modify the dose only for the source(s) in that Channel.

The data in the Module are arranged as follows:

Treatment Machine Sequence	*;treatment machine information (single Item)*
Source Sequence	*;library of sources used in brachy application*
Application Setup Sequence	*;one or more applicators, sources, seeds etc*
>Brachy Accessory Device Sequence	*;application level shields etc*
>Channel Sequence	*;applicator, line source(s), seed(s) etc*
>>Channel Shield Sequence	*;channel-specific shields*
>>Brachy Control Point Sequence	*;mechanism to support individual source dwell times*

Table C.8-51. RT Brachy Application Setups Module Attributes

Attribute Name	Tag	Type	Attribute Description
Brachy Treatment Technique	(300A,0200)	1	Type of brachytherapy treatment technique. Enumerated Values: **INTRALUMENARY** **INTRACAVITARY** **INTERSTITIAL** **CONTACT** **INTRAVASCULAR** **PERMANENT** See Section C.8.8.15.1.
Brachy Treatment Type	(300A,0202)	1	Type of brachytherapy treatment. Defined Terms: **MANUAL** manually positioned **HDR** High dose rate **MDR** Medium dose rate **LDR** Low dose rate **PDR** Pulsed dose rate
Treatment Machine Sequence	(300A,0206)	1	A Sequence describing treatment machine to be used for treatment delivery. Only a single Item shall be included in this Sequence.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for treatment delivery.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for treatment delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for treatment delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for treatment delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for treatment delivery.

Attribute Name	Tag	Type	Attribute Description
>Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7030 "Institutional Departments, Units and Services".*
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for treatment delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for treatment delivery.
Source Sequence	(300A,0210)	1	Sequence of Sources to be used within Application Setups. One or more Items shall be included in this Sequence.
>Source Number	(300A,0212)	1	Identification number of the Source. The value of Source Number (300A,0212) shall be unique within the RT Plan in which it is created.
>Source Serial Number	(3008,0105)	3	Identifier for the Source Instance. Identifies the actual source Instance of the source, to which Source Strength Reference Date (300A,022C) and Source Strength Reference Time (300A,022E) refer.
>Source Model ID	(300A,021B)	3	Identifier for the Source Model. Identifies the model, the source Instance belongs to.
>Source Description	(300A,021C)	3	Description of the source.
>Source Type	(300A,0214)	1	Type of Source. Defined Terms: **POINT** **LINE** **CYLINDER** **SPHERE**
>Source Manufacturer	(300A,0216)	3	Manufacturer of Source.
>Active Source Diameter	(300A,0218)	3	Diameter of active Source (mm).
>Active Source Length	(300A,021A)	3	Length of active Source (mm).
>Material ID	(300A,00E1)	3	User-supplied identifier for encapsulation material of active Source.
>Source Encapsulation Nominal Thickness	(300A,0222)	3	Nominal thickness of wall of encapsulation (mm). See Section C.8.8.15.12.
>Source Encapsulation Nominal Transmission	(300A,0224)	3	Nominal transmission through wall of encapsulation (between 0 and 1). See Section C.8.8.15.12
>Source Isotope Name	(300A,0226)	1	Name of Isotope.
>Source Isotope Half Life	(300A,0228)	1	Half-life of Isotope (days).
>Source Strength Units	(300A,0229)	1C	Measurement unit of Source Strength. Required if the source is not a gamma-emitting (photon) source. May be present otherwise. Enumerated Values: **AIR_KERMA_RATE** Air Kerma Rate if Source is Gamma emitting Isotope. **DOSE_RATE_WATER** Dose Rate in Water if Source is Beta emitting Isotope.

Attribute Name	Tag	Type	Attribute Description
>Reference Air Kerma Rate	(300A,022A)	1	Air Kerma Rate in air of Isotope specified at Source Strength Reference Date (300A,022C) and Source Strength Reference Time (300A,022E) (in μGy h^{-1} at 1 m). Value shall be zero for non-gamma sources.
>Source Strength	(300A,022B)	1C	Source Strength of Isotope at Source Strength Reference Date (300A,022C) and Source Strength Reference Time (300A,022E), in units specified in Source Strength Units (300A,0229). Required if the source is not a gamma-emitting (photon) source. See Section C.8.8.15.13.
>Source Strength Reference Date	(300A,022C)	1	Reference date for Reference Air Kerma Rate (300A,022A) or Source Strength (300A,022B) of Isotope.
>Source Strength Reference Time	(300A,022E)	1	Reference time for Air Kerma Rate (300A,022A) or Source Strength (300A,022B) of Isotope.
Application Setup Sequence	(300A,0230)	1	Sequence of Application Setups for current RT Plan. One or more Items shall be included in this Sequence.
>Application Setup Type	(300A,0232)	1	Type of Application Setup. Defined Terms: **FLETCHER_SUIT** **DELCLOS** **BLOEDORN** **JOSLIN_FLYNN** **CHANDIGARH** **MANCHESTER** **HENSCHKE** **NASOPHARYNGEAL** **OESOPHAGEAL** **ENDOBRONCHIAL** **SYED_NEBLETT** **ENDORECTAL** **PERINEAL**
>Application Setup Number	(300A,0234)	1	Identification number of the Application Setup. The value of Application Setup Number (300A,0234) shall be unique within the RT Plan in which it is created.
>Application Setup Name	(300A,0236)	3	User-defined name for Application Setup.
>Application Setup Manufacturer	(300A,0238)	3	Manufacturer of Application Setup.
>Template Number	(300A,0240)	3	Identification number of the Template. The value of Template Number (300A,0240) shall be unique within the Application Setup in which it is created.
>Template Type	(300A,0242)	3	User-defined type for Template Device.
>Template Name	(300A,0244)	3	User-defined name for Template Device.
>Referenced Reference Image Sequence	(300C,0042)	3	Sequence of reference images used for validation of current Application Setup. One or more Items are permitted in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Total Reference Air Kerma	(300A,0250)	1	Total Reference Air Kerma for current Application Setup, i.e., the product of Air Kerma Rate of all Sources in all Channels with their respective Channel Times (μGy at 1 m). Value shall be zero for non-gamma sources.
>Brachy Accessory Device Sequence	(300A,0260)	3	Sequence of Brachy Accessory Devices associated with current Application Setup. One or more Items are permitted in this Sequence.
>>Brachy Accessory Device Number	(300A,0262)	2	Identification number of the Brachy Accessory Device. The value of Brachy Accessory Device Number (300A,0262) shall be unique within the Application Setup in which it is created.
>>Brachy Accessory Device ID	(300A,0263)	2	User or machine supplied identifier for Brachy Accessory Device.
>>Brachy Accessory Device Type	(300A,0264)	1	Type of Brachy Accessory Device. Defined Terms: **SHIELD** **DILATATION** **MOLD** **PLAQUE** **FLAB**
>>Brachy Accessory Device Name	(300A,0266)	3	User-defined name for Brachy Accessory Device.
>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Brachy Accessory Device. See Note.
>>Brachy Accessory Device Nominal Thickness	(300A,026A)	3	Nominal thickness of Brachy Accessory Device (mm). See Section C.8.8.15.12.
>>Brachy Accessory Device Nominal Transmission	(300A,026C)	3	Nominal Transmission through Brachy Accessory Device (between 0 and 1). See Section C.8.8.15.12.
>>Referenced ROI Number	(3006,0084)	2	Uniquely identifies ROI representing the Brachy Accessory specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. See Section C.8.8.15.2.
>Channel Sequence	(300A,0280)	1	Sequence of Channels for current Application Setup. One or more Items shall be included in this Sequence.
>>Channel Number	(300A,0282)	1	Identification number of the Channel. The value of Channel Number (300A,0282) shall be unique within the Application Setup in which it is created.
>>Channel Length	(300A,0284)	2	Length of Channel (mm). See Section C.8.8.15.3.
>>Channel Total Time	(300A,0286)	1	Total amount of time between first and final Control Points of the Brachy Control Point Sequence (300A,02D0) for current Channel (sec). Channel Total Time calculation is based upon the Reference Air Kerma Rate (300A,022A) of the Referenced Source Number (300C,000E).
>>Source Movement Type	(300A,0288)	1	Type of Source movement. See Section C.8.8.15.4. Defined Terms: **STEPWISE** **FIXED** **OSCILLATING** **UNIDIRECTIONAL**

Attribute Name	Tag	Type	Attribute Description
>>Number of Pulses	(300A,028A)	1C	Number of Pulses per fraction for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR.
>>Pulse Repetition Interval	(300A,028C)	1C	Pulse repetition interval (sec) for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR.
>>Source Applicator Number	(300A,0290)	3	Identification number of the Source Applicator. The value of Source Applicator Number (300A,0290) shall be unique within the Channel in which it is created.
>>Source Applicator ID	(300A,0291)	2C	User or machine supplied identifier for Source Applicator. Required if Source Applicator Number (300A,0290) is present.
>>Source Applicator Type	(300A,0292)	1C	Type of Source Applicator. Required if Source Applicator Number (300A,0290) is present. Defined Terms: **FLEXIBLE** **RIGID**
>>Source Applicator Name	(300A,0294)	3	User-defined name for Source Applicator.
>>Source Applicator Length	(300A,0296)	1C	Length of Source Applicator (mm), defined as the distance between the connector of the applicator and the distal-most position of the source. Required if Source Applicator Number (300A,0290) is present.
>>Source Applicator Tip Length	(300A,0274)	2C	Length of Source Applicator Tip (in mm), defined as the distance between the outer tip of the applicator and the center of the distal-most possible position of the source. Required if Channel Effective Length (300A,0271) is present. See Section C.8.8.15.16.
>>Source Applicator Manufacturer	(300A,0298)	3	Manufacturer of Source Applicator.
>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Source Applicator wall. See Note.
>>Source Applicator Wall Nominal Thickness	(300A,029C)	3	Nominal Thickness of Source Applicator wall (mm). See Section C.8.8.15.12.
>>Source Applicator Wall Nominal Transmission	(300A,029E)	3	Nominal Transmission through Source Applicator wall (between 0 and 1). See Section C.8.8.15.12.
>>Source Applicator Step Size	(300A,02A0)	1C	Distance of path along channel (in mm) between adjacent (potential) dwell positions. Required if Source Movement Type (300A,0288) is STEPWISE.
>>Referenced ROI Number	(3006,0084)	2C	Uniquely identifies ROI representing the Source Applicator specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. Required if Source Applicator Number (300A,0290) is present. See Section C.8.8.15.2.
>>Transfer Tube Number	(300A,02A2)	2	Identification number of the Transfer Tube. The value of Transfer Tube Number (300A,02A2) shall be unique within the Channel in which it is created.
>>Transfer Tube Length	(300A,02A4)	2C	Length of Transfer Tube of current afterloading Channel (mm). Required if value Transfer Tube Number (300A,02A2) is non-null.

Attribute Name	Tag	Type	Attribute Description
>>Channel Effective Length	(300A,0271)	3	Length of Channel (in mm) defined as the distance between the connector on the afterloader and the center of the distal-most possible position of the source. See Section C.8.8.15.16.
>>Channel Inner Length	(300A,0272)	2C	The total physical inner length of channel (in mm). Specifies the distance between the connector on the afterloader and the end of the channel. Required if Channel Effective Length (300A,0271) is present. See Section C.8.8.15.16.1.
>>Afterloader Channel ID	(300A,0273)	3	Identification of the Channel connection on the afterloader. See Section C.8.8.15.16.2.
>>Channel Shield Sequence	(300A,02B0)	3	Sequence of Channel Shields associated with current Channel. One or more Items are permitted in this Sequence. See Section C.8.8.15.5.
>>>Channel Shield Number	(300A,02B2)	1	Identification number of the Channel Shield. The value of Channel Shield Number (300A,02B2) shall be unique within the Channel in which it is created.
>>>Channel Shield ID	(300A,02B3)	2	User or machine supplied identifier for Channel Shield.
>>>Channel Shield Name	(300A,02B4)	3	User-defined name for Channel Shield.
>>>Material ID	(300A,00E1)	3	User-supplied identifier for material of Channel Shield. See Note.
>>>Channel Shield Nominal Thickness	(300A,02B8)	3	Nominal Thickness of Channel Shield (mm). See Section C.8.8.15.12.
>>>Channel Shield Nominal Transmission	(300A,02BA)	3	Nominal Transmission of Channel Shield (between 0 and 1). See Section C.8.8.15.12.
>>>Referenced ROI Number	(3006,0084)	2	Uniquely identifies ROI representing the Channel Shield specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set referenced by Referenced RT Structure Set Sequence (300C,0060) in RT General Plan Module. See Section C.8.8.15.2.
>>Referenced Source Number	(300C,000E)	1	Uniquely identifies the referenced Source within Source Sequence (300A,0210) for current Application Setup.
>>Number of Control Points	(300A,0110)	1	Number of control points in Channel. For an N-segment Channel there will be 2N (stepwise movement) or N+1 (continuous movement) control points.
>>Final Cumulative Time Weight	(300A,02C8)	1C	Value of Cumulative Time Weight (300A,02D6) for final Control Point in Brachy Control Point Sequence (300A,02D0). Required if Cumulative Time Weight (300A,02D6) is non-null in Control Points specified within Brachy Control Point Sequence (300A,02D0). See Section C.8.8.15.6.
>>Brachy Control Point Sequence	(300A,02D0)	1	Sequence of machine configurations describing this Channel. The number of Items in this Sequence shall equal the value of Number of Control Points (300A,0110). See Section C.8.8.15.7.
>>>Control Point Index	(300A,0112)	1	Index of current Control Point, starting at 0 for first Control Point.

Attribute Name	Tag	Type	Attribute Description
>>>Cumulative Time Weight	(300A,02D6)	2	Cumulative time weight to current Control Point (where the weighting is proportional to time values delivered). Cumulative Time Weight for first Item in Brachy Control Point Sequence (300A,02D0) is always zero. See Section C.8.8.15.6 and Section C.8.8.15.8.
>>>Control Point Relative Position	(300A,02D2)	1	Distance between current Control Point Position and the center of the distal-most possible Source position in current Channel (mm). See Section C.8.8.15.9.
>>>Control Point 3D Position	(300A,02D4)	3	Coordinates (x, y, z) of Control Point in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). See Section C.8.8.15.10.
>>>Control Point Orientation	(300A,0412)	3	(x,y,z) component of the direction vector of the brachy source or seed at the Control Point 3D Position (300A,02D4). See Section C.8.8.15.14.
>>>Brachy Referenced Dose Reference Sequence	(300C,0055)	3	A Sequence of Dose References for current Channel. One or more Items are permitted in this Sequence.
>>>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference described in Dose Reference Sequence. (300A,0010) within RT Prescription Module of current RT Plan.
>>>>Cumulative Dose Reference Coefficient	(300A,010C)	1	Coefficient used to calculate cumulative dose contribution from this Source to the referenced Dose Reference at the current Control Point. See Section C.8.8.15.11.

Note

Material ID (300A,00E1) may also be specified within a referenced ROI, if an ROI is used to describe the object.

C.8.8.15.1 Permanent Implants

In permanent implant techniques the value for Channel Total Time (300A,0286) shall be mean life time of the isotope. The Brachy Control Point Sequence (300A,02D0) shall consist of two Items: the first having Cumulative Time Weight (300A,02D6) = 0 and the second having Cumulative Time Weight (300A,02D6) = Final Cumulative Time Weight (300A,02C8).

C.8.8.15.2 Referenced ROI Number

The Structure Set ROI shall be used in the RT Brachy Application Setups Module to describe the 3D coordinates of Accessory Devices, Applicators and Channel Shields, but not individual source positions (see Section C.8.8.15.9 and Section C.8.8.15.10).

C.8.8.15.3 Channel Length

If specified, Channel Length (300A,0284) shall be the sum of the Source Applicator Length (300A,0296) and Transfer Tube Length (300A,02A4).

C.8.8.15.4 Oscillating Source Movement

In brachytherapy treatment techniques involving oscillating source movement (i.e., when Source Movement Type (300A,0288) is OSCILLATING), the Brachy Control Point Sequence (300A,02D0) shall consist of two Items. The first Control Point shall have Cumulative Time Weight (300A,02D6) = 0, and Control Point Relative Position (300A,02D2) equal to one end point of the oscillation. The second Control Point shall have Cumulative Time Weight (300A,02D6) = Final Cumulative Time Weight (300A,02C8), and Control Point Relative Position (300A,02D2) equal to the other end point of the oscillation. Transit time shall not be modeled explicitly for oscillating techniques.

C.8.8.15.5 Channel Shields

The effect of Channel Shields on dose contributions shall be specific to the Channel for which they are specified. There shall be no effect of these shields on the dose contributions from any other Channels.

C.8.8.15.6 Time Calculations

The treatment time at a given Control Point is equal to the Channel Total Time (300A,0286), multiplied by the Cumulative Time Weight (300A,02D6) for the Control Point, divided by the Final Cumulative Time Weight (300A,02C8). If the calculation for treatment time results in a time value that is not an exact multiple of the timer resolution, then the result shall be rounded to the nearest allowed timer value (i.e., less than a half resolution unit shall be rounded down to the nearest resolution unit, and equal or greater than half a resolution unit shall be rounded up to the nearest resolution unit).

Note also that if Final Cumulative Time Weight (300A,02C8) is equal to 100, then Cumulative Time Weight (300A,02D6) becomes equivalent to the percentage of Channel Total Time (300A,0286) delivered at each control point. If Final Cumulative Time Weight (300A,02C8) is equal to Channel Total Time (300A,0286), then the Cumulative Time Weight (300A,02D6) at each control point becomes equal to the cumulative treatment time delivered at that control point.

If Treatment Type (300A,0202) is PDR, then the Channel Total Time (3008,0286) shall specify the duration of a single pulse.

C.8.8.15.7 Brachy Control Point Sequence

The Control Points shall be arranged such that the first Control Point for a particular Channel describes the first dwell position and the final Control Point for the Channel describes the final dwell position. If Brachy Treatment Type (300A,0202) is PDR, the Brachy Control Point Sequence (300A,02D0) shall specify the sequence of machine configurations for a single pulse. Similarly, if Source Movement Type (300A,0288) is OSCILLATING, the Brachy Control Point Sequence (300A,02D0) shall specify the sequence of machine configurations for a single period.

Some examples of Brachytherapy specification using control points are as follows:

a) Stepwise motion; Four equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 100:

Control Point 0: Control Point Relative Position = 30, Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 30, Cumulative Time Weight = 25

Control Point 2: Control Point Relative Position = 20, Cumulative Time Weight = 25

Control Point 3: Control Point Relative Position = 20, Cumulative Time Weight = 50

Control Point 4: Control Point Relative Position = 10, Cumulative Time Weight = 50

Control Point 5: Control Point Relative Position = 10, Cumulative Time Weight = 75

Control Point 6: Control Point Relative Position = 0, Cumulative Time Weight = 75

Control Point 7: Control Point Relative Position = 0, Cumulative Time Weight = 100

b) Fixed (manually placed) sources; Final Cumulative Time Weight = 100:

Control Point 0: Control Point Relative Position = 0, Control Point 3D Position = (x,y,z), Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 0, Control Point 3D Position = (x,y,z), Cumulative Time Weight = 100

c) Oscillating movement; Final Cumulative Time Weight = 100:

Control Point 0: Control Point Relative Position = 100, Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 0, Cumulative Time Weight = 100

d) Unidirectional movement; Final Cumulative Time Weight = 100:

Control Point 0: Control Point Relative Position = 0, Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 100, Cumulative Time Weight = 100

e) Stepwise motion with consideration of source transit times between dwell positions; Three equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 79:

Control Point 0: Control Point Relative Position = 30, Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 30, Cumulative Time Weight = 25

Control Point 2: Control Point Relative Position = 20, Cumulative Time Weight = 27

Control Point 3: Control Point Relative Position = 20, Cumulative Time Weight = 52

Control Point 4: Control Point Relative Position = 10, Cumulative Time Weight = 54

Control Point 5: Control Point Relative Position = 10, Cumulative Time Weight = 79

f) Stepwise motion with consideration of source transit times between dwell positions and to first and from last dwell position; Three equally weighted dwell positions; Step size = 10; Final Cumulative Time Weight = 383:

Control Point 0: Control Point Relative Position = 1200, Cumulative Time Weight = 0

Control Point 1: Control Point Relative Position = 30, Cumulative Time Weight = 150

Control Point 2: Control Point Relative Position = 30, Cumulative Time Weight = 175

Control Point 3: Control Point Relative Position = 20, Cumulative Time Weight = 177

Control Point 4: Control Point Relative Position = 20, Cumulative Time Weight = 202

Control Point 5: Control Point Relative Position = 10, Cumulative Time Weight = 204

Control Point 6: Control Point Relative Position = 10, Cumulative Time Weight = 229

Control Point 7: Control Point Relative Position = 1200, Cumulative Time Weight = 383

C.8.8.15.8 Source Transit Time

The Source transit times between dwell positions of a remote afterloader may be considered by specifying a non-zero increment in the Cumulative Time Weight (300A,02D6) when the Source moves between Control Points. In this case the Channel Total Time (300A,0286) shall include the overall Source transit time for the Channel.

C.8.8.15.9 Control Point Relative Position

Control Point Relative Position (300A,02D2) shall describe where the center of a given source in a channel is located with respect to the end of the channel, i.e. to the center of the distal-most possible dwell position in the channel.

C.8.8.15.10 Control Point 3D Position

Control Point 3D Position (300A,02D4) shall describe the absolute 3D coordinates of a source. This position shall correspond to the *center* of a source in an applicator during a remote or manually controlled afterloading treatment.

C.8.8.15.11 Cumulative Dose Reference Coefficient

The Cumulative Dose Reference Coefficient (300A,010C) is the value by which Brachy Application Setup Dose (300A,00A4) is multiplied to obtain the dose to the referenced dose reference site at the current control point (and after previous control points have been successfully administered). The Cumulative Dose Reference Coefficient (300A,010C) is by definition zero for the initial control point. The Cumulative Dose Reference Coefficient (300A,010C) of the final control point multiplied by Brachy Application Setup Dose (300A,00A4) results in the final dose to the referenced dose reference site for the current channel. Dose calculation for dose reference sites other than points is not well defined.

If Treatment Type (300A,0202) is PDR, then the Cumulative Dose Reference Coefficient (3008,010C) shall specify the dose delivered to the dose reference during a single pulse. The total dose delivered to the dose reference shall then be expressed by Cumulative Dose Reference Coefficient (3008,010C) multiplied by Number of Pulses (300A,028A) multiplied by Brachy Application Setup Dose (300A,00A4).

C.8.8.15.12 Nominal Thickness and Nominal Transmission

If provided, Source Encapsulation Nominal Thickness (300A,0222), Brachy Accessory Device Nominal Thickness (300A,026A), Source Applicator Wall Nominal Thickness (300A,029C), and Channel Shield Nominal Thickness (300A,02B8) shall indicate that the related objects are of uniform thickness with the specified value. If this is not the case, these Attributes shall not be provided.

If provided, Source Encapsulation Nominal Transmission (300A,0224), Brachy Accessory Device Nominal Transmission (300A,026C), Source Applicator Wall Nominal Transmission (300A,029E), and Channel Shield Nominal Transmission (300A,02BA) shall indicate that the related objects are of uniform transmission with the specified value. If this is not the case, these Attributes shall not be provided.

No assumptions are made about the source characteristics beyond the parameters specified here.

C.8.8.15.13 Reference Point for Calibration of Beta Emitting Isotopes

For beta emitting isotopes, Source Strength (300A,022B) shall be defined at reference point (r0,θ0), where r0 is the radial distance of 2 mm from the source longitudinal axis, and θ0 is the angle of 90 degrees between the source longitudinal axis and the line defined by the center of the source and the reference point. Refer to:

- IEC 60601-2-17 (Medical electrical equipment - Particular requirements for the safety of automatically-controlled brachytherapy afterloading equipment), where the beta source strength is defined as: ABSORBED DOSE RATE [Gy s-1] in water at 2 mm along the perpendicular bisector from a RADIOACTIVE SOURCE emitting beta RADIATION.
- Nath et. al.: Intravascular brachytherapy physics: Report of the AAPM Radiation Therapy Committee Task Group No. 60, Med. Phys 26 (2) Feb 1999, pp 119-152.

C.8.8.15.14 Orientation of Brachy Sources

The Control Point Orientation (300A,0412) shall be used to define the orientation of an anisotropic brachytherapy source or seed for the purpose of calculating the effect of the anisotropy on the dose calculation. The Control Point Orientation (300A,0412) shall be given by the direction vector of the long axis of the Brachy source or seed in the insertion direction, in the DICOM Patient-Based Coordinate System. The direction vector shall be oriented from the source center as defined by the Control Point 3D Position (300A,02D4) along the long axis of the source and in the insertion direction.

C.8.8.15.15 Source Model ID

The Source Model ID (300A,021B) ties together the physical source properties. The creator of the plan has used this ID to select the radioactive source model for the plan. An example would be the name of the used TG-43 data.

C.8.8.15.16 Geometric Parameters

A Channel is the combination of the Transfer Tube and the Source Applicator. A Channel is physically connected to one of the connection sockets of the afterloader. Afterloader Channel ID (300A,0273) unambiguously identifies the afterloader channel to which the applicator is connected; see Section C.8.8.15.16.2. Both Afterloader Channel ID (300A,0273) and Source Applicator ID (300A,0291) describe the connection between the afterloader and the applicator (so called channel mapping). Channel Number (300A,0282) is used to index the Items within the Channel Sequence (300A,0280) and does not serve as the identification of the channel socket at the afterloader.

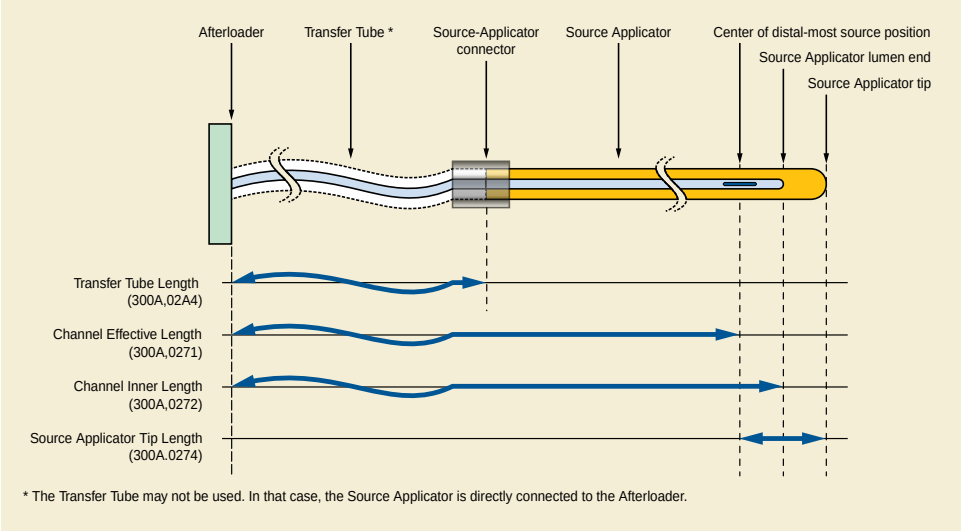


Figure C.8.8.15-1. RT Brachy Channel Geometric Parameters

Note

Channel Length (300A,0284) has been interpreted in different ways. Channel Effective Length (300A,0271) should be used instead, as the distance from the afterloader to the center of the distal-most possible dwell position following the definition in Figure C.8.8.15-1.

Additionally, the Transfer Tube Length (300A,02A4) may be specified. If Transfer Tube Length (300A,02A4) is absent or has no value, the distance from the Source Applicator connector to the center of the distal-most possible dwell position is equal to the value of the Channel Effective Length (300A,0271). If Transfer Tube Length (300A,02A4) has a value, the distance from the Source Applicator connector to the center of the distal-most possible dwell position is equal to the Channel Effective Length (300A,0271) minus the Transfer Tube Length (300A,02A4). The concept of Source Applicator Length (300A,0296) should not be used any longer.

C.8.8.15.16.1 Channel Inner Length

The Channel Inner Length (300A,0272) is the measurable physical inner length of the channel. It specifies the distance between the connector on the afterloader and the inner end of the channel. In the RT Brachy Session Record Module it shall be specified as the measured or verified length.

C.8.8.15.16.2 Afterloader Channel ID

The Afterloader Channel ID (300A,0273) is the connector socket identification on the afterloader where the channel is connected.

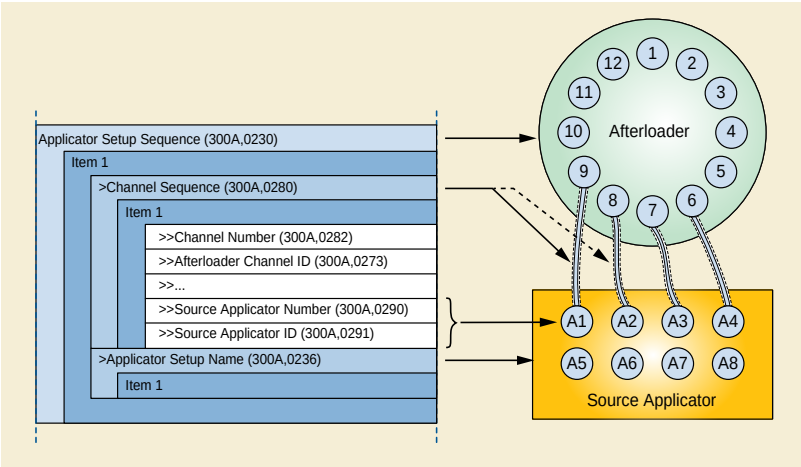


Figure C.8.8.15-2. RT Brachy Channel and Applicator IDs

C.8.8.16 Approval Module

Table C.8-52. Approval Module Attributes

Attribute Name	Tag	Type	Attribute Description
Approval Status	(300E,0002)	1	Approval status at the time the SOP Instance was created. Enumerated Values: **APPROVED** Reviewer recorded that object met an implied criterion **UNAPPROVED** No review of object has been recorded **REJECTED** Reviewer recorded that object failed to meet an implied criterion
Review Date	(300E,0004)	2C	Date on which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Review Time	(300E,0005)	2C	Time at which object was reviewed. Required if Approval Status (300E,0002) is APPROVED or REJECTED.
Reviewer Name	(300E,0008)	2C	Name of person who reviewed object. Required if Approval Status (300E,0002) is APPROVED or REJECTED.

C.8.8.17 RT General Treatment Record Module

Table C.8-53. RT General Treatment Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	Instance number identifying this particular Instance of the object.
Treatment Date	(3008,0250)	2	Date when current fraction was delivered, or Date last fraction was delivered in case of RT Treatment Summary Record IOD. See Note.
Treatment Time	(3008,0251)	2	Time when current fraction was delivered (begun), or Time last fraction was delivered (begun) in case of RT Treatment Summary Record IOD. See Note.
Referenced RT Plan Sequence	(300C,0002)	2	Reference to a RT Plan. Zero or one Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Referenced Treatment Record Sequence	(3008,0030)	3	Reference to RT Treatment Records to which the current RT Treatment Record is significantly related. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Note

Treatment Date (3008,0250) and Treatment Time (3008,0251) can be used to chronologically order a sequence of treatments, where each treatment is represented by an Instance of a RT Beams Treatment Record or RT Brachy Treatment Record. In the case of a RT Treatment Summary Record, it can be used to identify the period for which the treatment summary is valid. Therefore, implementers are strongly advised to include values for these Attributes whenever possible.

C.8.8.18 RT Treatment Machine Record Module

Table C.8-54. RT Treatment Machine Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Treatment Machine Sequence	(300A,0206)	1	Sequence describing treatment machine used for treatment delivery. Only a single Item shall be included in this Sequence.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine used for treatment delivery.
>Manufacturer	(0008,0070)	2	Manufacturer of the equipment used for treatment delivery.
>Institution Name	(0008,0080)	2	Institution where the equipment is located that was used for treatment delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that was used for treatment delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that was used for treatment delivery.
>Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*
>Manufacturer's Model Name	(0008,1090)	2	Manufacturer's model name of the equipment used for treatment delivery.
>Device Serial Number	(0018,1000)	2	Manufacturer's serial number of the equipment used for treatment delivery.

C.8.8.19 Measured Dose Reference Record Module

Table C.8-55. Measured Dose Reference Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Measured Dose Reference Sequence	(3008,0010)	1	Sequence of doses measured during treatment delivery, summed over entire session. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required only if Measured Dose Reference Number (3008,0064) is not present. It shall not be present otherwise.
>Measured Dose Reference Number	(3008,0064)	1C	Unique identifier of measured dose point. Required only if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>Dose Units	(3004,0002)	1	Units used to describe measured dose. Enumerated Values: **GY** Gray **RELATIVE** Dose relative to implicit reference value
>Measured Dose Value	(3008,0016)	2	Measured Dose in units specified by Dose Units (3004,0002).
>Measured Dose Type	(3008,0014)	2	Type of dose measurement. Defined Terms: **DIODE** semiconductor diode **TLD** thermoluminescent dosimeter **ION_CHAMBER** ion chamber **GEL** dose sensitive gel **EPID** electronic portal imaging device **FILM** dose sensitive film
>Measured Dose Description	(3008,0012)	3	User-defined description of Dose Reference (e.g., "Exit dose", "Point A").

C.8.8.20 Calculated Dose Reference Record Module

Table C.8-56. Calculated Dose Reference Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Calculated Dose Reference Sequence	(3008,0070)	1	Sequence of doses estimated for each treatment delivery. One or more Items shall be included in this Sequence.
>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required only if Calculated Dose Reference Number (3008,0072) is not present. It shall not be present otherwise.
>Calculated Dose Reference Number	(3008,0072)	1C	Unique identifier of dose reference point within RT Treatment Record IOD. Required only if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>Calculated Dose Reference Dose Value	(3008,0076)	2	Calculated Dose (Gy).
>Calculated Dose Reference Description	(3008,0074)	3	User-defined description of Calculated Dose Reference.

C.8.8.21 RT Beams Session Record Module

Table C.8-57. RT Beams Session Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Fraction Group Number	(300C,0022)	3	Identifier of Fraction Group within referenced RT Plan.
Number of Fractions Planned	(300A,0078)	2	Total number of treatments (Fractions) planned for current Fraction Group.
Primary Dosimeter Unit	(300A,00B3)	1	Measurement unit of machine dosimeter. Enumerated Values: **MU** Monitor Unit **MINUTE** minute
Treatment Session Beam Sequence	(3008,0020)	1	Sequence of Beams administered during treatment session. One or more Items shall be included in this Sequence.
>Referenced Beam Number	(300C,0006)	3	References Beam specified by Beam Number (300A,00C0) in Beam Sequence (300A,00B0) in RT Beams Module within referenced RT Plan.
>Beam Name	(300A,00C2)	3	User-defined name for delivered Beam.
>Beam Description	(300A,00C3)	3	User-defined description for delivered Beam.
>Beam Type	(300A,00C4)	1	Motion characteristic of delivered Beam. Enumerated Values: **STATIC** All Control Point Sequence (300A,0111) Attributes remain unchanged between consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134). **DYNAMIC** One or more Control Point Sequence (300A,0111) Attributes change between one or more consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134).
>Radiation Type	(300A,00C6)	1	Particle type of delivered Beam. Defined Terms: **PHOTON** **ELECTRON** **NEUTRON** **PROTON**
>Primary Fluence Mode Sequence	(3002,0050)	3	Sequence defining whether the primary fluence of the treatment beam used a non-standard fluence-shaping when the beam was delivered. Only a single Item is permitted in this Sequence.
>>Fluence Mode	(3002,0051)	1	Describes whether the fluence shaping is the standard mode for the beam or an alternate. Enumerated Values: **STANDARD** Uses standard fluence-shaping **NON_STANDARD** Uses a non-standard fluence-shaping mode
>>Fluence Mode ID	(3002,0052)	1C	Identifier for the specific fluence-shaping mode. Required if Fluence Mode (3002,0051) has value NON_STANDARD.

Attribute Name	Tag	Type	Attribute Description
>High-Dose Technique Type	(300A,00C7)	1C	Type of high-dose treatment technique. Defined Terms: **TBI** Total Body Irradiation **HDR** High Dose Rate Required if treatment technique requires a dose that would normally require overriding of treatment machine safety controls.
>Referenced Verification Image Sequence	(300C,0040)	3	Sequence of verification images obtained during delivery of current beam. One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Start Meterset	(3008,0078)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number at which image acquisition starts.
>>End Meterset	(3008,007A)	3	Cumulative Meterset Weight within Beam referenced by Referenced Beam Number at which image acquisition ends.
>Referenced Measured Dose Reference Sequence	(3008,0080)	3	Sequence of doses measured during treatment delivery for current Beam. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely references Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Measured Dose Reference Number (3008,0082) is not present. It shall not be present otherwise.
>>Referenced Measured Dose Reference Number	(3008,0082)	1C	Uniquely references Measured Dose Reference specified by Measured Dose Reference Number (3008,0064) in Measured Dose Reference Sequence (3008,0010). Required if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>>Measured Dose Value	(3008,0016)	1	Measured Dose in units specified by Dose Units (3004,0002) in Sequence referenced by Measured Dose Reference Sequence (3008,0010) or Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan as defined above.
>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	Sequence of doses estimated for each treatment delivery. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Calculated Dose Reference Number (3008,0092) is not present.
>>Referenced Calculated Dose Reference Number	(3008,0092)	1C	Uniquely identifies Calculated Dose Reference specified by Calculated Dose Reference Number (3008,0072) within Calculated Dose Reference Sequence (3008,0070). Required if Referenced Dose Reference Number (300C,0051) is not present.
>>Calculated Dose Reference Dose Value	(3008,0076)	1	Calculated Dose (Gy).
>Source-Axis Distance	(300A,00B4)	3	Radiation source to gantry rotation axis distance of the equipment that was used for beam delivery (mm).

Attribute Name	Tag	Type	Attribute Description
>Beam Limiting Device Leaf Pairs Sequence	(3008,00A0)	1	Sequence of beam limiting device (collimator) jaw or leaf (element) leaf pair values. One or more Items shall be included in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup used within current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence (300A,0180) of RT Treatment Record.
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current delivered Beam.
>Recorded Wedge Sequence	(3008,00B0)	1C	Sequence of treatment wedges present during delivered Beam. Required if Number of Wedges (300A,00D0) is non-zero. One or more Items shall be included in this Sequence.
>>Wedge Number	(300A,00D2)	3	Identification number of the Wedge. The value of Wedge Number (300A,00D2) shall be unique within the wedge Sequence.
>>Wedge Type	(300A,00D3)	2	Type of wedge defined for delivered Beam. Defined Terms: **STANDARD** standard (static) wedge **DYNAMIC** moving Beam Limiting Device (collimator) jaw simulating wedge **MOTORIZED** single wedge that can be removed from beam remotely
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for wedge.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Wedge Angle	(300A,00D5)	3	Nominal wedge angle delivered (degrees).
>>Wedge Orientation	(300A,00D8)	3	Orientation of wedge, i.e., orientation of IEC WEDGE FILTER coordinate system with respect to IEC BEAM LIMITING DEVICE coordinate system (degrees).
>Number of Compensators	(300A,00E0)	2	Number of compensators associated with current delivered Beam.
>Recorded Compensator Sequence	(3008,00C0)	3	Sequence of treatment compensators associated with current Beam. One or more Items are permitted in this Sequence.
>>Referenced Compensator Number	(300C,00D0)	1	Uniquely identifies compensator specified by Compensator Number (300A,00E4) within Beam referenced by Referenced Beam Number (300C,0006).

Attribute Name	Tag	Type	Attribute Description
>>Compensator Type	(300A,00EE)	2	Type of compensator (if any). Defined Terms: **STANDARD** physical (static) compensator **DYNAMIC** moving Beam Limiting Device (collimator) simulating compensator
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for compensator.
>>Accessory Code	(300A,00F9)	3	An identifier for the Compensator intended to be read by a device such as a bar-code reader.
>>Compensator Tray ID	(300A,00EF)	3	User-supplied identifier for compensator tray.
>>Tray Accessory Code	(300A,0355)	3	An identifier for the Tray intended to be read by a device such as a bar-code reader.
>Number of Boli	(300A,00ED)	2	Number of boli used with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	3	Sequence of boli associated with Beam. One or more Items are permitted in this Sequence.
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI representing the bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set IOD referenced by referenced RT Plan in Referenced RT Plan Sequence (300C,0002) in RT General Treatment Record Module.
>>Bolus ID	(300A,00DC)	3	User-supplied identifier for the Bolus.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Number of Blocks	(300A,00F0)	2	Number of shielding blocks or Electron Inserts associated with Beam.
>Recorded Block Sequence	(3008,00D0)	3	Sequence of blocks associated with current Beam. One or more Items are permitted in this Sequence.
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray or Electron Insert.
>>Tray Accessory Code	(300A,0355)	3	An identifier for the Tray intended to be read by a device such as a bar-code reader.
>>Accessory Code	(300A,00F9)	3	An identifier for the Block intended to be read by a device such as a bar-code reader.
>>Referenced Block Number	(300C,00E0)	3	Uniquely identifies block specified by Block Number (300A,00FC) within Beam referenced by Referenced Beam Number (300C,0006).
>>Block Name	(300A,00FE)	2	User-defined name for block.
>Applicator Sequence	(300A,0107)	3	Sequence of Applicators associated with Beam. Only a single Item is permitted in this Sequence.
>>Applicator ID	(300A,0108)	1	User or machine supplied identifier for Applicator.
>>Accessory Code	(300A,00F9)	3	An identifier for the accessory intended to be read by a device such as a bar-code reader.

Attribute Name	Tag	Type	Attribute Description
>>Applicator Type	(300A,0109)	1	Type of Applicator. Defined Terms: **ELECTRON_SQUARE** square electron applicator **ELECTRON_RECT** rectangular electron applicator **ELECTRON_CIRC** circular electron applicator **ELECTRON_SHORT** short electron applicator **ELECTRON_OPEN** open (dummy) electron applicator **PHOTON_SQUARE** square photon applicator **PHOTON_RECT** rectangular photon applicator **PHOTON_CIRC** circular photon applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator (deprecated)
>>Applicator Geometry Sequence	(300A,0431)	3	Describes the applicator aperture geometry. Only a single Item is permitted in this Sequence.
>>>Applicator Aperture Shape	(300A,0432)	1	Aperture shape of the applicator. Defined Terms: **SYM_SQUARE** A square-shaped aperture symmetrical to the central axis. **SYM_RECTANGLE** A rectangular-shaped aperture symmetrical to the central axis. **SYM_CIRCULAR** A circular-shaped aperture symmetrical to the central axis.
>>>Applicator Opening	(300A,0433)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system. In case of square-shaped applicator contains the length of the sides of the square. In case of circular-shaped applicators, contains the diameter of the circular aperture. Required if Applicator Aperture Shape (300A,0432) is SYM_SQUARE or SYM_CIRCULAR.
>>>Applicator Opening X	(300A,0434)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in X-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.
>>>Applicator Opening Y	(300A,0435)	1C	Opening (in mm) of the applicator's aperture in IEC BEAM LIMITING DEVICE coordinate system in Y-Direction. Required if Applicator Aperture Shape (300A,0432) is SYM_RECTANGLE.
>> Source to Applicator Mounting Position Distance	(300A,0436)	3	Radiation source to applicator mounting position distance (in mm) for current applicator.
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>General Accessory Sequence	(300A,0420)	3	A Sequence of General Accessories associated with this Beam. One or more Items are permitted in this Sequence.
>>General Accessory Number	(300A,0424)	1	Identification Number of the General Accessory. The value shall be unique within the Sequence.
>>General Accessory ID	(300A,0421)	1	User or machine supplied identifier for General Accessory.
>>General Accessory Description	(300A,0422)	3	User supplied description of General Accessory.

Attribute Name	Tag	Type	Attribute Description
>>General Accessory Type	(300A,0423)	3	Specifies the type of accessory. Defined Terms: **GRATICULE** Accessory tray with a radio-opaque grid **IMAGE_DETECTOR** Image acquisition device positioned in the beam line **RETICLE** Accessory tray with radio-transparent markers or grid
>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory
>>Source to General Accessory Distance	(300A,0425)	3	Radiation source to general accessory distance (in mm) for current accessory.
>Current Fraction Number	(3008,0022)	2	Fraction number for this beam administration.
>Treatment Delivery Type	(300A,00CE)	2	Delivery Type of treatment. Defined Terms: **TREATMENT** Normal patient treatment **OPEN_PORTFILM** Portal image acquisition with open field **TRMT_PORTFILM** Portal image acquisition with treatment port **CONTINUATION** Continuation of interrupted treatment **SETUP** No treatment beam is applied for this RT Beam. To be used for specifying the gantry, couch, and other machine positions where X-Ray set-up images or measurements are to be taken. **VERIFICATION** Treatment used for Quality Assurance rather than patient treatment
>Treatment Termination Status	(3008,002A)	1	Conditions under which treatment was terminated. Enumerated Values: **NORMAL** treatment terminated normally **OPERATOR** operator terminated treatment **MACHINE** machine terminated treatment **UNKNOWN** status at termination unknown
>Treatment Termination Code	(3008,002B)	3	Treatment machine termination code. This code is dependent upon the particular application and equipment.
>Treatment Verification Status	(3008,002C)	2	Conditions under which treatment was verified by a verification system. Enumerated Values: **VERIFIED** treatment verified **VERIFIED_OVR** treatment verified with at least one out-of-range value overridden **NOT_VERIFIED** treatment verified manually
>Specified Primary Meterset	(3008,0032)	3	Desired machine setting of primary Meterset.
>Specified Secondary Meterset	(3008,0033)	3	Desired machine setting of secondary Meterset.
>Delivered Primary Meterset	(3008,0036)	3	Machine setting actually delivered as recorded by primary Meterset.
>Delivered Secondary Meterset	(3008,0037)	3	Machine setting actually delivered as recorded by secondary Meterset.
>Specified Treatment Time	(3008,003A)	3	Treatment Time set (sec).
>Delivered Treatment Time	(3008,003B)	3	Treatment Time actually delivered (sec).

Attribute Name	Tag	Type	Attribute Description
>Number of Control Points	(300A,0110)	1	Number of control points delivered. Value shall be greater than or equal to 2.
>Control Point Delivery Sequence	(3008,0040)	1	Sequence of beam control points for current treatment beam. The number of Items in this Sequence shall equal the value of Number of Control Points (300A,0110). See Section C.8.8.21.1.
>>Referenced Control Point Index	(300C,00F0)	3	Uniquely identifies Control Point specified by Control Point Index (300A,0112) within Beam referenced by Referenced Beam Number (300C,0006).
>>Treatment Control Point Date	(3008,0024)	1	Date when the delivery of radiation at this control point began. For the final control point this shall be the Date when the previous control point ended.
>>Treatment Control Point Time	(3008,0025)	1	Time when the delivery of radiation at this control point began. For the final control point this shall be the Time when the previous control point ended.
>>Specified Meterset	(3008,0042)	2	Desired machine setting for current control point. See Section C.8.8.21.2.
>>Delivered Meterset	(3008,0044)	1	Machine setting actually delivered at current control point. See Section C.8.8.21.2.
>>Dose Rate Set	(300A,0115)	2	Dose Rate set on treatment machine for segment beginning at current control point (Meterset/min).
>>Dose Rate Delivered	(3008,0048)	2	Dose Rate actually delivered for segment beginning at current control point (Meterset/min).
>>Nominal Beam Energy	(300A,0114)	3	Nominal Beam Energy at control point.
>>Nominal Beam Energy Unit	(300A,0015)	1C	Units used for Nominal Beam Energy (300A,0114). Required if Nominal Beam Energy (300A,0114) is present. Defined Terms: **MV** Megavolt **MEV** Mega electron-Volt If Radiation Type (300A,00C6) is PHOTON, Nominal Beam Energy Unit (300A,0015) shall be MV. If Radiation Type (300A,00C6) is ELECTRON, Nominal Beam Energy Unit (300A,0015) shall be MEV.
>>Wedge Position Sequence	(300A,0116)	3	Sequence of Wedge positions for current control point. One or more Items are permitted in this Sequence.
>>>Referenced Wedge Number	(300C,00C0)	1	Uniquely identifies wedge specified by Wedge Number (300A,00D2) within the Recorded Wedge Sequence (3008,00B0).
>>>Wedge Position	(300A,0118)	1	Position of Wedge at current control point. Enumerated Values: **IN** **OUT**

Attribute Name	Tag	Type	Attribute Description
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	Sequence of beam limiting device (collimator) jaw or leaf (element) positions. One or more Items shall be included in this Sequence. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if beam limiting device (collimator) changes during beam administration.
>>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device. The value of this Attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an element of Beam Limiting Device Leaf Pairs Sequence (3008,00A0). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>>Leaf/Jaw Positions	(300A,011C)	1	Positions of beam limiting device (collimator) leaf (element) or jaw pairs (mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) defined in element of Beam Limiting Device Leaf Pairs Sequence (3008,00A0). Values shall be in IEC leaf subscript order 101, 102, … 1N, 201, 202 … 2N.
>>Gantry Angle	(300A,011E)	1C	Treatment machine gantry angle, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Gantry Angle changes during beam administration.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment beginning at current Control Point. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040), or if Gantry Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Gantry Pitch Angle	(300A,014A)	3	Gantry Pitch Angle. i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). If used, must be present for first Item of Control Point Sequence, or if used and Gantry Pitch Rotation Angle changes during Beam, must be present. See Section C.8.8.25.6.5.

Attribute Name	Tag	Type	Attribute Description
>>Gantry Pitch Rotation Direction	(300A,014C)	3	Direction of Gantry Pitch Angle when viewing along the positive X-axis of the IEC GANTRY coordinate system, for segment following Control Point. If used, must be present for first Item of Control Point Sequence, or if used and Gantry Pitch Rotation Direction changes during Beam, must be present. See Section C.8.8.14.8 and Section C.8.8.25.6.5. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Beam Stopper Position	(3008,0230)	3	Position of Beam Stopper during beam administration. Enumerated Values: **EXTENDED** Beam Stopper extended **RETRACTED** Beam Stopper retracted **UNKNOWN** Position unknown
>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device (collimator) angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if beam limiting device (collimator) angle changes during beam delivery.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment beginning at current Control Point. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Beam Limiting Device Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Patient Support Angle changes during beam administration.
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment beginning at current Control Point. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040), or if Patient Support Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Eccentric Axis Distance	(300A,0124)	3	Distance (positive) from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis (mm).
>>Table Top Eccentric Angle	(300A,0125)	1C	Table Top (non-isocentric) angle, i.e., orientation of IEC TABLE TOP ECCENTRIC coordinate system with respect to IEC PATIENT SUPPORT coordinate system (degrees). Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Table Top Eccentric Angle changes during beam administration.

Attribute Name	Tag	Type	Attribute Description
>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	Direction of Table Top Eccentric Rotation when viewing table from above, for segment beginning at current Control Point. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Table Top Eccentric Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Pitch Angle	(300A,0140)	1C	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Pitch Angle changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.25.6.2.
>>Table Top Pitch Rotation Direction	(300A,0142)	1C	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Pitch Rotation Direction changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	1C	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the IEC Y-axis of the IEC TABLE TOP coordinate system (degrees). If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Roll Angle changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.25.6.2.
>>Table Top Roll Rotation Direction	(300A,0146)	1C	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. If required by treatment delivery device, shall be present for first Item of Control Point Sequence. If required by treatment delivery device and if Table Top Roll Rotation Direction changes during Beam, shall be present in all subsequent Items of Control Point Sequence. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Table Top Vertical Position changes during beam administration.

Attribute Name	Tag	Type	Attribute Description
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Table Top Longitudinal Position changes during beam administration.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Control Point Delivery Sequence (3008,0040) or if Table Top Lateral Position changes during beam administration.
>>Corrected Parameter Sequence	(3008,0068)	3	A Sequence of Items describing any corrections made to any Attributes prior to delivery of the next control point. One or more Items are permitted in this Sequence.
>>>Parameter Sequence Pointer	(3008,0061)	1	Contains the Data Element Tag of the parent Sequence containing the Attribute that was corrected. The value is limited in scope to the Treatment Session Beam Sequence (3008,0020) and all nested Sequences therein.
>>>Parameter Item Index	(3008,0063)	1	Contains the Sequence Item index (starting at 1) of the corrected Attribute within its parent Sequence.
>>>Parameter Pointer	(3008,0065)	1	Contains the Data Element Tag of the Attribute that was corrected.
>>>Correction Value	(3008,006A)	1	The value applied to the Attribute that was referenced by the Parameter Sequence Pointer (3008,0061), Parameter Item Index (3008,0063) and Parameter Pointer (3008,0065).
>>Override Sequence	(3008,0060)	3	Sequence of parameters that were overridden during the administration of the beam segment immediately prior to the current control point. One or more Items are permitted in this Sequence.
>>>Override Parameter Pointer	(3008,0062)	2	Contains the Data Element Tag of the Attribute that was overridden.
>>>Parameter Sequence Pointer	(3008,0061)	3	Contains the Data Element Tag of the parent Sequence containing the Attribute that was overridden. The value is limited in scope to the Treatment Session Beam Sequence (3008,0020) and all nested Sequences therein.
>>>Parameter Item Index	(3008,0063)	3	Contains the Sequence Item index (monotonically increasing from 1) of the overridden Attributes within its parent Sequence. The value is limited in scope to the Treatment Session Beam Sequence (3008,0020) and all nested Sequences therein.
>>>Parameter Value Number	(3008,0067)	3	Positive integer identifying which value of a multi-valued Attribute identified by Override Parameter Pointer (3008,0062) is referenced. The value 1 identifies the first value.
>>>Operators' Name	(0008,1070)	2	Name of operator who authorized override.
>>>Operator Identification Sequence	(0008,1072)	3	Identification of the operator who authorized override. Only a single Item is permitted in this Sequence.
>>>>Include Table 10-1 “Person Identification Macro Attributes Description”			
>>>Override Reason	(3008,0066)	3	User-defined description of reason for override of parameter specified by Override Parameter Pointer (3008,0062).

C.8.8.21.1 Control Point Machine Delivery Parameters

All treatment machine delivery parameters (including table angles and positions) in the RT Treatment Session Record Module shall be specified as absolute, not relative, values at the Control Point.

C.8.8.21.2 Specified and Delivered Meterset Values

C.8.8.21.2.1 Beam Level

The value of Specified Primary Meterset (3008,0032) shall be the value specified by Beam Meterset (300A,0086) in the corresponding Fraction Group of the referenced RT Plan. The referenced RT Plan is found in the Referenced RT Plan Sequence (300C,0002), and within this plan the Fraction Group is found using the Referenced Fraction Group Number (300C,0022) in this Module. The Beam is found in the referenced RT Plan using the Referenced Beam Number (300C,0006) in the same Item of the Treatment Session Beam Sequence (3008,0020) as the Specified Primary Meterset (3008,0032).

The value of Delivered Primary Meterset (3008,0036) shall be the accumulated value of the delivered Meterset across all Control Points, which is recorded in this Item of the Treatment Session Beam Sequence (3008,0020).

Note that, for example, when a partial treatment has occurred and resumption(s) have been delivered that complete delivery of all control points remaining, the sum of the Delivered Primary Meterset (3008,0036) values in all RT Beams Session Records for the beam in question and the fraction being treated will match the specified Meterset for the whole fraction.

C.8.8.21.2.2 Control Point Level

Specified Meterset (3008,0042) contains the MU as specified in the corresponding RT Plan at a given control point.

Delivered Meterset (3008,0044) shall contain one of the following three values:

- the Meterset value at which the delivery of the current beam started
- the Specified Meterset
- the Meterset value at which the delivery of the current beam ended

Control points that already have been treated in an earlier session shall contain the Meterset value at which the delivery of the current beam started. Control points that have been completely treated during the current session shall contain the Specified Meterset value for this Control Point. Control Points that have not yet been treated or not completely shall contain the total delivered MU up to the point where the interruption has occurred (i.e., the last control point treated).

This can be expressed by the following equation:

$DelMS[CP_n] = MAX (StartMS, MIN (SpecMS[CP_n], EndMS))$

with

$DelMS[CP_n]$ Delivered Meterset value at control point n

$SpecMS[CP_n]$ Specified Meterset value at control point n

StartMS Meterset value where delivery of current beam started

EndMS Meterset value where delivery of current beam ended

By this definition it is unambiguously recorded, which 'segments' of control points have been delivered in case of partial treatments.

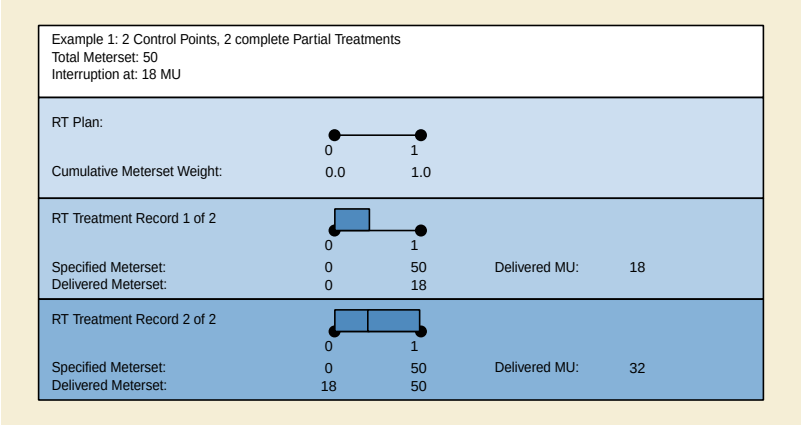


Figure C.8.8.21-1. Control Point Example 1: 2 Control Points, 2 Complete Partial Treatments

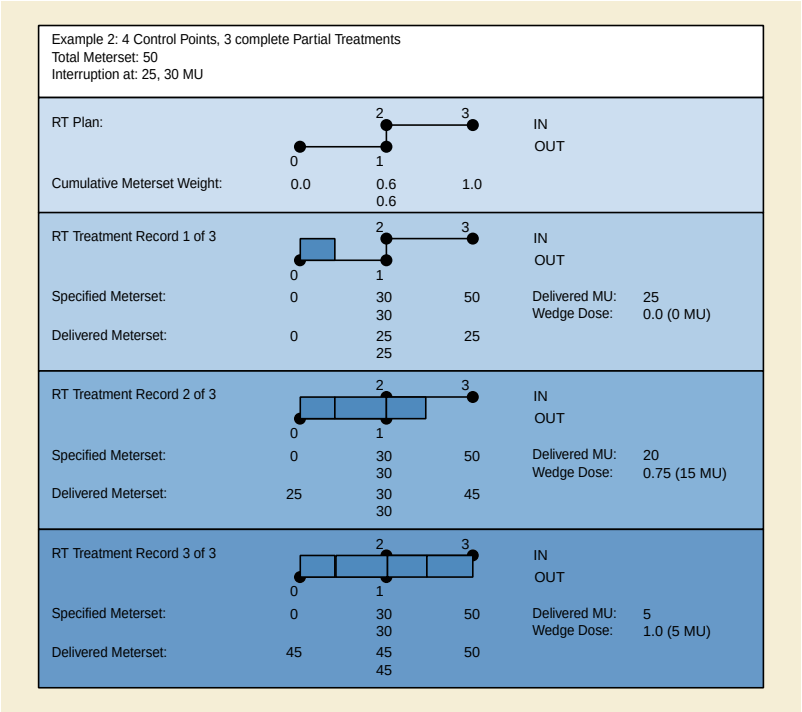


Figure C.8.8.21-2. Control Point Example 1: 2 Control Points, 2 Complete Partial Treatments

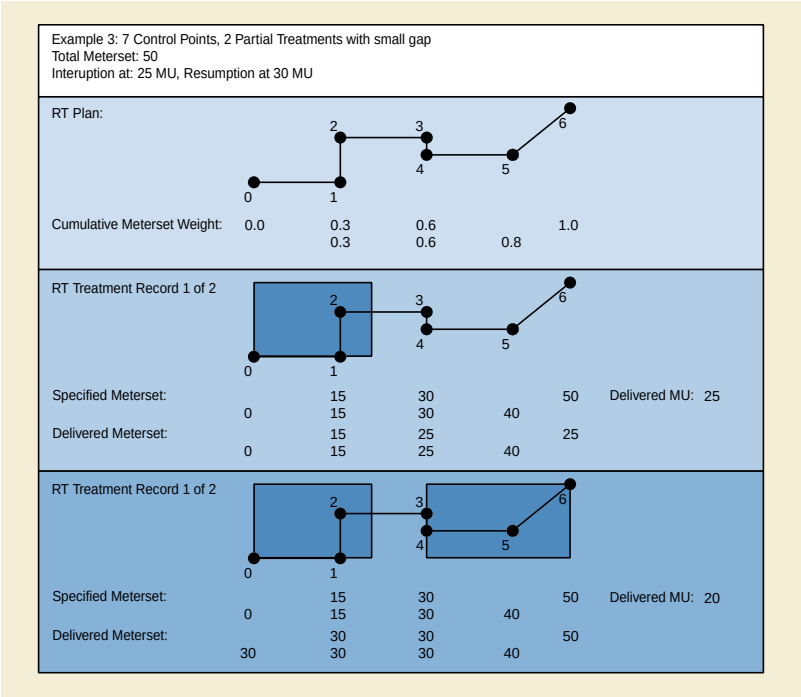


Figure C.8.8.21-3. Control Point Example 3: 7 Control Points, 2 Partial Treatments with Small Gap

C.8.8.22 RT Brachy Session Record Module

Table C.8-58. RT Brachy Session Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Fraction Group Number	(300C,0022)	3	Identifier of Fraction Group within referenced RT Plan.
Number of Fractions Planned	(300A,0078)	2	Total number of treatments (Fractions) planned for current Fraction Group.
Brachy Treatment Technique	(300A,0200)	1	Type of brachytherapy treatment technique. Enumerated Values: **INTRALUMENARY** **INTRACAVITARY** **INTERSTITIAL** **CONTACT** **INTRAVASCULAR** **PERMANENT** See RT Plan IOD.
Brachy Treatment Type	(300A,0202)	1	Type of brachytherapy treatment. Defined Terms: **MANUAL** Manually positioned **HDR** High dose rate **MDR** Medium dose rate **LDR** Low dose rate **PDR** Pulsed dose rate

Attribute Name	Tag	Type	Attribute Description
Recorded Source Sequence	(3008,0100)	1	Sequence of Sources to be used within Application Setups. One or more Items shall be included in this Sequence.
>Source Number	(300A,0212)	1	Identification number of the Source. The value of Source Number (300A,0212) shall be unique within the Recorded Source Sequence (3008,0100) in which it is created.
>Source Type	(300A,0214)	1	Type of Source. Defined Terms: **POINT** **LINE** **CYLINDER** **SPHERE**
>Source Model ID	(300A,021B)	3	User-supplied identifier for the radioactive source model that was used for the source in the treatment plan of which this session record is based to. See Section C.8.8.15.15.
>Source Manufacturer	(300A,0216)	2	Manufacturer of source.
>Source Serial Number	(3008,0105)	2	Serial Number of source.
>Source Isotope Name	(300A,0226)	1	User-defined name of Isotope.
>Source Isotope Half Life	(300A,0228)	1	Half-life of Isotope (days).
>Source Strength Units	(300A,0229)	1C	Measurement unit of Source Strength. Required if the source is not a gamma-emitting (photon) source. May be present otherwise. Enumerated Values: **AIR_KERMA_RATE** Air Kerma Rate if Source is Gamma emitting Isotope. **DOSE_RATE_WATER** Dose Rate in Water if Source is Beta emitting Isotope.
>Reference Air Kerma Rate	(300A,022A)	1	Air Kerma Rate in air of Isotope specified at Source Strength Reference Date (300A,022C) and Source Strength Reference Time (300A,022E) (in μGy h^{-1} at 1 m). Value shall be zero for non-gamma sources.
>Source Strength	(300A,022B)	1C	Source Strength of Isotope at Source Strength Reference Date (300A,022C) and Source Strength Reference Time (300A,022E), in units specified in Source Strength Units (300A,0229). Required if the source is not a gamma-emitting (photon) source. See Section C.8.8.15.13.
>Source Strength Reference Date	(300A,022C)	1	Reference date for Reference Air Kerma Rate (300A,022A) or Source Strength (300A,022B) of Isotope.
>Source Strength Reference Time	(300A,022E)	1	Reference time for Air Kerma Rate (300A,022A) or Source Strength (300A,022B) of Isotope.
Treatment Session Application Setup Sequence	(3008,0110)	1	Sequence of Application Setups for RT Treatment Record for current RT Plan. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Application Setup Type	(300A,0232)	1	Type of Application Setup. Defined Terms: **FLETCHER_SUIT** **DELCLOS** **BLOEDORN** **JOSLIN_FLYNN** **CHANDIGARH** **MANCHESTER** **HENSCHKE** **NASOPHARYNGEAL** **OESOPHAGEAL** **ENDOBRONCHIAL** **SYED_NEBLETT** **ENDORECTAL** **PERINEAL**
>Referenced Brachy Application Setup Number	(300C,000C)	3	References application setup specified by Application Setup Number (300A,0234) in Application Setup Sequence (300A,0230) in RT Brachy Application Setups Module within referenced RT Plan.
>Application Setup Name	(300A,0236)	3	User-defined name for Application Setup.
>Application Setup Manufacturer	(300A,0238)	3	Manufacturer of Application Setup.
>Template Number	(300A,0240)	3	Identification number of the Template.
>Template Type	(300A,0242)	3	User-defined type for Template Device.
>Template Name	(300A,0244)	3	User-defined name for Template Device.
>Application Setup Check	(3008,0116)	3	Results of check-wire travel through all channels of current Application Setup. Enumerated Values: **PASSED** Passed check **FAILED** Failed check **UNKNOWN** Unknown status
>Referenced Verification Image Sequence	(300C,0040)	3	Sequence of verification images obtained during delivery of current beam. One or more Items are permitted in this Sequence. See Note.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Total Reference Air Kerma	(300A,0250)	1	Total Reference Air Kerma for current Application Setup, i.e., the sum of the products of the Air Kerma Rates of each Source in each Channel with its respective Channel Time (μGy at 1 m). Value shall be zero for non-gamma sources.
>Referenced Measured Dose Reference Sequence	(3008,0080)	3	Sequence of doses measured during treatment delivery, summed over entire session. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely references Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Measured Dose Reference Number (3008,0082) is not present. It shall not be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>>Referenced Measured Dose Reference Number	(3008,0082)	1C	Uniquely references Measured Dose Reference specified by Measured Dose Reference Number (3008,0064) in Measured Dose Reference Sequence (3008,0010). Required if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>>Measured Dose Value	(3008,0016)	1	Measured Dose in units specified by Dose Units (3004,0002) in Sequence referenced by Measured Dose Reference Sequence (3008,0010) or Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan as defined above.
>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	Sequence of doses estimated for each treatment delivery. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Calculated Dose Reference Number (3008,0092) is not present. It shall not be present otherwise.
>>Referenced Calculated Dose Reference Number	(3008,0092)	1C	Uniquely identifies Calculated Dose Reference specified by Calculated Dose Reference Number (3008,0072) within Calculated Dose Reference Sequence (3008,0070). Required if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>>Calculated Dose Reference Dose Value	(3008,0076)	1	Calculated Dose (Gy).
>Current Fraction Number	(3008,0022)	2	Fraction number for this application setup.
>Treatment Delivery Type	(300A,00CE)	2	Delivery Type of treatment. Defined Terms: **TREATMENT** normal patient treatment **CONTINUATION** continuation of interrupted treatment
>Treatment Termination Status	(3008,002A)	1	Conditions under which treatment was terminated. Enumerated Values: **NORMAL** treatment terminated normally **OPERATOR** operator terminated treatment **MACHINE** machine terminated treatment for other than NORMAL condition **UNKNOWN** status at termination unknown
>Treatment Termination Code	(3008,002B)	3	Treatment machine termination code. This code is dependent upon the particular application and equipment.
>Treatment Verification Status	(3008,002C)	2	Conditions under which treatment was verified by a verification system. Enumerated Values: **VERIFIED** treatment verified **VERIFIED_OVR** treatment verified with at least one out-of-range value overridden **NOT_VERIFIED** treatment verified manually
>Recorded Brachy Accessory Device Sequence	(3008,0120)	3	Sequence of Brachy Accessory Devices associated with current Application Setup. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Referenced Brachy Accessory Device Number	(3008,0122)	2	Identification number of the Brachy Accessory Device. The value of Brachy Accessory Device Number (300A,0262) shall be unique within the Application Setup in which it is created.
>>Brachy Accessory Device ID	(300A,0263)	2	User or machine supplied identifier for Brachy Accessory Device.
>>Brachy Accessory Device Type	(300A,0264)	1	Type of Brachy Accessory Device. Defined Terms: **SHIELD** **DILATATION** **MOLD** **PLAQUE** **FLAB**
>>Brachy Accessory Device Name	(300A,0266)	3	User-defined name for Brachy Accessory Device.
>Recorded Channel Sequence	(3008,0130)	1	Sequence of Channels for current Application Setup. One or more Items shall be included in this Sequence.
>>Channel Number	(300A,0282)	1	Identification number of the Channel. The value of Channel Number (300A,0282) shall be unique within the Application Setup in which it is created.
>>Referenced Channel Number	(0074,1406)	3	The channel to be delivered, specified by the value of Channel Number (300A,0282) in referenced RT Plan.
>>Channel Length	(300A,0284)	2	Length of Channel (mm). See RT Plan IOD.
>>Channel Effective Length	(300A,0271)	3	Length of Channel (in mm) defined as the distance between the connector on the afterloader and the center of the distal-most possible position of the source. See Section C.8.8.15.16.
>>Channel Inner Length	(300A,0272)	2C	The total physical inner length of channel (in mm). Specifies the distance between the connector on the afterloader and the end of the channel. Required if Channel Effective Length (300A,0271) is present. See Section C.8.8.15.16.1.
>>Afterloader Channel ID	(300A,0273)	3	Identification of the Channel connection on the afterloader. See Section C.8.8.15.16.2.
>>Specified Channel Total Time	(3008,0132)	1	Total amount of time in seconds, scaled for the current source delivery strength and other delivery factors, specified to be delivered at the time of treatment between the first Control Point and the final Control Point for the current Channel. In the case of resuming a partially delivered treatment, the Specified Channel Total time will only include the remainder to be treated. See Section C.8.8.22.2.
>>Delivered Channel Total Time	(3008,0134)	1	Total amount of time in seconds actually delivered between Control Point 0 and final Control Point of the Brachy Control Point Delivered Sequence (3008,0160) for current Channel.

Attribute Name	Tag	Type	Attribute Description
>>Source Movement Type	(300A,0288)	1	Type of Source movement. Defined Terms: **STEPWISE** **FIXED** **OSCILLATING** **UNIDIRECTIONAL**
>>Specified Number of Pulses	(3008,0136)	1C	Number of Pulses specified per fraction for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR. See Section C.8.8.22.1.
>>Delivered Number of Pulses	(3008,0138)	1C	Number of Pulses actually delivered per fraction for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR. See Section C.8.8.22.1.
>>Specified Pulse Repetition Interval	(3008,013A)	1C	Pulse repetition interval (sec) specified for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR. See Section C.8.8.22.1
>>Delivered Pulse Repetition Interval	(3008,013C)	1C	Pulse repetition interval (sec) actually delivered for current Channel. Required if Brachy Treatment Type (300A,0202) is PDR. See Section C.8.8.22.1.
>>Referenced Measured Dose Reference Sequence	(3008,0080)	3	Sequence of doses measured during treatment delivery, summed over entire session. One or more Items are permitted in this Sequence.
>>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely references Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Measured Dose Reference Number (3008,0082) is not present. It shall not be present otherwise.
>>>Referenced Measured Dose Reference Number	(3008,0082)	1C	References Measured Dose Reference specified by Measured Dose Reference Number (3008,0064) in Measured Dose Reference Sequence (3008,0010). Required if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>>>Measured Dose Value	(3008,0016)	1	Measured Dose.
>>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	Sequence of doses estimated for each treatment delivery. One or more Items are permitted in this Sequence.
>>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan. Required if Referenced Calculated Dose Reference Number (3008,0092) is not present. It shall not be present otherwise.
>>>Referenced Calculated Dose Reference Number	(3008,0092)	1C	Uniquely identifies Calculated Dose Reference specified by Calculated Dose Reference Number (3008,0072) within Calculated Dose Reference Sequence (3008,0070). Required if Referenced Dose Reference Number (300C,0051) is not present. It shall not be present otherwise.
>>>Calculated Dose Reference Dose Value	(3008,0076)	1	Calculated Dose (Gy).
>>Recorded Source Applicator Sequence	(3008,0140)	3	Sequence of recorded Source Applicators. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>>Referenced Source Applicator Number	(3008,0142)	2	Identification number of the Source Applicator. The value of Source Applicator Number (300A,0290) shall be unique within the Channel in which it is created.
>>>Source Applicator ID	(300A,0291)	2	User or machine supplied identifier for Source Applicator.
>>>Source Applicator Type	(300A,0292)	1	Type of Source Applicator. Defined Terms: **FLEXIBLE** **RIGID**
>>>Source Applicator Name	(300A,0294)	3	User-defined name for Source Applicator.
>>>Source Applicator Length	(300A,0296)	1	Length of Source Applicator (mm), defined as the distance between the connector of the applicator and the distal-most position of the source.
>>>Source Applicator Tip Length	(300A,0274)	2C	Length of Source Applicator Tip (in mm), defined as the distance between the outer tip of the applicator and the center of the distal-most possible position of the source. Required if Channel Effective Length (300A,0271) is present. See Section C.8.8.15.16.
>>>Source Applicator Manufacturer	(300A,0298)	3	Manufacturer of Source Applicator.
>>>Source Applicator Step Size	(300A,02A0)	1C	Distance of path along channel (mm) between adjacent (potential) dwell positions. Required if Source Movement Type (300A,0288) is STEPWISE.
>>Transfer Tube Number	(300A,02A2)	2	Identification number of the Transfer Tube. The value of Transfer Tube Number (300A,02A2) shall be unique within the Channel in which it is created.
>>Transfer Tube Length	(300A,02A4)	2C	Length of Transfer Tube of current afterloading Channel (mm). Required if value Transfer Tube Number (300A,02A2) is not zero length.
>>Recorded Channel Shield Sequence	(3008,0150)	3	Sequence of Channel Shields associated with current Channel. One or more Items are permitted in this Sequence. See RT Plan IOD for description of Channel Shields.
>>>Referenced Channel Shield Number	(3008,0152)	2	Identification number of the Channel Shield. The value of Channel Shield Number (300A,02B2) shall be unique within the Channel in which it is created.
>>>Channel Shield ID	(300A,02B3)	2	User or machine supplied identifier for Channel Shield.
>>>Channel Shield Name	(300A,02B4)	3	User-defined name for Channel Shield.
>>Referenced Source Number	(300C,000E)	1	Uniquely identifies the referenced Source within the Recorded Source Sequence (3008,0100) for current Application Setup.
>>Safe Position Exit Date	(3008,0162)	1C	Date on which the source(s) exited the safe. Required if Recorded Channel Sequence (3008,0130) is present and Brachy Treatment Type (300A,0202) is not MANUAL or PDR.
>>Safe Position Exit Time	(3008,0164)	1C	Time on which the source(s) exited the safe. Required if Recorded Channel Sequence (3008,0130) is present and Brachy Treatment Type (300A,0202) is not MANUAL or PDR.

Attribute Name	Tag	Type	Attribute Description
>>Safe Position Return Date	(3008,0166)	1C	Date on which the source(s) returned to the safe. Required if Recorded Channel Sequence (3008,0130) is present and Brachy Treatment Type (300A,0202) is not MANUAL or PDR.
>>Safe Position Return Time	(3008,0168)	1C	Time on which the source(s) returned to the safe. Required if Recorded Channel Sequence (3008,0130) is present and Brachy Treatment Type (300A,0202) is not MANUAL or PDR.
>>Number of Control Points	(300A,0110)	1	Number of control points in Channel. For an N-segment Channel there will be 2N (stepwise movement) or N+1 (continuous movement) control points.
>>Brachy Control Point Delivered Sequence	(3008,0160)	1	Sequence of machine configurations describing this Channel. The number of Items in this Sequence shall equal the value of Number of Control Points (300A,0110). See RT Plan IOD and Section C.8.8.22.1 for description of Brachy Control Point Delivered Sequence.
>>>Referenced Control Point Index	(300C,00F0)	3	Index of current Control Point, starting at 0 for first Control Point.
>>>Treatment Control Point Date	(3008,0024)	1	Date when the delivery of radiation at this control point began. For the final control point this shall be the Date when the previous control point ended.
>>>Treatment Control Point Time	(3008,0025)	1	Time when the delivery of radiation at this control point began. For the final control point this shall be the Time when the previous control point ended.
>>>Control Point Relative Position	(300A,02D2)	1	Distance in mm between current Control Point Position and the center of the distal-most possible Source position in current Channel. See RT Plan IOD.
>>>Override Sequence	(3008,0060)	3	Sequence of parameters that were overridden during the administration of the treatment immediately prior to the current control point. One or more Items are permitted in this Sequence.
>>>>Override Parameter Pointer	(3008,0062)	2	Contains the Data Element Tag of the Attribute that was overridden.
>>>>Operators' Name	(0008,1070)	2	Name of operator who authorized override.
>>>>Operator Identification Sequence	(0008,1072)	3	Identification of the operator who authorized override. Only a single Item is permitted in this Sequence.
>>>>>Include Table 10-1 “Person Identification Macro Attributes Description”			
>>>>Override Reason	(3008,0066)	3	User-defined description of reason for override of parameter specified by Override Parameter Pointer (3008,0062).
>>Pulse Specific Brachy Control Point Delivered Sequence	(3008,0171)	3	Brachy Control Point Delivered Sequence for each PDR treatment pulse. Number of Items in the Sequence shall be equal to the Delivered Number of Pulses (3008,0138).
>>>Pulse Number	(3008,0172)	1	Identification Number of this delivered Pulse. The pulse numbers for a treatment start at 1 and increase monotonically by 1. A given SOP Instance might only contain some of the pulses of the given treatment.
>>>Safe Position Exit Date	(3008,0162)	1	Date on which the source(s) exited the safe.
>>>Safe Position Exit Time	(3008,0164)	1	Time at which the source(s) exited the safe.

Attribute Name	Tag	Type	Attribute Description
>>>Safe Position Return Date	(3008,0166)	1	Date on which the source(s) returned to the safe.
>>>Safe Position Return Time	(3008,0168)	1	Time at which the source(s) returned to the safe.
>>>Brachy Pulse Control Point Delivered Sequence	(3008,0173)	1	List of control points for this pulse. See Section C.8.8.22.1.
>>>>Referenced Control Point Index	(300C,00F0)	3	Index of current Control Point, starting at 0 for first Control Point in this Sequence.
>>>>Treatment Control Point Date	(3008,0024)	1	Date when the delivery of radiation at this control point began. For the final control point, this shall be the Date when the previous control point ended.
>>>>Treatment Control Point Time	(3008,0025)	1	Time when the delivery of radiation at this control point began. For the final control point, this shall be the Time when the previous control point ended.
>>>>Control Point Relative Position	(300A,02D2)	1	Distance in mm between current Control Point Position and the center of the distal-most possible Source position in current Channel. See Section C.8.8.15.9.
>>>>Override Sequence	(3008,0060)	3	Parameters which were overridden during the administration of the treatment immediately prior to the current control point. One or more Items are permitted in this Sequence.
>>>>>Override Parameter Pointer	(3008,0062)	2	Data Element Tag of the Attribute that was overridden.
>>>>>Operators' Name	(0008,1070)	2	Name of operator who authorized override.
>>>>>Operator Identification Sequence	(0008,1072)	3	Identification of the operator who authorized override. Only a single Item is permitted in this Sequence.
>>>>>>*Include Table 10-1 “Person Identification Macro Attributes Description”*			
>>>>>Override Reason	(3008,0066)	3	User-defined description of reason for override.

Note

The Referenced Verification Image Sequence (300C,0040) may contain either images taken specifically for verification of the brachy application setup or reference images used in place of verification images, as might be done in HDR treatment planning.

C.8.8.22.1 PDR (Pulsed Dose Rate) Treatment

In Brachytherapy treatment techniques where Brachy Treatment Type (300A,0202) is PDR, the Brachy Control Point Sequence (300A,02D0) shall consist of 2N Items, where N = Delivered Number of Pulses (3008,0138). Each control point pair shall represent a single pulse and consist of the first control point of the pulse and the last control point of the pulse.

The Brachy Pulse Control Point Delivered Sequence (3008,0173) is consistent with the Brachy Control Point Delivered Sequence (3008,0160) as defined in the enclosing Recorded Channel Sequence (3008,0130) except all control points delivered are listed in this Sequence as opposed to listing only the start and end control points in the Brachy Control Point Delivered Sequence (3008,0160).

C.8.8.22.2 Specified Channel Total Time

Total time is derived from the Brachy Control Point Sequence (300A,02D0) by scaling times for the current source delivery strength and accounting for other delivery device capabilities influencing the actual delivery.

In brachytherapy treatment techniques where Brachy Treatment Type (300A,0202) is PDR, the Specified Channel Total Time (3008,0132) shall consist of the specified channel total time summed over the Specified Number of Pulses (3008,0136).

The following examples describe the contents of Specified Channel Total Time (3008,0132), Delivered Channel Total Time (3008,0134) and Treatment Termination Status (3008,002A) under normal and interrupted delivery conditions.

Example:

- Fraction delivered without interruption
  - Session 1:
    - Specified Channel Total Time = 100.0 seconds
    - Delivered Channel Total Time = 100.0 seconds
    - Treatment Termination Status = NORMAL
- Fraction delivered with interruption. Second session delivered in timely manner such that there is negligible source decay between sessions.
  - Session 1:
    - Specified Channel Total Time = 100.0 seconds
    - Delivered Channel Total Time = 50.0 seconds
    - Treatment Termination Status = OPERATOR or MACHINE
  - Session 2:
    - Specified Channel Total Time = 50.0 seconds
    - Delivered Channel Total Time = 50.0 seconds
    - Treatment Termination Status = NORMAL
- Fraction delivered with interruption. Second session delivered later such that additional source decay between sessions must be accounted for. In Session 2 the source is at approximately 96% of Session 1 strength.
  - Session 1:
    - Specified Channel Total Time = 100.0 seconds
    - Delivered Channel Total Time = 50.0 seconds
    - Treatment Termination Status = OPERATOR or MACHINE
  - Session 2:
    - Specified Channel Total Time = 52.0 seconds
    - Delivered Channel Total Time = 52.0 seconds
    - Treatment Termination Status = NORMAL

C.8.8.23 RT Treatment Summary Record Module

Table C.8-59. RT Treatment Summary Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Current Treatment Status	(3008,0200)	1	Status of the Treatment at the time the Treatment Summary was created. Enumerated Values: **NOT_STARTED** **ON_TREATMENT** **ON_BREAK** **SUSPENDED** **STOPPED** **COMPLETED** See Section C.8.8.23.1.
Treatment Status Comment	(3008,0202)	3	Comment on current treatment status.
First Treatment Date	(3008,0054)	2	Date of delivery of the first treatment.
Most Recent Treatment Date	(3008,0056)	2	Date of delivery of the most recent administration.
Fraction Group Summary Sequence	(3008,0220)	3	Sequence describing current state of planned vs. delivered fraction groups. One or more Items are permitted in this Sequence.
>Referenced Fraction Group Number	(300C,0022)	3	References Fraction Group Number (300A,0071) in Fraction Group Sequence (300A,0070) in the referenced RT Plan.
>Fraction Group Type	(3008,0224)	2	Indicates type of fraction group. Enumerated Values: **EXTERNAL_BEAM** **BRACHY**
>Number of Fractions Planned	(300A,0078)	2	Number of fractions planned for this fraction group.
>Number of Fractions Delivered	(3008,005A)	2	Number of fractions delivered as of Treatment Summary Report.
>Fraction Status Summary Sequence	(3008,0240)	3	Sequence describing status of fractions in Fraction Group. One or more Items are permitted in this Sequence.
>>Referenced Fraction Number	(3008,0223)	1	Identifies fraction.
>>Treatment Date	(3008,0250)	2	Date when fraction was delivered.
>>Treatment Time	(3008,0251)	2	Time when fraction was delivered.
>>Treatment Termination Status	(3008,002A)	2	Conditions under which treatment was terminated. Enumerated Values: **NORMAL** treatment terminated normally **OPERATOR** operator terminated treatment **MACHINE** machine terminated treatment for other than NORMAL condition **UNKNOWN** status at termination unknown
Treatment Summary Measured Dose Reference Sequence	(3008,00E0)	3	Sequence of references to Measured Dose References. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Referenced Dose Reference Number	(300C,0051)	3	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan referenced in Referenced RT Plan Sequence (300C,0002) of RT General Treatment Record Module.
>Dose Reference Description	(300A,0016)	3	User-defined description of Dose Reference.
>Cumulative Dose to Dose Reference	(3008,0052)	1	Cumulative Dose delivered to Dose Reference (Gy).
Treatment Summary Calculated Dose Reference Sequence	(3008,0050)	3	Sequence of references to Calculated Dose References. One or more Items are permitted in this Sequence.
>Referenced Dose Reference Number	(300C,0051)	3	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Plan referenced in Referenced RT Plan Sequence (300C,0002) of RT General Treatment Record Module.
>Dose Reference Description	(300A,0016)	3	User-defined description of Dose Reference.
>Cumulative Dose to Dose Reference	(3008,0052)	1	Cumulative Dose delivered to Dose Reference (Gy).

Note

The RT Treatment Summary Record IOD may contain references to related RT Treatment Session Record IODs. These references are contained within the Referenced Treatment Record Sequence (3008,0030) of the RT General Treatment Record Module.

C.8.8.23.1 Current Treatment Status

Enumerated Values:

NOT_STARTED Patient has not yet begun treatment
ON_TREATMENT Patient is currently undergoing treatment
ON_BREAK Patient is currently not undergoing treatment, but a resumption date is known
SUSPENDED Patient is currently not undergoing treatment, but resumption of treatment is planned at an unknown date
STOPPED Patient has stopped treatment without completing the planned course
COMPLETED Patient completed the planned course of treatment

A change in the Current Treatment Status (or any other field) in a RT Treatment Summary Record Object shall define a new Instance of the RT Treatment Summary Record IOD.

C.8.8.24 RT Ion Tolerance Tables Module

The RT Ion Tolerance Tables Module contains information describing the maximum allowed differences between the planned and measured Attributes for Ion therapy.

Table C.8.8.24-1. RT Ion Tolerance Tables Module Attributes

Attribute Name	Tag	Type	Description
Ion Tolerance Table Sequence	(300A,03A0)	1	Sequence of ion tolerance tables to be used for delivery of treatment plan. One or more Items shall be included in this Sequence. See Note 1.

Attribute Name	Tag	Type	Description
>Tolerance Table Number	(300A,0042)	1	Identification number of the Tolerance Table. The value of Tolerance Table Number (300A,0042) shall be unique within the RT Ion Plan in which it is created.
>Tolerance Table Label	(300A,0043)	3	User-defined label for Tolerance Table.
>Gantry Angle Tolerance	(300A,0044)	3	Maximum permitted difference (in degrees) between planned and delivered Gantry Angle.
>Beam Limiting Device Angle Tolerance	(300A,0046)	3	Maximum permitted difference (in degrees) between planned and delivered Beam Limiting Device Angle.
>Beam Limiting Device Tolerance Sequence	(300A,0048)	3	Sequence of beam limiting device (collimator) tolerances. One or more Items are permitted in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Beam Limiting Device Position Tolerance	(300A,004A)	1	Maximum permitted difference (in mm) between planned and delivered leaf (element) or jaw positions for current beam limiting device (collimator).
>Patient Support Angle Tolerance	(300A,004C)	3	Maximum permitted difference (in degrees) between planned and delivered Patient Support Angle.
>Table Top Vertical Position Tolerance	(300A,0051)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Vertical Position.
>Table Top Longitudinal Position Tolerance	(300A,0052)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Longitudinal Position.
>Table Top Lateral Position Tolerance	(300A,0053)	3	Maximum permitted difference (in mm) between planned and delivered Table Top Lateral Position.
>Table Top Pitch Angle Tolerance	(300A,004F)	3	Maximum permitted difference (in degrees) between planned and delivered Table Top Pitch Angle.
>Table Top Roll Angle Tolerance	(300A,0050)	3	Maximum permitted difference (in degrees) between planned and delivered Table Top Roll Angle.
>Snout Position Tolerance	(300A,004B)	3	Maximum permitted difference (in mm) between planned and delivered Snout Position.
>Head Fixation Angle Tolerance	(300A,0152)	3	Maximum permitted difference (in degrees) between planned and delivered Head Fixation Angle (300A,0148).
>Chair Head Frame Position Tolerance	(300A,0153)	3	Maximum permitted difference (in mm) between planned and delivered Chair Head Frame Position (300A,0151).
>Fixation Light Azimuthal Angle Tolerance	(300A,0154)	3	Maximum permitted difference (in degrees) between planned and delivered Fixation Light Azimuthal Angle (300A,0356).
>Fixation Light Polar Angle Tolerance	(300A,0155)	3	Maximum permitted difference (in mm) between planned and delivered Fixation Light Polar Angle (300A,0358).

Note 1: Tolerance Tables may be used to compare planned values to actual machine values. If the absolute difference between the planned and actual values exceeds the Tolerance Table value, treatment may be inhibited or the operator may be warned.

C.8.8.25 RT Ion Beams Module

The RT Ion Beams Module contains information defining equipment parameters for delivery of external Ion radiation beams.

Table C.8.8.25-1. RT Ion Beams Module Attributes

Attribute Name	Tag	Type	Description
Ion Beam Sequence	(300A,03A2)	1	Sequence of setup and/or treatment beams for current RT Ion Plan. One or more Items shall be included in this Sequence.
>Beam Number	(300A,00C0)	1	Identification number of the Beam. The value of Beam Number (300A,00C0) shall be unique within the RT Ion Plan in which it is created. See Section C.8.8.25.1.
>Beam Name	(300A,00C2)	1	User-defined name for Beam. See Section C.8.8.25.1.
>Beam Description	(300A,00C3)	3	User-defined description for Beam. See Section C.8.8.25.1.
>Beam Type	(300A,00C4)	1	Motion characteristic of Beam. Enumerated Values: **STATIC** All Ion Control Point Sequence (300A,03A8) Attributes remain unchanged between consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134). **DYNAMIC** One or more Ion Control Point Sequence (300A,03A8) Attributes change between one or more consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134).
>Radiation Type	(300A,00C6)	1	Particle type of Beam. Defined Terms: **PHOTON** **PROTON** **ION**
>Radiation Mass Number	(300A,0302)	1C	Mass number of radiation. Required if Radiation Type (300A,00C6) is ION
>Radiation Atomic Number	(300A,0304)	1C	Atomic number of radiation. Required if Radiation Type (300A,00C6) is ION
>Radiation Charge State	(300A,0306)	1C	Charge state of radiation. Required if Radiation Type (300A,00C6) is ION
>Scan Mode	(300A,0308)	1	The method of beam scanning to be used during treatment. Defined Terms: **NONE** No beam scanning is performed. **UNIFORM** Between control points, the beam is scanned to create a uniform lateral fluence distribution across the field. **MODULATED** Between control points, the beam is scanned to create a modulated lateral fluence distribution across the field. **MODULATED_SPEC** Between control points, the beam is scanned to create a modulated lateral fluence distribution across the field. The specific scan mode is defined by Modulated Scan Mode Type (300A,0309).

Attribute Name	Tag	Type	Description
>Modulated Scan Mode Type	(300A,0309)	1C	Defines the specialization of a modulated scan mode. Defined Terms: **STATIONARY** The Meterset is delivered while the beam spot is at the specified position. The beam is always turned off when the position changes. **LEAPING** The Meterset is mainly delivered at the specified spot position, while some of the Meterset is delivered while the spot is moved from the prior spot position. This mode also supports turning off the beam between spot positions. **LINEAR** The Meterset is delivered uniformly while the beam spot position changes. This mode also supports turning off the beam between line segments. Note The Defined Term MIXED was previously defined. It is now retired. Required if Scan Mode (300A,0308) is MODULATED_SPEC. See Section C.8.8.25.8.
>Treatment Machine Name	(300A,00B2)	2	User-defined name identifying treatment machine to be used for beam delivery. See Section C.8.8.25.2.
>Manufacturer	(0008,0070)	3	Manufacturer of the equipment to be used for beam delivery.
>Institution Name	(0008,0080)	3	Institution where the equipment is located that is to be used for beam delivery.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located that is to be used for beam delivery.
>Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that is to be used for beam delivery.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that is to be used for beam delivery.
>Primary Dosimeter Unit	(300A,00B3)	1	Measurement unit of machine dosimeter. Enumerated Values: **MU** Monitor Unit **NP** number of particles
>Referenced Tolerance Table Number	(300C,00A0)	3	Uniquely identifies Tolerance Table specified by Tolerance Table Number (300A,0042) within Tolerance Table Sequence in RT Ion Tolerance Tables Module. These tolerances are to be used for verification of treatment machine settings.

Attribute Name	Tag	Type	Description
>Virtual Source-Axis Distances	(300A,030A)	1	Distance (in mm) from virtual source position to gantry rotation axis or nominal isocenter position (fixed beam-lines) of the equipment to be used for beam delivery. Specified by a numeric pair - the VSAD in the IEC Gantry X direction followed by the VSAD in the IEC Gantry Y direction. The VSAD is commonly used for designing apertures in contrast to the effective source-axis-distance (ESAD) that is commonly used with the inverse square law for calculating the dose decrease with distance. See Section C.8.8.25.4.
>Depth Dose Parameters Sequence	(300A,0505)	3	Set of parameters describing the depth dose distribution. Only a single Item is permitted in this Sequence.
>>Reference Dose Definition	(300A,0512)	1	Definition of the 100% reference dose level. Defined Terms: **HIGHEST** **MAXIMUM** **CENTER** See Section C.8.8.25.9.
>>Distal Depth	(300A,0502)	1	Penetration depth in water (mm) of the particle excluding any user-installed range modifying devices, measured at the Distal Depth Fraction (300A,0501). See Section C.8.8.25.9.
>>Distal Depth Fraction	(300A,0501)	1	Fraction of the value of dose relative to the 100% level defined by Reference Dose Definition (300A,0512). This determines the Distal Depth (300A,0502). A value of 1.0 refers to 100% of the reference dose level defined by the Reference Dose Definition (300A,0512). See Section C.8.8.25.9.
>>Nominal Range Modulated Region Depths	(300A,0504)	1C	The depths of the proximal and distal limits of the range modulated region in water. Contains two values (in mm). The first value defines the depth of the proximal limit. The second value defines the depth of the distal limit. Required if Reference Dose Definition (300A,0512) has the value CENTER. See Section C.8.8.25.9.
>>Nominal Range Modulation Fractions	(300A,0503)	1C	Fractions of the Reference Dose Definition (300A,0512) defining the proximal and distal limits at which the range-modulated region is defined. Contains two values. The first value defines the modulation fraction value at the proximal limit and the second value defines the modulation fraction value at the distal limit. A value of 1.0 refers to the 100% reference dose level as defined in Reference Dose Definition (300A,0512). Required if Nominal Range Modulated Region Depths (300A,0504) is present. See Section C.8.8.25.9.

Attribute Name	Tag	Type	Description
>Ion Beam Limiting Device Sequence	(300A,03A4)	3	Sequence of beam limiting device (collimator) jaw or leaf (element) sets. One or more Items are permitted in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Isocenter to Beam Limiting Device Distance	(300A,00BB)	2	Isocenter to beam limiting device (collimator) distance (in mm) of the equipment that is to be used for beam delivery. See Section C.8.8.25.4 and Section C.8.8.25.10.
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>>Leaf Position Boundaries	(300A,00BE)	1C	Boundaries of beam limiting device (collimator) leaves (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), i.e., X-axis for MLCY, Y-axis for MLCX. Contains N+1 values, where N is the Number of Leaf/Jaw Pairs (300A,00BC), starting from Leaf (Element) Pair 1. Required if RT Beam Limiting Device Type (300A,00B8) is MLCX or MLCY. May be present otherwise. See Section C.8.8.25.3.
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Patient Setup to be used for current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence of RT Patient Setup Module.
>Referenced Reference Image Sequence	(300C,0042)	3	Reference images used for validation of current beam. One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Reference Image Number	(300A,00C8)	1	Uniquely identifies Reference Image within Referenced Reference Image Sequence (300C,0042).
>Treatment Delivery Type	(300A,00CE)	1	Delivery Type of treatment. Defined Terms: **TREATMENT** Normal patient treatment **OPEN_PORTFILM** Portal image acquisition with open field (the source of radiation is specified by Radiation Type (300A,00C6)) **TRMT_PORTFILM** Portal image acquisition with treatment port (the source of radiation is specified by Radiation Type (300A,00C6)) **CONTINUATION** Continuation of interrupted treatment **SETUP** No treatment beam is applied for this RT Beam. To be used for specifying the gantry, couch, and other machine positions where X-Ray set-up images or measurements shall be taken.

Attribute Name	Tag	Type	Description
>Referenced Dose Sequence	(300C,0080)	3	Related Instances of RT Dose (for grids, isodose curves, and named/unnamed point doses). One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			*The Referenced Class SOP UID shall be that of the RT Dose SOP Class (1.2.840.10008.5.1.4.1.1.481.2).*
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current beam.
>Total Wedge Tray Water-Equivalent Thickness	(300A,00D7)	3	Shift of the wedge tray induced on the range of the ion beam as measured in water (in mm).
>Ion Wedge Sequence	(300A,03AA)	1C	Sequence of treatment wedges. Required if Number of Wedges (300A,00D0) is non-zero. The number of Items shall be identical to the value of Number of Wedges (300A,00D0).
>>Wedge Number	(300A,00D2)	1	Identification number of the Wedges. The value of Wedge Number (300A,00D2) shall be unique within the Beam in which it was created.
>>Wedge Type	(300A,00D3)	2	Type of wedge (if any) defined for Beam. Defined Terms: **STANDARD** standard (static) wedge **MOTORIZED** single wedge that can be removed from beam remotely. **PARTIAL_STANDARD** wedge does not extend across the whole field and is operated manually. **PARTIAL_MOTORIZ** wedge does not extend across the whole field and can be removed from beam remotely.
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for Wedge.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Wedge Angle	(300A,00D5)	2	Nominal wedge angle (degrees).
>>Wedge Orientation	(300A,00D8)	2	Orientation of wedge, i.e., orientation of IEC WEDGE FILTER coordinate system with respect to the IEC BEAM LIMITING DEVICE coordinate systems (degrees).
>>Isocenter to Wedge Tray Distance	(300A,00D9)	1	Isocenter to downstream edge of wedge tray (mm). See Section C.8.8.25.4 and Section C.8.8.25.10
>Number of Compensators	(300A,00E0)	1	Number of compensators associated with current Beam.
>Total Compensator Tray Water-Equivalent Thickness	(300A,02E3)	3	Water-Equivalent thickness of the compensator tray (in mm) parallel to radiation beam axis.
>Ion Range Compensator Sequence	(300A,02EA)	1C	Sequence of compensators. Required if Number of Compensators (300A,00E0) is non-zero. The number of Items shall be identical to the value of Number of Compensators (300A,00E0).
>>Compensator Description	(300A,02EB)	3	User defined description for the compensator.
>>Compensator Number	(300A,00E4)	1	Identification number of the Compensator. The value of Compensator Number (300A,00E4) shall be unique within the Beam in which it is created.
>>Material ID	(300A,00E1)	2	User-supplied identifier for material used to manufacture Compensator.
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for the compensator.

Attribute Name	Tag	Type	Description
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Isocenter to Compensator Tray Distance	(300A,02E4)	1C	Isocenter to compensator tray attachment edge distance (in mm) for current range compensator. Required if Compensator Mounting Position (300A,02E1) is not DOUBLE_SIDED. See Section C.8.8.25.4 and Section C.8.8.25.10
>>Compensator Divergence	(300A,02E0)	1	Indicates presence or absence of geometrical divergence of the range compensator. Enumerated Values: **PRESENT** the range compensator is shaped according to the beam geometrical divergence. **ABSENT** the range compensator is not shaped according to the beam geometrical divergence.
>>Compensator Mounting Position	(300A,02E1)	1	Indicates on which side of the Compensator Tray the compensator is mounted. Enumerated Values: **PATIENT_SIDE** the Compensator is mounted on the side of the Compensator Tray that is towards the patient. **SOURCE_SIDE** the Compensator is mounted on the side of the Compensator Tray that is towards the radiation source. **DOUBLE_SIDED** the Compensator has a shaped (i.e., non-flat) surface on both sides of the Compensator Tray.
>>Compensator Rows	(300A,00E7)	1	Number of rows in the range compensator. A row is defined to be in the X direction of the IEC Beam Limiting Device Coordinate system.
>>Compensator Columns	(300A,00E8)	1	Number of columns in the range compensator. A column is defined to be in the Y direction of the IEC Beam Limiting Device Coordinate system.
>>Compensator Pixel Spacing	(300A,00E9)	1	Physical distance (in mm) between the center of each pixel projected onto machine isocentric plane. Specified by a numeric pair - adjacent row spacing followed by adjacent column spacing. See Section 10.7.1.3 for further explanation of the value order.
>>Compensator Position	(300A,00EA)	1	The x and y coordinates of the upper left hand corner (first pixel transmitted) of the range compensator, projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm).
>>Compensator Column Offset	(300A,02E5)	1C	The offset distance (in mm) applied to the x coordinate of Compensator Position (300A,00EA) for even numbered rows. Required if the compensator pattern is hexagonal.
>>Compensator Thickness Data	(300A,00EC)	1	A data stream of the pixel samples that comprise the range compensator, expressed as physical thickness (in mm), either parallel to radiation beam axis if Compensator Divergence (300A,02E0) equals ABSENT, or divergent according to the beam geometrical divergence if Compensator Divergence (300A,02E0) equals PRESENT. The order of pixels encoded is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the rows).

Attribute Name	Tag	Type	Description
>>Isocenter to Compensator Distances	(300A,02E6)	1C	A data stream of the pixel samples that comprise the distance from the isocenter to the compensator surface closest to the radiation source (in mm). The order of pixels encoded is left to right, top to bottom (upper left pixel, followed by the remainder of row 1, followed by the remainder of the rows). Required if Material ID (300A,00E1) is non-zero length, and Compensator Mounting Position (300A,02E1) is DOUBLE_SIDED. See Section C.8.8.14.9, Section C.8.8.25.4, Section C.8.8.25.10 and Section C.8.8.25.11.
>>Compensator Relative Stopping Power Ratio	(300A,02E7)	3	Compensator Linear Stopping Power Ratio, relative to water, at the beam energy specified by the Nominal Beam Energy (300A,0114) of the first Control Point of the Ion Control Point Sequence (300A,03A8).
>>Compensator Milling Tool Diameter	(300A,02E8)	3	The diameter (in mm) of the milling tool to be used to create the compensator. The diameter is expressed as the actual physical size and not a projected size at isocenter.
>Number of Boli	(300A,00ED)	1	Number of boli associated with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	1C	Sequence of boli associated with Beam. Required if Number of Boli (300A,00ED) is non-zero. The number of Items shall be identical to the value of Number of Boli (300A,00ED).
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Total Block Tray Water-Equivalent Thickness	(300A,00F3)	3	Water-Equivalent thickness of the block tray (in mm) parallel to radiation beam axis.
>Ion Block Sequence	(300A,03A6)	1C	Sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. The number of Items shall be identical to the value of Number of Blocks (300A,00F0).
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader. Shall not be present if Block Slab Sequence (300A,0441) is present within the same Item of Ion Block Sequence (300A,03A6) or when the Block Type (300A,00F8) has a value of APERTURE and Block Slab Sequence (300A,0441) is present in another Item having this value.
>>Isocenter to Block Tray Distance	(300A,00F7)	1	Isocenter to downstream edge of block tray (mm). See Section C.8.8.25.4 and Section C.8.8.25.10
>>Block Type	(300A,00F8)	1	Type of block. See Section C.8.8.14.4. Enumerated Values: **SHIELDING** blocking material is inside contour **APERTURE** blocking material is outside contour

Attribute Name	Tag	Type	Description
>>Block Divergence	(300A,00FA)	1	Indicates presence or otherwise of geometrical divergence. Enumerated Values: **PRESENT** block edges are shaped for beam divergence **ABSENT** block edges are not shaped for beam divergence
>>Block Mounting Position	(300A,00FB)	1	Indicates on which side of the Block Tray the block is mounted. Enumerated Values: **PATIENT_SIDE** the block is mounted on the side of the Block Tray that is towards the patient **SOURCE_SIDE** the block is mounted on the side of the Block Tray that is towards the radiation source
>>Block Number	(300A,00FC)	1	Identification number of the Block. The value of Block Number (300A,00FC) shall be unique within the Beam in which it is created.
>>Block Name	(300A,00FE)	3	User-defined name for block.
>>Material ID	(300A,00E1)	2	User-supplied identifier for material used to manufacture Block.
>>Block Thickness	(300A,0100)	1	Physical thickness of block (in mm) parallel to radiation beam axis. See Section C.8.8.14.4.
>>Block Number of Points	(300A,0104)	1	Number of (x,y) pairs defining the block edge.
>>Block Data	(300A,0106)	1	A data stream of (x,y) pairs that comprise the block edge. The number of pairs shall be equal to Block Number of Points (300A,0104), and the vertices shall be interpreted as a closed polygon. Coordinates are projected onto the machine isocentric plane in the IEC BEAM LIMITING DEVICE coordinate system (mm). See Section C.8.8.25.11.
>>Number of Block Slab Items	(300A,0440)	3	Number of Block Slabs comprising the Block. Value shall be greater than 1.
>>Block Slab Sequence	(300A,0441)	1C	Sequence of slab(s) that comprise the block. Required if Number of Block Slab Items (300A,0440) is present. Shall be present only in the first Item of Ion Block Sequence (300A,03A6) if multiple Items are present where Block Type (300A,00F8) has a value of APERTURE. If this Sequence is present, Accessory Code (300A,00F9) shall not be present within the same Item of Ion Block Sequence (300A,03A6). The number of Items included in this Sequence shall equal the value of Number of Block Slab Items (300A,0440).
>>>Block Slab Number	(300A,0443)	1	Identification number of the Block Slab. The value shall start at 1, and increase monotonically by 1. The number indicates the order of the slabs with respect to the source, where number 1 corresponds to the slab nearest to the source.
>>>Block Slab Thickness	(300A,0442)	3	Physical thickness of block slab (in mm) parallel to radiation beam axis. The sum of the Block Slab Thickness (300A,0442) values of all Items of this Sequence shall be equal to the Block Thickness (300A,0100) of the block.

Attribute Name	Tag	Type	Description
>>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory.
>Snout Sequence	(300A,030C)	3	Sequence of Snouts associated with Beam. Only a single Item is permitted in this Sequence.
>>Snout ID	(300A,030F)	1	User or machine supplied identifier for Snout.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Applicator Sequence	(300A,0107)	3	Sequence of Applicators associated with Beam. Only a single Item is permitted in this Sequence.
>>Applicator ID	(300A,0108)	1	User or machine supplied identifier for Applicator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Applicator Type	(300A,0109)	1	Type of applicator. Defined Terms: **ION_SQUARE** square ion applicator **ION_RECT** rectangular ion applicator **ION_CIRC** circular ion applicator **ION_SHORT** short ion applicator **ION_OPEN** open (dummy) ion applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>General Accessory Sequence	(300A,0420)	3	A Sequence of General Accessories associated with this Beam. One or more Items are permitted in this Sequence.
>>General Accessory Number	(300A,0424)	1	Identification Number of the General Accessory. The value shall be unique within the Sequence.
>>General Accessory ID	(300A,0421)	1	User or machine supplied identifier for General Accessory.
>>General Accessory Description	(300A,0422)	3	User supplied description of General Accessory.
>>General Accessory Type	(300A,0423)	3	Specifies the type of accessory. Defined Terms: **GRATICULE** Accessory tray with a radio-opaque grid **IMAGE_DETECTOR** Image acquisition device positioned in the beam line **RETICLE** Accessory tray with radio-transparent markers or grid
>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory
>>Isocenter to General Accessory Distance	(300A,0426)	3	Isocenter to general accessory distance (in mm) for current accessory. See Section C.8.8.25.10.
>Number of Range Shifters	(300A,0312)	1	Number of range shifters associated with current beam.
>Range Shifter Sequence	(300A,0314)	1C	Sequence of range shifters associated with Beam. Required if Number of Range Shifters (300A,0312) is non-zero. The number of Items shall be identical to the value of Number of Range Shifters (300A,0312).

Attribute Name	Tag	Type	Description
>>Range Shifter Number	(300A,0316)	1	Identification number of the Range Shifter. The value of Range Shifter Number (300A,0316) shall be unique within the Beam in which it is created.
>>Range Shifter ID	(300A,0318)	1	User or machine supplied identifier for Range Shifter.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Range Shifter Type	(300A,0320)	1	Type of Range Shifter. Defined Terms: **ANALOG** Device is variable thickness and is composed of opposing sliding wedges, water column or similar mechanism. **BINARY** Device is composed of different thickness materials that can be moved in or out of the beam in various stepped combinations.
>>Range Shifter Description	(300A,0322)	3	User defined description of Range Shifter.
>Number of Lateral Spreading Devices	(300A,0330)	1	Number of lateral spreading devices associated with current beam.
>Lateral Spreading Device Sequence	(300A,0332)	1C	Sequence of lateral spreading devices associated with Beam. Required if Number of Lateral Spreading Devices (300A,0330) is non-zero. The number of Items shall be identical to the value of Number of Lateral Spreading Devices (300A,0330).
>>Lateral Spreading Device Number	(300A,0334)	1	Identification number of the Lateral Spreading Device. The value of Lateral Spreading Device Number (300A,0334) shall be unique within the Beam in which it is created.
>>Lateral Spreading Device ID	(300A,0336)	1	User or machine supplied identifier for Lateral Spreading Device.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Lateral Spreading Device Type	(300A,0338)	1	Type of Lateral Spreading Device. Defined Terms: **SCATTERER** metal placed into the beam path to scatter charged particles laterally. **MAGNET** nozzle configuration of magnet devices to expand beam laterally.
>>Lateral Spreading Device Description	(300A,033A)	3	User-defined description for lateral spreading device.
>Number of Range Modulators	(300A,0340)	1	Number of range modulators associated with current beam.
>Range Modulator Sequence	(300A,0342)	1C	Sequence of range modulators associated with Beam. Required if Number of Range Modulators (300A,0340) is non-zero. The number of Items shall be identical to the value of Number of Range Modulators (300A,0340).
>>Range Modulator Number	(300A,0344)	1	Identification number of the Range Modulator. The value of Range Modulator Number (300A,0344) shall be unique within the Beam in which it is created.
>>Range Modulator ID	(300A,0346)	1	User or machine supplied identifier for Range Modulator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.

Attribute Name	Tag	Type	Description
>>Range Modulator Type	(300A,0348)	1	Type of Range Modulator. Defined Terms: **FIXED** fixed modulation width and weights using ridge filter or constant speed wheel with constant beam current **WHL_FIXEDWEIGHTS** selected wheel/track (Range Modulator ID) is spinning at constant speed. Modulation width is adjusted by switching constant beam current on and off at wheel steps indicated by Range Modulator Gating Values. **WHL_MODWEIGHTS** selected wheel/track (Range Modulator ID) is spinning at constant speed. Weight per wheel step is adjusted by modulating beam current according to selected Beam Current Modulation ID (300A,034C). Only one Item in the Range Modulator Sequence (300A,0342) can have a Range Modulator Type (300A,0348) of WHL_MODWEIGHTS.
>>Range Modulator Description	(300A,034A)	3	User-defined description of Range Modulator.
>>Beam Current Modulation ID	(300A,034C)	1C	User-supplied identifier for the beam current modulation pattern. Required if Range Modulator Type (300A,0348) is WHL_MODWEIGHTS
>Include Table C.8.8.28-1 "Patient Support Identification Macro Attributes"			
>Fixation Light Azimuthal Angle	(300A,0356)	3	Azimuthal angle (degrees) of the fixation light coordinate around IEC BEAM LIMITING DEVICE Y-axis. Used for eye treatments. See Section C.8.8.25.6.4.
>Fixation Light Polar Angle	(300A,0358)	3	Polar angle (degrees) of the fixation light coordinate. Used for eye treatments. See Section C.8.8.25.6.4.
>Fixation Eye	(300A,0150)	3	The eye used for fixation. Enumerated Values: **L** left eye **R** right eye
>Final Cumulative Meterset Weight	(300A,010E)	1C	Value of Cumulative Meterset Weight (300A,0134) for final Control Point in Ion Control Point Sequence (300A,03A8). Required if Cumulative Meterset Weight is non-null in Control Points specified within Ion Control Point Sequence. See Section C.8.8.14.1.
>Number of Control Points	(300A,0110)	1	Number of control points in Beam. Value shall be greater than or equal to 2.
>Ion Control Point Sequence	(300A,03A8)	1	Sequence of machine configurations describing Ion treatment beam. The number of Items shall be identical to the value of Number of Control Points (300A,0110). See Section C.8.8.25.7.
>>Control Point Index	(300A,0112)	1	Index of current Control Point, starting at 0 for first Control Point.
>>Cumulative Meterset Weight	(300A,0134)	2	Cumulative weight to current control point. Cumulative Meterset Weight for the first Item in Control Point Sequence shall always be zero. Cumulative Meterset Weight for the final Item in Ion Control Point Sequence shall always be equal to Final Cumulative Meterset Weight.

Attribute Name	Tag	Type	Description
>>Referenced Dose Reference Sequence	(300C,0050)	3	A Sequence of Dose References for current Beam. One or more Items are permitted in this Sequence.
>>>Referenced Dose Reference Number	(300C,0051)	1	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module.
>>>Cumulative Dose Reference Coefficient	(300A,010C)	2	Coefficient used to calculate cumulative dose contribution from this Beam to the referenced Dose Reference at the current Control Point.
>>Nominal Beam Energy	(300A,0114)	1C	Nominal Beam Energy at control point in MeV per nucleon. Defined at nozzle entrance before all Beam Modifiers. Required for first Item of Control Point Sequence, or if Nominal Beam Energy changes during Beam, and KVP (0018,0060) is not present.
>>KVP	(0018,0060)	1C	Peak kilo voltage output of the setup X-Ray generator to be used. Required for first Item of Control Point Sequence, or if kVp changes during setup, and Nominal Beam Energy (300A,0114) is not present.
>>Meterset Rate	(300A,035A)	3	Specifies the speed of delivery of the specified dose in units specified by Primary Dosimeter Unit (300A,00B3) per minute.
>>Ion Wedge Position Sequence	(300A,03AC)	1C	Sequence of Wedge positions for current control point. Required for first Item of Ion Control Point Sequence if Number of Wedges (300A,00D0) is non-zero, and in subsequent control points if Wedge Position (300A,0118) or Wedge Thin Edge Position (300A,00DB) changes during beam. The number of Items shall be identical to the value of Number of Wedges (300A,00D0).
>>>Referenced Wedge Number	(300C,00C0)	1	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1).
>>>Wedge Position	(300A,0118)	1	Position of Wedge at current Control Point. Enumerated Values: **IN** **OUT**
>>>Wedge Thin Edge Position	(300A,00DB)	1C	Closest distance from the central axis of the beam along a wedge axis to the thin edge as projected to the machine isocentric plane (mm). Value is positive is the wedge does not cover the central axis, negative if it does. Required if Wedge Type (300A,00D3) of the wedge referenced by Referenced Wedge Number (300C,00C0) is PARTIAL_STANDARD or PARTIAL_MOTORIZ. See Section C.8.8.25.6.4.
>>Range Shifter Settings Sequence	(300A,0360)	1C	Sequence of Range Shifter settings for the current control point. One or more Items shall be included in this Sequence. Required for first Item of Control Point Sequence if Number of Range Shifters (300A,0312) is non-zero, or if Range Shifter Setting (300A,0362) changes during Beam.
>>>Referenced Range Shifter Number	(300C,0100)	1	Uniquely references Range Shifter described by Range Shifter Number (300A,0316) in Range Shifter Sequence (300A,0314).
>>>Range Shifter Setting	(300A,0362)	1	Machine specific setting Attribute for the range shifter. The specific encoding of this value should be documented in a Conformance Statement. See Section C.8.8.25.5.
>>>Isocenter to Range Shifter Distance	(300A,0364)	3	Isocenter to downstream edge of range shifter (mm) at current control point. See Section C.8.8.25.4 and Section C.8.8.25.10

Attribute Name	Tag	Type	Description
>>>Range Shifter Water Equivalent Thickness	(300A,0366)	3	Water equivalent thickness (in mm) of the range shifter at the central axis for the beam energy incident upon the device.
>>Lateral Spreading Device Settings Sequence	(300A,0370)	1C	Sequence of Lateral Spreading Device settings for the current control point. One or more Items shall be included in this Sequence. Required for first Item of Control Point Sequence if Number of Lateral Spreading Devices (300A,0330) is non-zero, or if Lateral Spreading Device Setting (300A,0372) changes during Beam.
>>>Referenced Lateral Spreading Device Number	(300C,0102)	1	Uniquely references Lateral Spreading Device described by Lateral Spreading Device Number (300A,0334) in Lateral Spreading Device Sequence (300A,0332).
>>>Lateral Spreading Device Setting	(300A,0372)	1	Machine specific setting Attribute for the lateral spreading device. The specific encoding of this value should be documented in a Conformance Statement. See Section C.8.8.25.5.
>>>Isocenter to Lateral Spreading Device Distance	(300A,0374)	3	Isocenter to downstream edge of Lateral Spreading Device (mm) at current control point. See Section C.8.8.25.4 and Section C.8.8.25.10
>>>Lateral Spreading Device Water Equivalent Thickness	(300A,033C)	3	Water equivalent thickness (in mm) of the lateral spreading device at the central axis for the beam energy incident upon the device.
>>Range Modulator Settings Sequence	(300A,0380)	1C	Sequence of Range Modulator Settings for current control point. One or more Items shall be included in this Sequence. Required for first Item of Control Point Sequence if Number of Range Modulators (300A,0340) is non-zero, or if Range Modulator Setting changes during Beam.
>>>Referenced Range Modulator Number	(300C,0104)	1	Uniquely references Range Modulator described by Range Modulator Number (300A,0344) in Range Modulator Sequence (300A,0342).
>>>Range Modulator Gating Start Value	(300A,0382)	1C	Start position defines the range modulator position at which the beam is switched on. Required if Range Modulator Type (300A,0348) of the range modulator referenced by Referenced Range Modulator Number (300C,0104) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS
>>>Range Modulator Gating Stop Value	(300A,0384)	1C	Stop position defines the range modulator position at which the beam is switched off. Required if Range Modulator Type (300A,0348) of the range modulator referenced by Referenced Range Modulator Number (300C,0104) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS
>>>Range Modulator Gating Start Water Equivalent Thickness	(300A,0386)	3	If Range Modulator Type (300A,0348) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS: Water equivalent thickness (in mm) of the range modulator at the position specified by Range Modulator Gating Start Value (300A,0382). If Range Modulator Type (300A,0348) is FIXED: Minimum water equivalent thickness (in mm) of the range modulator.

Attribute Name	Tag	Type	Description
>>>Range Modulator Gating Stop Water Equivalent Thickness	(300A,0388)	3	If Range Modulator Type (300A,0348) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS: Water equivalent thickness (in mm) of the range modulator at the position specified by Range Modulator Gating Stop Value (300A,0384). If Range Modulator Type (300A,0348) is FIXED: Maximum water equivalent thickness (in mm) of the range modulator.
>>>Isocenter to Range Modulator Distance	(300A,038A)	3	Isocenter to downstream edge of range modulator (mm) at current control point. See Section C.8.8.25.4 and Section C.8.8.25.10
>>Include Table C.8.8.27-1 "Beam Limiting Device Position Macro Attributes"			
>>Gantry Angle	(300A,011E)	1C	Gantry angle of radiation source, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first Item of Control Point Sequence, or if Gantry Angle changes during Beam.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. Required for first Item of Control Point Sequence, or if Gantry Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Gantry Pitch Angle	(300A,014A)	2C	Gantry Pitch Angle of the radiation source, i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). Required for first Item of Control Point Sequence, or if Gantry Pitch Rotation Angle changes during Beam. See Section C.8.8.25.6.5.
>>Gantry Pitch Rotation Direction	(300A,014C)	2C	Direction of Gantry Pitch Angle when viewing along the positive X-axis of the IEC GANTRY coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Gantry Pitch Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.5. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for first Item of Control Point Sequence, or if Beam Limiting Device Angle changes during Beam.

Attribute Name	Tag	Type	Description
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. Required for first Item of Control Point Sequence, or if Beam Limiting Device Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Scan Spot Tune ID	(300A,0390)	1C	User-supplied or machine code identifier for machine configuration to produce beam spot. This may be the nominal spot size or some other machine specific value. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Scan Spot Reordering Allowed	(300A,0395)	3	Indicates whether the spot delivery order shall remain the same as planned order. Enumerated Values: **ALLOWED** The delivery device may deliver the spots in any order **NOT ALLOWED** The delivery device shall not change the order of the spots within the map and must deliver them in the prescribed order.
>>Number of Scan Spot Positions	(300A,0392)	1C	Number of spot positions used to specify scanning pattern for current segment beginning at control point. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Scan Spot Position Map	(300A,0394)	1C	A data stream of (x,y) pairs that define the coordinates of the scan spots as projected onto the machine isocentric plane in the IEC GANTRY coordinate system (mm). Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC. Contains 2N values where N is the Number of Scan Spot Positions (300A,0392). See Section C.8.8.25.8.
>>Scan Spot Meterset Weights	(300A,0396)	1C	A set of Meterset weights corresponding to scan spot positions. The order of weights matches the positions in Scan Spot Positions (300A,0394). The sum contained in all Meterset weights shall match the difference of the cumulative Meterset weight of the current control point to the following control point. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC. See Section C.8.8.25.8.
>>Scanning Spot Size	(300A,0398)	3	The Scanning Spot Size as calculated using the Full Width Half Maximum (FWHM). Specified by a numeric pair - the size measured in air at isocenter in IEC GANTRY X direction followed by the size in the IEC GANTRY Y direction (mm).
>>Number of Paintings	(300A,039A)	1C	The number of times the scan pattern given by Scan Spot Position Map (300A,0394) and Scan Spot Meterset Weights (300A,0396) shall be applied at the current control point. To obtain the Meterset weight per painting, the values in the Scan Spot Meterset Weights (300A,0396) should be divided by the value of this Attribute. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for first Item of Control Point Sequence, or if Patient Support Angle changes during Beam.

Attribute Name	Tag	Type	Description
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. Required for first Item of Control Point Sequence, or if Patient Support Rotation Direction changes during Beam. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Pitch Angle	(300A,0140)	2C	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). Required for first Item of Control Point Sequence, or if Table Top Pitch Angle changes during Beam. See Section C.8.8.25.6.2.
>>Table Top Pitch Rotation Direction	(300A,0142)	2C	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Table Top Pitch Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	2C	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system (degrees). Required for first Item of Control Point Sequence, or if Table Top Roll Angle changes during Beam. See Section C.8.8.25.6.2.
>>Table Top Roll Rotation Direction	(300A,0146)	2C	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Table Top Roll Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation.
>>Head Fixation Angle	(300A,0148)	3	Angle (in degrees) of the head fixation for eye treatments with respect to the Table Top Pitch Angle (300A,0140) coordinate system. Positive head fixation angle is the same direction as positive Table Top pitch. See Section C.8.8.25.6.4.

Attribute Name	Tag	Type	Description
>>Chair Head Frame Position	(300A,0151)	3	A device-specific value that specifies the relationship between the chair in which the patient is sitting and the head frame in which their head is fixed. It shall be expressed as a distance in mm, such that positive is towards the patient's head away from the seat. Note This value is not intended to be used for geometric calculations, however, for the same device, the relative distance is meaningful. Typically used for eye treatments.
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Vertical Position changes during Beam. See Section C.8.8.14.6.
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Longitudinal Position changes during Beam. See Section C.8.8.14.6.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). Required for first Item of Control Point Sequence, or if Table Top Lateral Position changes during Beam. See Section C.8.8.14.6.
>>Snout Position	(300A,030D)	2C	Axial position of the snout (in mm) measured from isocenter to the downstream side of the snout (without consideration of variable length elements such as blocks, MLC and/or compensators). Required for first Item in Control Point Sequence, or if Snout Position changes during Beam.
>>Isocenter Position	(300A,012C)	2C	Isocenter coordinates (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). Required for first Item of Segment Control Point Sequence, or if Segment Isocenter Position changes during Beam.
>>Surface Entry Point	(300A,012E)	3	Patient surface entry point coordinates (x,y,z), along the central axis of the beam, in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm).
>>External Contour Entry Point	(300A,0133)	3	External Contour entry point coordinates (x,y,z) in the Patient-Based Coordinate System described in Section C.7.6.2.1.1 (mm). See Section C.8.8.14.15.

C.8.8.25.1 Beam Identifying Information

Beam Number (300A,00C0) is provided to link related information across Modules, and its value has no real-world interpretation. Beam Name (300A,00C2), a Type 1 Attribute, is intended to store the primary beam identifier (often referred to as "Field ID"). Beam Description (300A,00C3), a Type 3 Attribute, is intended to store additional beam identifying information (often referred to as "Field Name").

C.8.8.25.2 Treatment Machine Name

The DICOM Standard does not support the transmission of treatment unit modeling information such as depth doses and beam profiles. In the case of Ion therapy, the Treatment Machine Name Attribute is used to uniquely identify a treatment port (or beam line), since there is in effect only one treatment machine (i.e., synchrotron).

C.8.8.25.3 Leaf Position Boundaries

The Leaf Position Boundaries (300A,00BE) shall be the positions of the mechanical boundaries (projected to the isocentric plane) between beam limiting device (collimator) leaves, fixed for a given beam limiting device (collimator). Leaf/Jaw positions (300A,011C) are values specific to a given control point, specifying the beam limiting device (collimator) leaf (element) openings.

In an RT Ion Plan, the Virtual SAD can have different values along the X/Y axes (see Section C.8.8.25.4). Thus the effects of possibly different X/Y SADs shall be taken into account when leaf position boundaries and leaf/jaw positions are projected from the virtual source to the plane of isocenter.

Leaf Position Boundaries (300A,00BE), are outside the control point sequence, which may define a collimator rotation. Therefore their values shall be defined for a collimator angle of 0 Deg IEC nominal position). For rotated collimators, the leaf position calculation is as follows: Define M_x and M_y as the magnification factors for the scaling of the leaf positions from their real space position to the isocenter plane. M_x and M_y are calculated from the virtual SADs $VSAD_x$ or $VSAD_y$, respectively, and the Isocenter to Beam Limiting Device Distance (300A,00BB).

The magnification factor M_α for an arbitrary beam limiting device angle a then becomes:

Snout Position (300A,030D) may be changed between beams, and possibly between control points as well. This results in different effective isocenter to beam limiting device distances and thus leaf position boundaries for the same physical beam limiting device for each beam and possibly control points.

The values for Beam Limiting Device Distances (300A,00BB) and Leaf Position Boundaries (300A,00BE) are defined outside the control point sequence. Therefore the Isocenter to Beam Limiting Device Distance (300A,00BB) and the Leaf Position Boundaries (300A,00BE) shall be defined to apply to the first control point of the respective beam. If the snout position changes for subsequent control points, this must be taken into account for the projection of the leaf/jaw positions (i.e., replace *IsocenterToBeamLimitingDeviceDistance* in the above formula by the effective distance as calculated from the shift in snout position).

C.8.8.25.4 Virtual Source-Axis Distances and the Use of Trays in Ion Therapy

The apparent source position in ion therapy is not constant or can be different in x or y direction. The apparent source position (as measured from field size projections) shall be called Virtual Source, the distance from the virtual source to isocenter the Virtual SAD.

Most of the cases, no trays are used for blocks, compensators and wedges. However, the concept of trays together with the mounting position is useful for specifying exactly at which point the position of these devices shall be measured. Therefore, trays shall always be present, even though they are only virtual trays.

Figure C.8.8.25-1 shows an example.

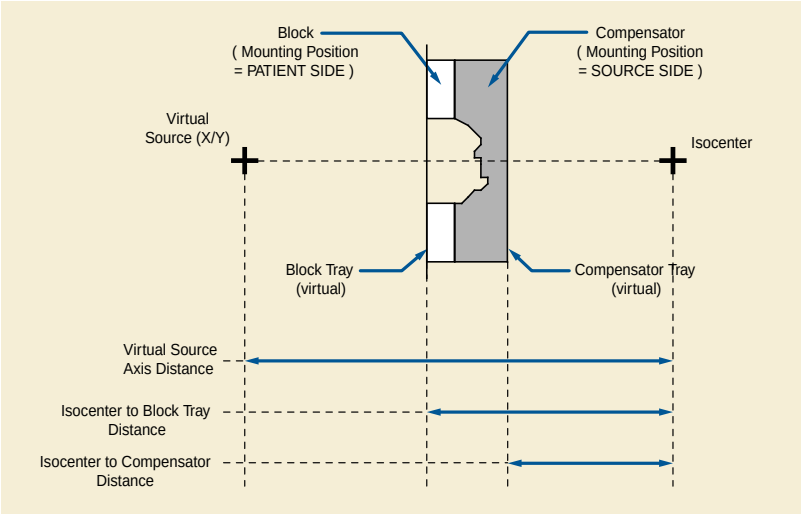


Figure C.8.8.25-1. Virtual Source-Axis Distances

Examples: The use of the above Attributes for snout positioning and block/compensator manufacturing:

a. Snout positioning:

The mounting positions as depicted in the drawing are only examples. As the block tray does not really exist in most of the cases, it is only used as a reference position. As some machines use the downstream face of the block as a reference position for their snout positioning, it could make sense to define for example that the block mounting position must be SOURCE_SIDE. In this case, one uses the downstream face of the block as the reference position, which is the same side as used by the machine. This definition is always independent of the actual thickness of the block. The Isocenter-Block Distance is defined and the machine can deduce the position of the snout from this value.

b. Scaling of block/compensator data for manufacturing

The Isocenter position is always used as the reference position for all distances measured 'from isocenter'. Real size block and compensator manufacturing should be based on the distance from the Virtual Source (X/Y) to the device, i.e., VirtualSourceToDeviceDistance = VirtualSAD - IsocenterToDeviceDistance.

C.8.8.25.5 Range Shifter and Lateral Spreading Device Settings

The Range Shifter and Lateral Spreading Device Settings Attributes are used to capture machine specific values related to these devices. For example, some machines may specify the Range Shifter setting as the desired Water-Equivalent Thickness (in mm). Others contain a series of interchangeable plates, whose position in or out of the beam is specified by a series of ones and zeros (i.e., 100010 would specify that plates #1 and #5 are in the beam). If the device does not use a specific setting, but rather is defined by the ID, then the Enumerated Values IN/OUT shall be used for the setting.

C.8.8.25.6 Coordinate Systems

Where explicitly specified, the coordinate systems defined by IEC 61217 shall be applied, with the exception of the IEC PATIENT Coordinate System.

In addition, the following sections define the coordinate systems to be used in situations where IEC 61217 coordinate systems are not applicable. No other coordinate systems shall be used.

C.8.8.25.6.1 Fixed Beam Line

The direction of fixed beam-line can be described as a gantry system, provided that the position of the (virtual) gantry bearing is defined. The relation between their patient support coordinate system axes and the choice of the 'gantry' angle, e.g., 90 or 270 deg, shall be consistent with a standard gantry coordinate system. All coordinate systems derived from the IEC GANTRY coordinate system (BEAM LIMITING DEVICE, WEDGE, X-RAY IMAGE RECEPTOR) automatically follow in the same way as defined in a 'real' gantry system.

The IEC PATIENT SUPPORT system is linked to the IEC GANTRY coordinate system through its common parent system, the IEC FIXED coordinate system. The Y-axis of IEC GANTRY points towards the (virtual) gantry bearing. The Y-axis of the IEC FIXED coordinate system has to point in the same direction. Z-axis in IEC FIXED coordinate system is always pointing upwards. With Y and Z-axes defined, the X-axis of IEC FIXED is also given.

Figure C.8.8.25-2a and Figure C.8.8.25-2b show IEC FIXED (F), GANTRY (G) and PATIENT SUPPORT (S) coordinate systems for a horizontal fixed beam-line.

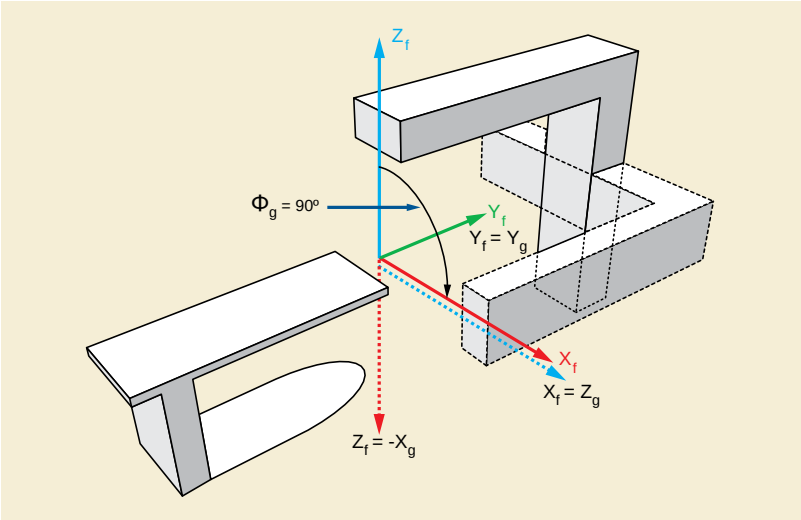


Figure C.8.8.25-2a. Fixed Beam Line - View Along IEC FIXED Y-axis

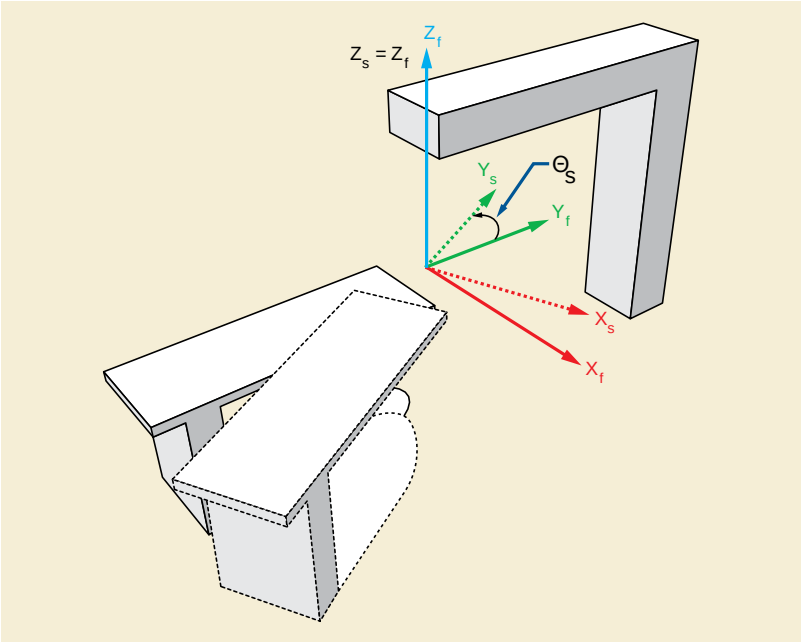


Figure C.8.8.25-2b. Fixed Beam Line - View From Top (Along IEC FIXED Z-axis)

C.8.8.25.6.2 Table Top Pitch and Table Top Roll

For further information, see Section C.8.8.14.12.

C.8.8.25.6.3 Seated Treatments

RT Ion Plan contains an Attribute Patient Support Type (300A,0350), which can be CHAIR or TABLE. The patient support type CHAIR does not change the coordinate axes of the patient support coordinate systems relative to their parent systems. It is more an Attribute of the type like the patient position in imaging (i.e., HFS, HFP, …).

The orientation of the treatment chair shall be defined with the chair positioned in such way, that the patient looks towards the gantry bearing (or along the Y axis of the IEC FIXED system) if all angles, especially IEC PATIENT SUPPORT angle are 0°. All other parameters follow straight forward, once this definition is accepted. i.e., chair rotation is a rotation of IEC PATIENT SUPPORT coordinate

system; a backward tilt of the chair is a positive rotation of the PITCHED TABLE TOP coordinate system. A translation of the chair is a translation of the IEC TABLE TOP system.

The roll angle is typically 0º.

For a seated treatment on a horizontal beam-line, the following angles are therefore defined:If IEC GANTRY angle is 90º (270º), IEC PATIENT SUPPORT angle is 270º (90º) for the position where the patient looks into the beam port.

C.8.8.25.6.4 Ocular Treatments

C.8.8.25.6.4.1 Gantry Beam Line

Eye treatments on the gantry shall use all existing IEC coordinate systems with their standard definition. This applies especially to IEC BEAM LIMITING DEVICE, IEC WEDGE FILTER, IEC X-RAY IMAGE RECEPTOR.

IEC PATIENT SUPPORT, and IEC TABLE TOP coordinate systems are defined as above. Additionally, a rotation of the head fixation device is possible. The Head Fixation Angle (300A,0148) shall be defined as the angle of the head fixation device with respect to the TABLE TOP coordinate system. Positive head fixation angle is in the same direction as positive PATIENT SUPPORT pitch, i.e., backwards.

Proton eye treatments require an additional coordinate system for the placement of the fixation light. Since it is usually mounted onto the beam port the 'natural' coordinate system for devices mounted there is the IEC BEAM LIMITING DEVICE coordinate system. The angles for the fixation light positions shall therefore be defined as follows:

Rotation of the fixation light about the IEC BEAM LIMITING DEVICE Z-axis (Zb) is defined as Azimuthal Angle. The Azimuthal Angle is equal to 0° when the fixation light is positioned on the axis Xb of the IEC BEAM LIMITING DEVICE coordinate system. An increase in the value of the Azimuthal Angle corresponds to clockwise rotation of the fixation light as view along the axis Zb towards the virtual source.

The polar angle is always positive and defined as the angle between IEC BEAM LIMITING DEVICE Z-axis and the line connecting isocenter with the fixation light position.

Proton eye treatments require the wedge thin edge position as one additional. The wedge thin edge position allows the specification of a wedge, which does not cover the full open field. The wedge thin edge position is positive, if the wedge does not cover the isocenter position and negative, if it does cover.

Figure C.8.8.25-5 and Figure C.8.8.25-6 show the angles and Attributes as described above.

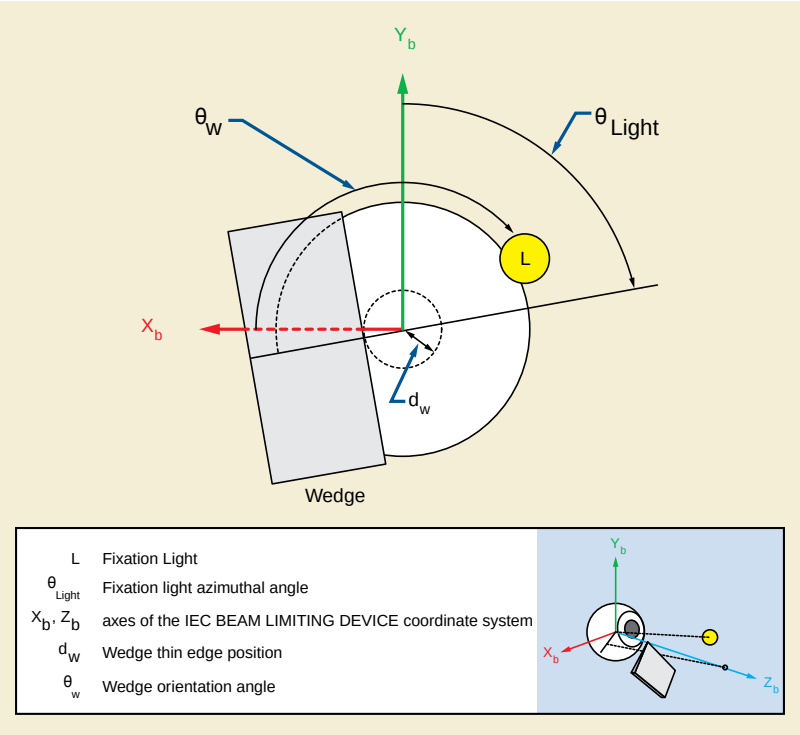


Figure C.8.8.25-5. Patient's eye view

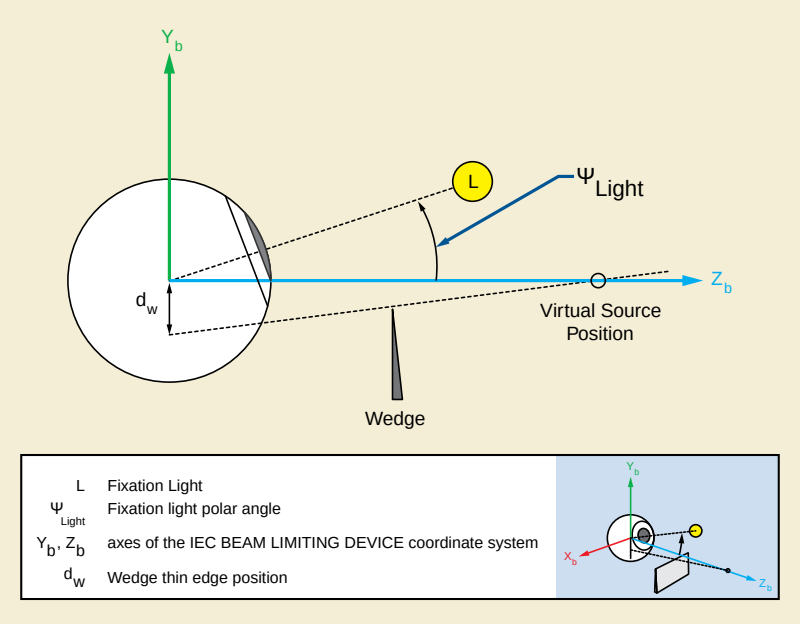


Figure C.8.8.25-6. Lateral view along the positive axis Xb

C.8.8.25.6.4.2 Fixed Beam Line

The coordinate systems for the treatment chair are defined above and shall also be applied to seated eye treatments.

In this case, it is recommended that a beam limiting device angle of 90º be formally applied (provided the gantry angle is defined to be 90º (and not 270º). This results in the same coordinates of the fixation light and wedge relative to the patient as in the treatment situation with the patient lying on the table.

C.8.8.25.6.5 Gantry Pitch Angle

The Gantry Pitch Angle is not defined in IEC 61217. This angle is defined in the DICOM Standard in a way compatible with the current notion of IEC by introducing it as rotation of the IEC GANTRY System as indicated below.

The Gantry Pitch Angle is defined as the rotation of the coordinate axes Yg, Zg about axis Xg by an angle ψg; See Figure C.8.8.25-7. An increase in the value of angle ψg corresponds to the clockwise rotation as viewed from the isocenter along the positive Xg axis

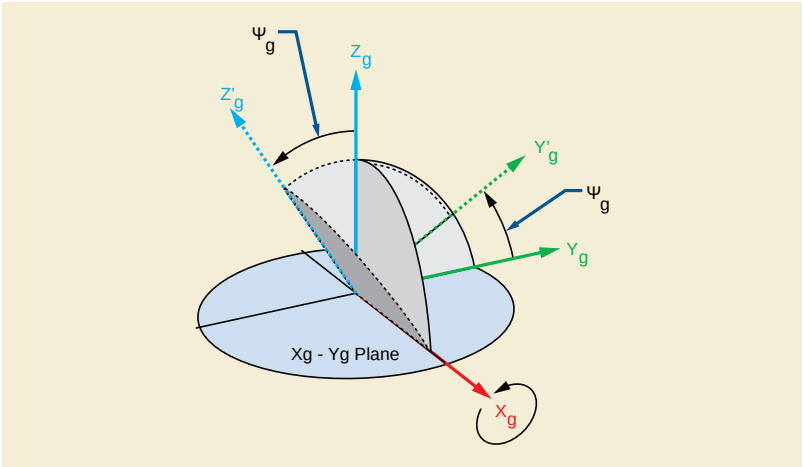


Figure C.8.8.25-7. Gantry Pitch Angle

C.8.8.25.7 Ion Control Point Sequence

The control point sequence for RT Ion Beams is defined using the same rule set as in the RT Beams Module (see Section C.8.8.14.5). Specifically, the following rules apply:

- All parameters that change at any control point of a given beam shall be specified explicitly at all control points (including those preceding the change).
- All parameters of an irradiation segment (i.e., with values of the Cumulative Meterset Weight (300A,0134) different at the beginning and at the end of the segment) shall therefore be specified in 2 separate control points denoting the beginning and at the end of this segment. Each irradiation segment is therefore represented by 2 control points.
- Parameters changing during the segment shall be represented by their different values at those control points. Parameters that do not change during the segment shall be represented with equal values at both control points (unless they are constant for all control points of the beam). For example, a beam delivery involving two independent irradiation segments will require 4 control points. Control Points 0 and 1 define the first irradiation segment. Between control points 1 and 2, no radiation is given (Meterset is constant), but other parameters may change. Finally, the second irradiation segment occurs between control points 2 and 3.

This definition allows unambiguous and explicit determination of those parameters changing while irradiation is occurring, as opposed to those parameters that change between irradiation segments. No assumptions are made about the behavior of machine parameters between specified control points, and communicating devices shall agree on this behavior outside the Standard.

The following example illustrates this rule (not all parameters are shown), in the case of a scanning beam with 2 segments and Final Cumulative Meterset Weight (300A,010E) of 70.

Control Point 0: All applicable treatment parameters defined, Cumulative Meterset Weight (300A,0134) = 0 Nominal Energy: 200 Scan Spot Position Map: (-40, -35), (-40, -30) [Positions for 1st segment] Scan Spot Meterset Weight: 10, 20. Values add up to Meterset difference between Control Points 0 and 1.

Control Point 1: All applicable treatment parameters defined, Cumulative Meterset Weight (300A,0134) = 30.0 Nominal Energy: 200 Scan Spot Position Map: (-40, -35), (-40, -30) [Positions for 1st segment] Scan Spot Meterset Weight: 0.0, 0.0. All values are 0.0, because the Cumulative Meterset Weight difference between Control Point 1 and 2 is 0.0.

Control Point 2: All applicable treatment parameters defined, Cumulative Meterset Weight (300A,0134) = 30.0 Nominal Energy: 180 Scan Spot Position Map: (-55, -40), (-55, -35) [Positions for 2nd segment] Scan Spot Meterset Weight: 25, 15. Values add up to the Cumulative Meterset Weight difference between Control Points 2 and 3.

Control Point 3: All applicable treatment parameters defined, Cumulative Meterset Weight (300A,0134) = 70.0 Nominal Energy: 180 Scan Spot Position Map: (-55, -40), (-55, -35) [Positions for 2nd segment] Scan Spot Meterset Weight: 0.0, 0.0. All values are 0.0, because there is no following control point (end of sequence).

C.8.8.25.8 Scan Spot Maps

The Scan Spot Position Map (300A,0394) and Scan Spot Meterset Weights (300A,0396) shall be used as follows.

The following specifies for each value of Modulated Scan Mode Type (300A,0309) the definition of the map which is included in the Control Point 1 having Cumulative Meterset Weight (300A,0134) = 20, followed by a Control Point 2 having Cumulative Meterset Weight(300A,0134) = 20.

If Modulated Scan Mode Type (300A,0309) is STATIONARY:

Position (X,Y)	**(1.0, 2.0)**	**(6.0, 2.0)**	**(6.0, 3.0)**	**(2.0, 3.0)**	**(2.0, 5.0)**	**(7.0, 5.0)**
Meterset Weights	2	6	1	5	3	3

Delivery Description:

- The beam is positioned at Scan Spot Position (1.0, 2.0).
- The beam is delivered with a Meterset Weight of 2.
- The beam is switched off and positioned at Scan Spot Position (6.0, 2.0).
- The beam is delivered with a Meterset Weight of 6.
- The beam is switched off and positioned at Scan Spot Position (6.0, 3.0).
- The beam is delivered with a Meterset Weight of 1.
- The beam is switched off and positioned at Scan Spot Position (2.0, 3.0).
- The beam is delivered with a Meterset Weight of 5.
- The beam is switched off and positioned at Scan Spot Position (2.0, 5.0).
- The beam is delivered with a Meterset Weight of 3.
- The beam is switched off and positioned at Scan Spot Position (7.0, 5.0).
- The beam is delivered with a Meterset Weight of 3.

If Modulated Scan Mode Type (300A,0309) is LEAPING:

Position (X,Y)	**(1.0, 2.0)**	**(6.0, 2.0)**	**(6.0, 3.0)**	**(2.0, 3.0)**	**(7.0, 5.0)**	**(7.0, 5.0)**
Meterset Weights	1	5	4	6	0	4

Delivery Description:

- The beam is positioned at Scan Spot Position (1.0, 2.0).
- The beam is delivered with a Meterset Weight of 1.

- The beam is moved and positioned at Scan Spot Position (6.0, 2.0).
- The beam is delivered until a Meterset Weight of 5 is reached (including the Meterset delivered when the beam position changes).
- The beam is moved and positioned at Scan Spot Position (6.0, 3.0).
- The beam is delivered until a Meterset Weight of 4 is reached (including the Meterset delivered when the beam position changes).
- The beam is moved and positioned at Scan Spot Position (2.0, 3.0).
- The beam is delivered until a Meterset Weight of 6 is reached (including the Meterset delivered when the beam position changes).
- The beam is switched off and positioned at Scan Spot Position (7.0, 5.0).
- The beam is delivered with a Meterset Weight of 4.

If Modulated Scan Mode Type (300A,0309) is LINEAR:

Position (X,Y)	**(1.0, 2.0)**	**(6.0, 2.0)**	**(6.0, 3.0)**	**(2.0, 3.0)**	**(7.0, 5.0)**	**(7.0, 5.0)**
Meterset Weights	0	6	4	6	0	4

Delivery Description:

- The beam is positioned at Scan Spot Position (1,.0 2.0).
- The beam is continuously delivered with a Meterset Weight of 6, while being moved from Scan Spot Position (1.0, 2.0) to Scan Spot Position (6.0, 2.0).
- The beam is continuously delivered with a Meterset Weight of 4, while being moved from Scan Spot Position (6.0, 2.0) to Scan Spot Position (6.0, 3.0).
- The beam is continuously delivered with a Meterset Weight of 6, while being moved from Scan Spot Position (6.0, 3.0) to Scan Spot Position (2.0, 3.0).
- The beam is switched off and positioned at Scan Spot Position (7.0, 5.0).
- The beam is delivered with Meterset Weight of 4.

C.8.8.25.9 Depth Dose Parameters Sequence Attributes

Some delivery systems determine the settings of the range shifter (or beam energy) and range modulators internally based upon clinical parameters.

The Attributes mentioned in this section represent those clinical parameters.

When the Depth Dose Parameters Sequence (300A,0505) is present, those specifications have precedence over the definitions of the Range Shifters defined in Range Shifter Settings Sequence (300A,0360) and the Range Modulator defined in Range Modulator Settings Sequence (300A,0380).

The following three figures explain the use of the Range Modulated Region Attributes.

Figure C.8.8.25.9-1 shows an example of those Attributes with the following values:

Nominal Range Modulated Region Depths (300A,0504) = 147\298

Reference Dose Definition (300A,0512) = CENTER

Distal Depth (300A,0502) = 301

Distal Depth Fraction (300A,0501) = 0.9

Nominal Range Modulation Fractions (300A,0503) = 0.95\0.98

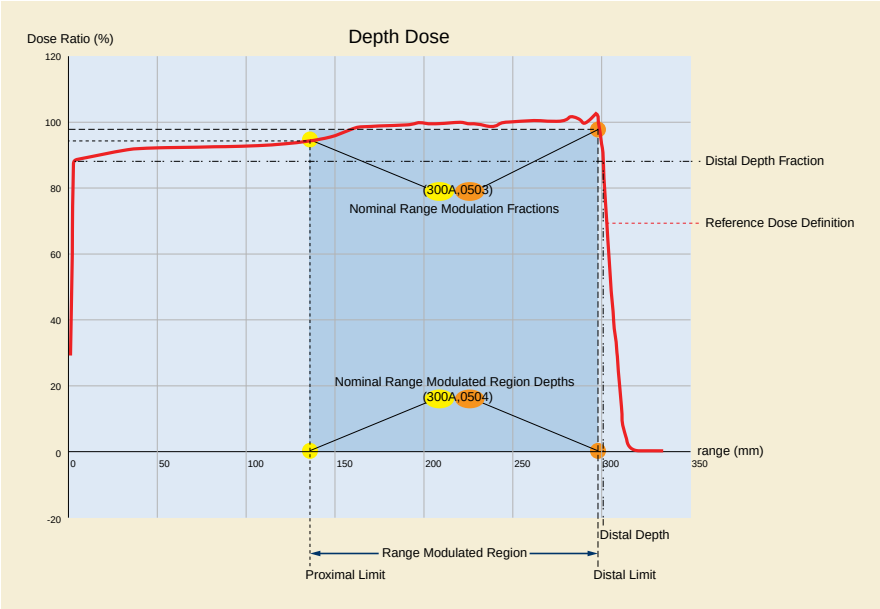


Figure C.8.8.25.9-1. Attributes specifying a depth dose distribution parameters in case of Reference Dose Definition (300A,0512) = CENTER

Figure C.8.8.25.9-2 is an expansion of the steep-gradient part of the depth dose curve for better readability of the parameters annotating this part.

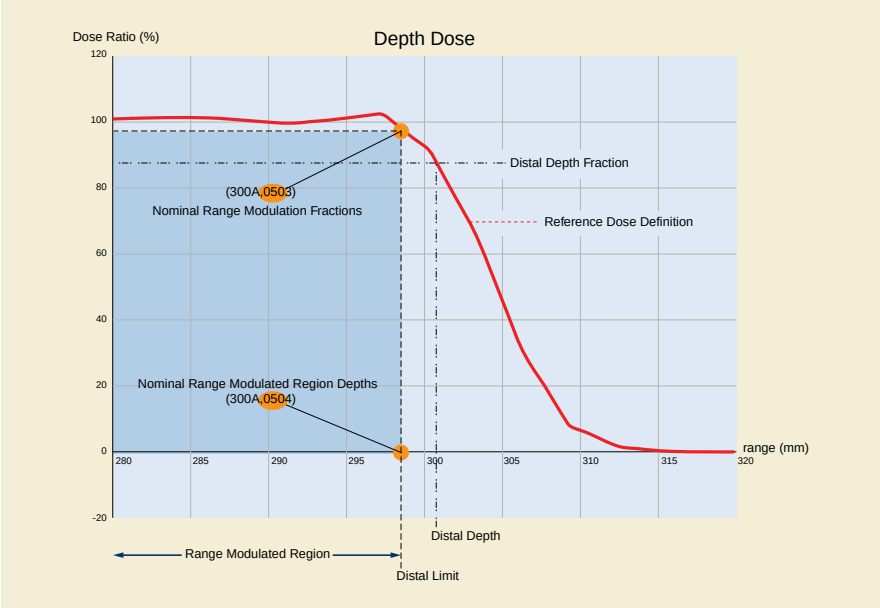


Figure C.8.8.25.9-2. Attributes specifying a generic depth dose distribution. Abscissa expanded near distal edge of dose distribution.

Defined Terms for Reference Dose Definition (300A,0512):

HIGHEST The maximum dose for the highest energy of the non-range modulated component is used for determining the fractions.

MAXIMUM The maximum dose of the range modulated depth dose distribution is used for determining the fractions.

CENTER The dose measured at the center of the range modulated region of the depth dose distribution is used for determining the fractions.

Figure C.8.8.25.9-3 shows the usage of the Defined Terms of Reference Dose Definition (300A,0512).

In Figure C.8.8.25.9-3, the modulated region is defined the same as in Figure C.8.8.25.9-1:

- Nominal Range Modulated Region Depths (300A,0504) = (147\298)

In this example, the 100% reference level for the dose definition is determined for the Defined Terms specified in Reference Dose Definition (300A,0512) as follows:

HIGHEST The maximum dose for the highest energy of the non-range modulated component is located at 304 mm and used for determining the fractions.

MAXIMUM The maximum dose of the range modulated depth dose distribution is located at 300 mm and used for determining the fractions.

CENTER The dose measured at 220 mm depth at the center of the range modulated region of the depth dose distribution is used for determining the fractions.

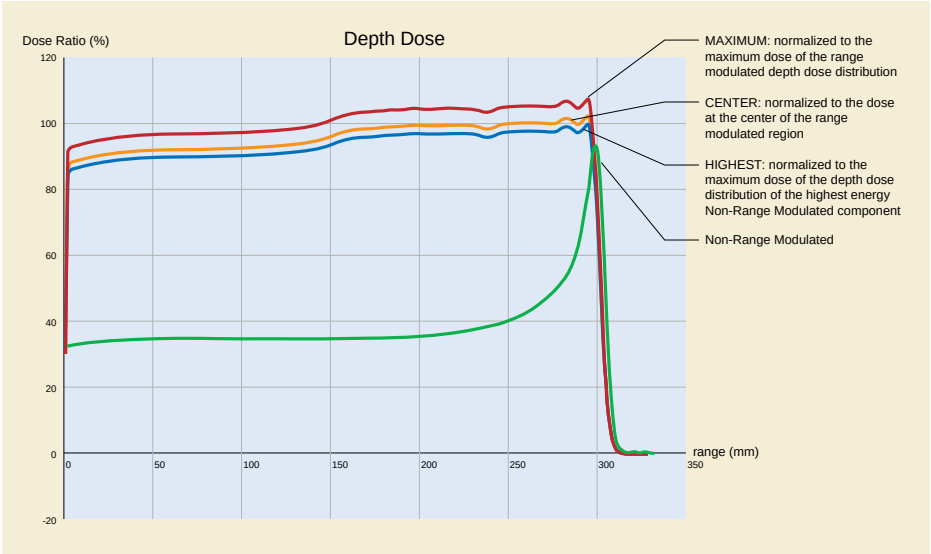


Figure C.8.8.25.9-3. Representation of the different Reference Dose Definition (300A,0512) using the range modulated depth dose distribution or highest energy component depth dose distribution.

C.8.8.25.10 Isocenter to Accessory Distance

Snout Position (300A,030D) is defined at the Control Point level and can therefore vary during the beam, causing all the accessories attached to the Snout (Applicator, Block, Compensator, etc.) to move as well.

For each accessory which is attached to the Snout and has its distance to isocenter defined at the Beam level (such as Isocenter to Beam Limiting Device Distance (300A,00BB), Isocenter to Compensator Tray Distance (300A,02E4), Isocenter to Block Tray Distance (300A,00F7)), the prescribed physical position of the accessory is defined at the first Control Point.

This is consistent with the approach used for Beam Limiting Device Boundaries and Positions (see Section C.8.8.25.3 Leaf Position Boundaries).

For accessories which are attached to the Snout whose distance is defined at the Control Point level, such as Isocenter to Lateral Spreading Device Distance (300A,0374) and Isocenter to Range Modulator Distance (300A,038A), and are attached to the Snout, both the Snout Position (300A,030D) and the accessory distance must change by the same amount.

C.8.8.25.11 Block and Compensator Data

Similarly to Section C.8.8.25.3, in the case where Snout Position (300A,030D) changes between control points, the scaling factor to be used to convert from DICOM data defined at the isocenter plane (such as Block Data (300A,0106) and Isocenter to Compensator Distances (300A,02E6)) to the physical dimension of the accessories is purely based on the Isocenter to Compensator Tray Distance

(300A,02E4) and Isocenter to Compensator Distances (300A,02E6) defined at the beam level and should not take into account the possible effect of Snout Position (300A,030D) changes between Control Points.

C.8.8.26 RT Ion Beams Session Record Module

Table C.8.8.26-1 specifies the Attributes that describe the measured and recorded settings acquired during Ion Radiation Treatments.

Table C.8.8.26-1. RT Ion Beams Session Record Module Attributes

Attribute Name	Tag	Type	Description
Referenced Fraction Group Number	(300C,0022)	3	Identifier of fraction group within referenced RT Ion Plan.
Number of Fractions Planned	(300A,0078)	2	Total number of treatments (fractions) planned for current fraction group.
Primary Dosimeter Unit	(300A,00B3)	1	Measurement unit of the machine dosimeter. Enumerated Values: **MU** Monitor Units **NP** Number of Particles
Treatment Session Ion Beam Sequence	(3008,0021)	1	Sequence of setup and/or treatment beams administered during treatment session. One or more Items shall be included in this Sequence.
>Referenced Beam Number	(300C,0006)	1	References Beam specified by Beam Number (300A,00C0) in Ion Beam Sequence (300A,03A2) in RT Ion Beams Module within the referenced RT Ion Plan.
>Beam Name	(300A,00C2)	1	User-defined name for Beam. See Section C.8.8.25.1.
>Beam Description	(300A,00C3)	3	User-defined description for Beam. See Section C.8.8.25.1.
>Beam Type	(300A,00C4)	1	Motion characteristic of Beam. Enumerated Values: **STATIC** All Ion Control Point Sequence (300A,03A8) Attributes remain unchanged between consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134). **DYNAMIC** One or more Ion Control Point Sequence (300A,03A8) Attributes change between one or more consecutive pairs of control points with changing Cumulative Meterset Weight (300A,0134).
>Radiation Type	(300A,00C6)	1	Particle type of Beam. Defined Terms: **PHOTON** **PROTON** **ION**
>Radiation Mass Number	(300A,0302)	1C	Mass number of radiation. Required if Radiation Type (300A,00C6) is ION
>Radiation Atomic Number	(300A,0304)	1C	Atomic number of radiation. Required if Radiation Type (300A,00C6) is ION
>Radiation Charge State	(300A,0306)	1C	Charge state of radiation. Required if Radiation Type (300A,00C6) is ION

Attribute Name	Tag	Type	Description
>Scan Mode	(300A,0308)	1	The method of beam scanning used during treatment. Defined Terms: **NONE** No beam scanning is performed. **UNIFORM** Between control points, the beam is scanned to create a uniform lateral fluence distribution across the field. **MODULATED** Between control points, the beam is scanned to create a modulated lateral fluence distribution across the field. **MODULATED_SPEC** Between control points, the beam is scanned to create a modulated lateral fluence distribution across the field. The specific scan mode is defined by Modulated Scan Mode Type (300A,0309).
>Modulated Scan Mode Type	(300A,0309)	1C	Defines the specialization of a modulated scan mode. Defined Terms: **STATIONARY** The Meterset is delivered while the beam spot is at the specified position. The beam is always turned off when the position changes. **LEAPING** The Meterset is mainly delivered at the specified spot position, while some of the Meterset is delivered while the spot is moved from the prior spot position. This mode also supports turning off the beam between spot positions. **LINEAR** ~~TThe~~The Meterset is delivered uniformly while the beam spot position changes. This mode also supports turning off the beam between line segments. Note The Defined Term MIXED was previously defined. It is now retired. Required if Scan Mode (300A,0308) is MODULATED_SPEC. See Section C.8.8.25.8.
>Referenced Tolerance Table Number	(300C,00A0)	3	Uniquely identifies Ion Tolerance Table specified by Tolerance Table Number (300A,0042) within Ion Tolerance Table Sequence in RT Ion Tolerance Tables Module. These tolerances are to be used for verification of treatment machine settings.
>Beam Limiting Device Leaf Pairs Sequence	(3008,00A0)	3	Sequence of beam limiting device (collimator) jaw or leaf (element) sets. One or more Items are permitted in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).

Attribute Name	Tag	Type	Description
>Referenced Patient Setup Number	(300C,006A)	3	Uniquely identifies Ion Patient Setup to be used for current beam, specified by Patient Setup Number (300A,0182) within Patient Setup Sequence of RT Patient Setup Module.
>Referenced Verification Image Sequence	(300C,0040)	3	Sequence of verification images obtained during delivery of current beam. One or more Items are permitted in this Sequence. See Section C.8.8.14.2.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Measured Dose Reference Sequence	(3008,0080)	3	Sequence of doses measured during treatment delivery for current Beam. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely references Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Ion Plan. Required if Referenced Measured Dose Reference Number (3008,0082) is not present.
>>Referenced Measured Dose Reference Number	(3008,0082)	1C	Uniquely references Measured Dose Reference specified by Measured Dose Reference Number (3008,0064) in Measured Dose Reference Sequence (3008,0010). Required if Referenced Dose Reference Number (300C,0051) is not present.
>>Measured Dose Value	(3008,0016)	1	Measured Dose in units specified by Dose Units (3004,0002) in Sequence referenced by Measured Dose Reference Sequence (3008,0010) or Dose Reference Sequence (300A,0010) in RT Prescription Module of Referenced RT Ion Plan as defined above.
>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	Sequence of doses estimated for each treatment delivery. One or more Items are permitted in this Sequence.
>>Referenced Dose Reference Number	(300C,0051)	1C	Uniquely identifies Dose Reference specified by Dose Reference Number (300A,0012) in Dose Reference Sequence (300A,0010) in RT Prescription Module of referenced RT Ion Plan. Required if Referenced Calculated Dose Reference Number (3008,0092) is not present.
>>Referenced Calculated Dose Reference Number	(3008,0092)	1C	Uniquely identifies Calculated Dose Reference specified by Calculated Dose Reference Number (3008,0072) within Calculated Dose Reference Sequence (3008,0070). Required if Referenced Dose Reference Number (300C,0051) is not present.
>>Calculated Dose Reference Dose Value	(3008,0076)	1	Calculated Dose (Gy).
>Number of Wedges	(300A,00D0)	1	Number of wedges associated with current beam.
>Recorded Wedge Sequence	(3008,00B0)	1C	Sequence of treatment wedges. Required if Number of Wedges (300A,00D0) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Wedges (300A,00D0).
>>Wedge Number	(300A,00D2)	1	Identification number of the Wedges. The value of Wedge Number (300A,00D2) shall be unique within the Beam in which it was created.

Attribute Name	Tag	Type	Description
>>Wedge Type	(300A,00D3)	2	Type of wedge (if any) defined for Beam. Defined Terms: **STANDARD** standard (static) wedge **MOTORIZED** single wedge that can be removed from beam remotely. **PARTIAL_STANDARD** wedge does not extend across the whole field and is operated manually. **PARTIAL_MOTORIZ** wedge does not extend across the whole field and can be removed from beam remotely.
>>Wedge ID	(300A,00D4)	3	User-supplied identifier for Wedge.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Wedge Angle	(300A,00D5)	2	Nominal wedge angle (degrees).
>>Wedge Orientation	(300A,00D8)	2	Orientation of wedge, i.e., orientation of IEC WEDGE FILTER coordinate system with respect to the IEC BEAM LIMITING DEVICE coordinate systems (degrees).
>Number of Compensators	(300A,00E0)	1	Number of range compensators associated with current Beam.
>Recorded Compensator Sequence	(3008,00C0)	1C	Sequence of treatment compensators. Required if Number of Compensators (300A,00E0) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Compensators (300A,00E0).
>>Referenced Compensator Number	(300C,00D0)	1	Uniquely identifies compensator specified by Compensator Number (300A,00E4) within Beam referenced by Referenced Beam Number (300C,0006).
>>Compensator ID	(300A,00E5)	3	User-supplied identifier for compensator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Number of Boli	(300A,00ED)	1	Number of boli associated with current Beam.
>Referenced Bolus Sequence	(300C,00B0)	1C	Sequence of boli associated with Beam. Required if Number of Boli (300A,00ED) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Boli (300A,00ED).
>>Referenced ROI Number	(3006,0084)	1	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Number of Blocks	(300A,00F0)	1	Number of shielding blocks associated with Beam.
>Recorded Block Sequence	(3008,00D0)	1C	Sequence of blocks associated with Beam. Required if Number of Blocks (300A,00F0) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Blocks (300A,00F0).

Attribute Name	Tag	Type	Description
>>Block Tray ID	(300A,00F5)	3	User-supplied identifier for block tray.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Referenced Block Number	(300C,00E0)	1	Uniquely identifies block specified by Block Number (300A,00FC) within Beam referenced by Referenced Beam Number (300C,0006).
>>Block Name	(300A,00FE)	3	User-defined name for block.
>Recorded Snout Sequence	(3008,00F0)	1C	Sequence of Snouts associated with Beam. Required if Snout Sequence (300A,030C) is included in the RT Ion Plan referenced within the Referenced RT Plan Sequence (300C,0002). Only a single Item shall be included in this Sequence.
>>Snout ID	(300A,030F)	1	User or machine supplied identifier for Snout.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Applicator Sequence	(300A,0107)	1C	Sequence of Applicators associated with Beam. Required if Applicator Sequence (300A,0107) is included in the RT Ion Plan referenced within the Referenced RT Plan Sequence (300C,0002). Only a single Item shall be included in this Sequence.
>>Applicator ID	(300A,0108)	1	User or machine supplied identifier for Applicator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>>Applicator Type	(300A,0109)	1	Type of applicator. Defined Terms: **ION_SQUARE** square ion applicator **ION_RECT** rectangular ion applicator **ION_CIRC** circular ion applicator **ION_SHORT** short ion applicator **ION_OPEN** open (dummy) ion applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator
>>Applicator Description	(300A,010A)	3	User-defined description for Applicator.
>General Accessory Sequence	(300A,0420)	3	A Sequence of General Accessories associated with this Beam. One or more Items are permitted in this Sequence.
>>General Accessory Number	(300A,0424)	1	Identification Number of the General Accessory. The value shall be unique within the Sequence.
>>General Accessory ID	(300A,0421)	1	User or machine supplied identifier for General Accessory.
>>General Accessory Description	(300A,0422)	3	User supplied description of General Accessory.
>>General Accessory Type	(300A,0423)	3	Specifies the type of accessory. Defined Terms: **GRATICULE** Accessory tray with a radio-opaque grid **IMAGE_DETECTOR** Image acquisition device positioned in the beam line **RETICLE** Accessory tray with radio-transparent markers or grid
>>Accessory Code	(300A,00F9)	3	Machine-readable identifier for this accessory
>Number of Range Shifters	(300A,0312)	1	Number of range shifters associated with current beam.

Attribute Name	Tag	Type	Description
>Recorded Range Shifter Sequence	(3008,00F2)	1C	Sequence of range shifters recorded with Beam. Required if Number of Range Shifters (300A,0312) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Range Shifters (300A,0312).
>>Referenced Range Shifter Number	(300C,0100)	1	Uniquely identifies range shifter specified by Range Shifter Number (300A,0316) within Beam referenced by Referenced Beam Number (300C,0006).
>>Range Shifter ID	(300A,0318)	1	User or machine supplied identifier for Range Modulator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Number of Lateral Spreading Devices	(300A,0330)	1	Number of lateral spreading devices associated with current beam.
>Recorded Lateral Spreading Device Sequence	(3008,00F4)	1C	Sequence of lateral spreading devices associated with Beam. Required if Number of Lateral Spreading Devices (300A,0330) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Lateral Spreading Devices (300A,0330).
>>Referenced Lateral Spreading Device Number	(300C,0102)	1	Uniquely identifies lateral spreading device specified by Lateral Spreading Device Number (300A,0334) within Beam referenced by Referenced Beam Number (300C,0006).
>>Lateral Spreading Device ID	(300A,0336)	1	User or machine supplied identifier for Lateral Spreading Device.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.
>Number of Range Modulators	(300A,0340)	1	Number of range modulators associated with current beam.
>Recorded Range Modulator Sequence	(3008,00F6)	1C	Sequence of range modulators associated with Beam. Required if Number of Range Modulators (300A,0340) is non-zero. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Range Modulators (300A,0340).
>>Referenced Range Modulator Number	(300C,0104)	1	Uniquely identifies range modulator specified by Range Modulator Number (300A,0344) within Beam referenced by Referenced Beam Number (300C,0006).
>>Range Modulator ID	(300A,0346)	1	User or machine supplied identifier for Range Modulator.
>>Accessory Code	(300A,00F9)	3	An accessory identifier to be read by a device such as a bar code reader.

Attribute Name	Tag	Type	Description
>>Range Modulator Type	(300A,0348)	1	Type of Range Modulator. Defined Terms: **FIXED** fixed modulation width and weights using ridge filter or constant speed wheel with constant beam current **WHL_FIXEDWEIGHTS** selected wheel/track (Range Modulator ID) is spinning at constant speed. Modulation width is adjusted by switching constant beam current on and off at wheel steps indicated by Range Modulator Interrupt Values **WHL_MODWEIGHTS** selected wheel/track (Range Modulator ID) is spinning at constant speed. Weight per wheel step is adjusted by modulating beam current according to selected Beam Current Modulation ID (300A,034C) Only one Item in the Recorded Range Modulator Sequence (3008,00F6) can have a Range Modulator Type (300A,0348) of WHL_MODWEIGHTS.
>>Beam Current Modulation ID	(300A,034C)	1C	User-supplied identifier for the beam current modulation pattern. Required if Range Modulator Type (300A,0348) is WHL_MODWEIGHTS
>Include Table C.8.8.28-1 "Patient Support Identification Macro Attributes"			
>Fixation Light Azimuthal Angle	(300A,0356)	3	Azimuthal angle (degrees) of the fixation light coordinate around IEC PATIENT SUPPORT Y-axis. Used for eye treatments. See Section C.8.8.25.6.4.
>Fixation Light Polar Angle	(300A,0358)	3	Polar angle (degrees) of the fixation light coordinate. Used for eye treatments. See Section C.8.8.25.6.4.
>Fixation Eye	(300A,0150)	3	The eye used for fixation. Enumerated Values: **L** left eye **R** right eye
>Current Fraction Number	(3008,0022)	2	Fraction number for this beam administration.
>Treatment Delivery Type	(300A,00CE)	2	Delivery Type of treatment. Defined Terms: **TREATMENT** normal patient treatment **OPEN_PORTFILM** portal image acquisition with open field (the source of radiation is specified by Radiation Type (300A,00C6)) **TRMT_PORTFILM** portal image acquisition with treatment port (the source of radiation is specified by Radiation Type (300A,00C6)) **CONTINUATION** continuation of interrupted treatment **SETUP** no treatment beam was applied for this RT Beam. To be used for specifying the gantry, couch, and other machine positions where X-Ray set-up images or measurements were taken **VERIFICATION** Treatment used for Quality Assurance rather than patient treatment

Attribute Name	Tag	Type	Description
>Treatment Termination Status	(3008,002A)	1	Conditions under which treatment was terminated. Enumerated Values: **NORMAL** treatment terminated normally **OPERATOR** operator terminated treatment **MACHINE** machine terminated treatment **UNKNOWN** status at termination unknown
>Treatment Termination Code	(3008,002B)	3	Treatment machine termination code. This code is dependent upon the particular application and equipment.
>Treatment Verification Status	(3008,002C)	2	Conditions under which treatment was verified by a verification system. Enumerated Values: **VERIFIED** treatment verified **VERIFIED_OVR** treatment verified with at least one out-of-range value overridden **NOT_VERIFIED** treatment verified manually
>Specified Primary Meterset	(3008,0032)	3	Desired machine setting of primary Meterset in units specified by Primary Dosimeter Unit (300A,00B3). See Section C.8.8.26.1.
>Specified Secondary Meterset	(3008,0033)	3	Desired machine setting of secondary Meterset. See Section C.8.8.26.1.
>Delivered Primary Meterset	(3008,0036)	3	Machine setting actually delivered as recorded by primary Meterset in units specified by Primary Dosimeter Unit (300A,00B3). See Section C.8.8.26.1.
>Delivered Secondary Meterset	(3008,0037)	3	Machine setting actually delivered as recorded by secondary Meterset. See Section C.8.8.26.1.
>Specified Treatment Time	(3008,003A)	3	Treatment Time set (sec).
>Delivered Treatment Time	(3008,003B)	3	Treatment Time actually delivered (sec).
>Delivered Depth Dose Parameters Sequence	(300A,0506)	3	Set of parameters describing the depth dose distribution. Only a single Item is permitted in this Sequence.
>>Delivered Reference Dose Definition	(300A,0511)	1	Definition of the 100% delivered reference dose level. See Section C.8.8.25.9.
>>Delivered Distal Depth	(300A,0508)	1	Penetration depth in water (mm) of the delivered particle excluding any user-installed range modifying devices, measured at the Delivered Distal Depth Fraction (300A,0507). See Section C.8.8.25.9.
>>Delivered Distal Depth Fraction	(300A,0507)	1	Fraction of the value of dose relative to the 100% level defined by Delivered Reference Dose Definition (300A,0511). This determines the Delivered Distal Depth (300A,0508). A value of 1.0 refers to 100% of the reference dose level defined by the Delivered Reference Dose Definition (300A,0511). See Section C.8.8.25.9.

Attribute Name	Tag	Type	Description
>>Delivered Nominal Range Modulated Region Depths	(300A,0510)	1C	The depths of the proximal and distal limits of the range modulated region in water. Contains two values (in mm). The first value defines the depth of the proximal limit. The second value defines the depth of the distal limit. Required if Delivered Reference Dose Definition (300A,0511) has the value CENTER. See Section C.8.8.25.9.
>>Delivered Nominal Range Modulation Fractions	(300A,0509)	1C	Delivered Fractions of the Delivered Reference Dose Definition (300A,0511) defining the proximal and distal limits at which the range-modulated region is defined. Contains two values. The first value defines the modulation fraction value at the proximal limit and the second value defines the modulation fraction value at the distal limit. A value of 1.0 refers to the 100% reference dose level as defined in Delivered Reference Dose Definition (300A,0511). Required if Delivered Nominal Range Modulated Region Depths (300A,0510) is present. See Section C.8.8.25.9.
>Number of Control Points	(300A,0110)	1	Number of control points in Beam.
>Ion Control Point Delivery Sequence	(3008,0041)	1	Sequence of beam control points for current ion treatment beam. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Control Points (300A,0110). See Section C.8.8.21.1.
>>Referenced Control Point Index	(300C,00F0)	1	Uniquely identifies Control Point specified by Control Point Index (300A,0112) within the Beam referenced by Referenced Beam Number (300C,0006).
>>Treatment Control Point Date	(3008,0024)	1	Date when the delivery of radiation at this control point began. For the final control point this shall be the Date when the previous control point ended.
>>Treatment Control Point Time	(3008,0025)	1	Time when the delivery of radiation at this control point began. For the final control point this shall be the Time when the previous control point ended.
>>Specified Meterset	(3008,0042)	2	Desired machine setting for current control point in units specified by Primary Dosimeter Unit (300A,00B3).
>>Delivered Meterset	(3008,0044)	1	Machine setting actually delivered at current control point in units specified by Primary Dosimeter Unit (300A,00B3).
>>Meterset Rate Set	(3008,0045)	3	The specified speed of delivery of the specified dose in units specified by Primary Dosimeter Unit (300A,00B3) per minute.
>>Meterset Rate Delivered	(3008,0046)	3	The delivered speed of delivery of the specified dose in units specified by Primary Dosimeter Unit (300A,00B3) per minute.

Attribute Name	Tag	Type	Description
>>Nominal Beam Energy	(300A,0114)	1C	Nominal Beam Energy at control point in MeV per nucleon. Defined at nozzle entrance before all Beam Modifiers. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Nominal Beam Energy (300A,0114) changes during beam administration, and KVP (0018,0060) is not present.
>>KVP	(0018,0060)	1C	Peak kilo voltage output of the setup X-Ray generator used. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041), or if kVp changes during setup, and Nominal Beam Energy (300A,0114) is not present.
>>Ion Wedge Position Sequence	(300A,03AC)	1C	Sequence of Wedge positions for current control point. Required for first Item of Ion Control Point Sequence if Number of Wedges (300A,00D0) is non-zero, and in subsequent control points if Wedge Position (300A,0118) or Wedge Thin Edge Position (300A,00DB) changes during beam. One or more Items shall be included in this Sequence. The number of Items shall be identical to the value of Number of Wedges (300A,00D0).
>>>Referenced Wedge Number	(300C,00C0)	1	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1).
>>>Wedge Position	(300A,0118)	1	Position of Wedge at current control point. Enumerated Values: **IN** **OUT**
>>>Wedge Thin Edge Position	(300A,00DB)	1C	Closest distance from the central axis of the beam along a wedge axis to the thin edge as projected to the machine isocentric plane (mm). Value is positive is the wedge does not cover the central axis, negative if it does. Required if Wedge Type (300A,00D3) of the wedge referenced by Referenced Wedge Number (300C,00C0) is PARTIAL_STANDARD or PARTIAL_MOTORIZ. See Section C.8.8.25.6.4.
>>Include Table C.8.8.27-1 “Beam Limiting Device Position Macro Attributes”			
>>Range Shifter Settings Sequence	(300A,0360)	1C	Sequence of Range Shifter settings for the current control point. One or more Items shall be included in this Sequence. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Range Shifter Setting (300A,0362) changes during beam administration, and Number of Range Shifters (300A,0312) is non-zero.
>>>Referenced Range Shifter Number	(300C,0100)	1	Uniquely references Range Shifter described by Range Shifter Number (300A,0316) in Range Shifter Sequence (300A,0314).
>>>Range Shifter Setting	(300A,0362)	1	Machine specific setting Attribute for the range shifter. The specific encoding of this value should be documented in a Conformance Statement. See Section C.8.8.25.5.

Attribute Name	Tag	Type	Description
>>Lateral Spreading Device Settings Sequence	(300A,0370)	1C	Sequence of Lateral Spreading Device settings for the current control point. One or more Items shall be included in this Sequence. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Lateral Spreading Device Setting (300A,0372) changes during beam administration, and Number of Lateral Spreading Devices (300A,0330) is non-zero.
>>>Referenced Lateral Spreading Device Number	(300C,0102)	1	Uniquely references Lateral Spreading Device described by Lateral Spreading Device Number (300A,0334) in Lateral Spreading Device Sequence (300A,0332).
>>>Lateral Spreading Device Setting	(300A,0372)	1	Machine specific setting Attribute for the lateral spreading device. The specific encoding of this value should be documented in a Conformance Statement. See Section C.8.8.25.5.
>>Range Modulator Settings Sequence	(300A,0380)	1C	Sequence of Range Modulator Settings for current control point. One or more Items shall be included in this Sequence. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041), or if Range Modulator Settings change during beam administration, and Number of Range Modulators (300A,0340) is non-zero.
>>>Referenced Range Modulator Number	(300C,0104)	1	Uniquely references Range Modulator described by Range Modulator Number (300A,0344) in Range Modulator Sequence (300A,0342).
>>>Range Modulator Gating Start Value	(300A,0382)	1C	Start position defines the range modulator position at which the beam is switched on. Required if Range Modulator Type (300A,0348) of the range modulator referenced by Referenced Range Modulator Number (300C,0104) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS
>>>Range Modulator Gating Stop Value	(300A,0384)	1C	Stop position defines the range modulator position at which the beam is switched off. Required if Range Modulator Type (300A,0348) of the range modulator referenced by Referenced Range Modulator Number (300C,0104) is WHL_MODWEIGHTS or WHL_FIXEDWEIGHTS
>>Gantry Angle	(300A,011E)	1C	Treatment machine gantry angle, i.e., orientation of IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Gantry Angle changes during beam administration.
>>Gantry Rotation Direction	(300A,011F)	1C	Direction of Gantry Rotation when viewing gantry from isocenter, for segment beginning at current Control Point. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041), or if Gantry Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Gantry Pitch Angle	(300A,014A)	2C	Gantry Pitch Angle. i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system (degrees). Required for first Item of Control Point Sequence, or if Gantry Pitch Rotation Angle changes during Beam. See Section C.8.8.25.6.5.

Attribute Name	Tag	Type	Description
>>Gantry Pitch Rotation Direction	(300A,014C)	2C	Direction of Gantry Pitch Angle when viewing along the positive X-axis of the IEC GANTRY coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Gantry Pitch Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.5. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Beam Limiting Device Angle	(300A,0120)	1C	Beam Limiting Device (collimator) angle, i.e., orientation of IEC BEAM LIMITING DEVICE coordinate system with respect to IEC GANTRY coordinate system (degrees). Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if beam limiting device (collimator) angle changes during beam administration.
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment beginning at current Control Point. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Beam Limiting Device Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Scan Spot Tune ID	(300A,0390)	1C	User-supplied or machine code identifier for machine configuration to produce beam spot. This may be the nominal spot size or some other machine specific value. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Number of Scan Spot Positions	(300A,0392)	1C	Number of spot positions used to specify scanning pattern for current segment beginning at control point. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Scan Spot Position Map	(300A,0394)	1C	A data stream of (x,y) pairs that define the coordinates of the scan spots as projected onto the machine isocentric plane in the IEC GANTRY coordinate system (mm). Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC. Contains 2N values where N is the Number of Scan Spot Positions (300A,0392). See Section C.8.8.25.8.
>>Scan Spot Metersets Delivered	(3008,0047)	1C	A set of Meterset values delivered to the scan spot positions. The order of Metersets matches the positions in Scan Spot Position Map (300A,0394). The sum contained in all Metersets shall match the difference of the Delivered Meterset of the current control point to the following control point. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC. See Section C.8.8.25.8.
>>Scan Spot Time Offset	(300A,038F)	3	A set of time offsets (in microseconds). Each offset is the time from the Treatment Control Point Time (3008,0025) until both the beam has reached the X,Y position recorded in the Scan Spot Position Map (300A,0394) and ion delivery has started at this position. The order of values matches the order of positions in Scan Spot Position Map (300A,0394). The number of values shall equal the value of Number of Scan Spot Positions (300A,0392).

Attribute Name	Tag	Type	Description
>>Scanning Spot Size	(300A,0398)	3	The Scanning Spot Size as calculated using the Full Width Half Maximum (FWHM). Specified by a numeric pair - the size measured in air at isocenter in IEC GANTRY X direction followed by the size in the IEC GANTRY Y direction (mm).
>>Scan Spot Sizes Delivered	(300A,0399)	3	A data stream of (x,y) pairs that define the delivered spot sizes using the Full Width Half Maximum (FWHM) as measured by the delivery monitoring system. Specified by a numeric pair where the sizes are projected in air to the isocenter in IEC GANTRY X direction followed by the size in the IEC GANTRY Y direction (mm). The order of values shall match the order of positions in the Scan Spot Position Map (300A,0394) and contain 2N values where N is the Number of Scan Spot Positions (300A,0392).
>>Number of Paintings	(300A,039A)	1C	The intended number of times the scan pattern given by Scan Spot Position Map (300A,0394) and Scan Spot Meterset Weights (300A,0396) in the Referenced RT Plan was to be applied at the current control point. Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC.
>>Scan Spot Reordered	(300A,0393)	3	Indicates that the spots were delivered in a different order than in the plan. Enumerated Values: **YES** The delivery machine changed the spot order **NO** The delivery machine delivered the spots in the order as planned When absent it is not known if the treatment delivery device delivered or reported in the order as planned. See Note 1.
>>Scan Spot Prescribed Indices	(300A,0391)	1C	The indices of the prescribed spots corresponding to each delivered spot. These indices are the ordinal positions of the spots in the Scan Spot Meterset Weights (300A,0396) in the Ion Control Point Sequence (300A,03A8) of the referenced RT Ion Plan. The numbering of indices of the prescribed spots shall start at one (a value of one refers the first ordinal position). Required, if Scan Spot Reordered (300A,0393) equals YES. Contains N values where N is the Number of Scan Spot Positions (300A,0392).
>>Patient Support Angle	(300A,0122)	1C	Patient Support angle, i.e., orientation of IEC PATIENT SUPPORT (turntable) coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees). Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Patient Support Angle changes during beam administration.
>>Patient Support Rotation Direction	(300A,0123)	1C	Direction of Patient Support Rotation when viewing table from above, for segment beginning at current Control Point. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041), or if Patient Support Rotation Direction changes during beam administration. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation

Attribute Name	Tag	Type	Description
>>Table Top Pitch Angle	(300A,0140)	2C	Table Top Pitch Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system (degrees). Required for first Item of Control Point Sequence, or if Table Top Pitch Angle changes during Beam. See Section C.8.8.25.6.2.
>>Table Top Pitch Rotation Direction	(300A,0142)	2C	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Table Top Pitch Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	2C	Table Top Roll Angle, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system (degrees). Required for first Item of Control Point Sequence, or if Table Top Roll Angle changes during Beam. See Section C.8.8.25.6.2.
>>Table Top Roll Rotation Direction	(300A,0146)	2C	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. Required for first Item of Control Point Sequence, or if Table Top Roll Rotation Direction changes during Beam. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Head Fixation Angle	(300A,0148)	3	Angle (in degrees) of the head fixation for eye treatments with respect to the Table Top Pitch Angle (300A,0140) coordinate system. Positive head fixation angle is the same direction as positive Table Top Pitch. See Section C.8.8.25.6.4.
>>Chair Head Frame Position	(300A,0151)	3	A device-specific value that specifies the relationship between the chair in which the patient is sitting and the head frame in which their head is fixed. It shall be expressed as a distance in mm, such that positive is towards the patient's head away from the seat. Note This value is not intended to be used for geometric calculations, however, for the same device, the relative distance is meaningful. Typically used for eye treatments.
>>Table Top Vertical Position	(300A,0128)	2C	Table Top Vertical position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Table Top Vertical Position changes during beam administration.

Attribute Name	Tag	Type	Description
>>Table Top Longitudinal Position	(300A,0129)	2C	Table Top Longitudinal position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Table Top Longitudinal Position changes during beam administration.
>>Table Top Lateral Position	(300A,012A)	2C	Table Top Lateral position in IEC TABLE TOP coordinate system (mm). This value is interpreted as an absolute, rather than relative, Table setting. Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Table Top Lateral Position changes during beam administration.
>>Snout Position	(300A,030D)	2C	Axial position of the snout (in mm) measured from isocenter to the downstream side of the snout (without consideration of variable length elements such as blocks, MLC and/or compensators). Required for Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) or if Snout Position changes during beam administration.
>>Corrected Parameter Sequence	(3008,0068)	3	A Sequence of Items describing corrections made to any Attributes prior to delivery of the next control point. One or more Items are permitted in this Sequence.
>>>Parameter Sequence Pointer	(3008,0061)	1	Contains the Data Element Tag of the parent Sequence containing the Attribute that was corrected. The value is limited in scope to the Treatment Session Ion Beam Sequence (3008,0021) and all nested Sequences therein.
>>>Parameter Item Index	(3008,0063)	1	Contains the Sequence Item index (monotonically increasing from 1) of the corrected Attribute within its parent Sequence as indicated by Parameter Sequence Pointer (3008,0061).
>>>Parameter Pointer	(3008,0065)	1	Contains the Data Element Tag of the Attribute that was corrected.
>>>Correction Value	(3008,006A)	1	The value that was added the value referenced by the Parameter Sequence Pointer (3008,0061), Parameter Item Index (3008,0063) and Parameter Pointer (3008,0065).
>>Override Sequence	(3008,0060)	3	Sequence of parameters that were overridden during the administration of the beam segment immediately prior to the current control point. One or more Items are permitted in this Sequence.
>>>Parameter Sequence Pointer	(3008,0061)	1	Contains the Data Element Tag of the parent Sequence containing the Attribute that was overriden. The value is limited in scope to the Treatment Session Ion Beam Sequence (3008,0021) and all nested Sequences therein.
>>>Override Parameter Pointer	(3008,0062)	1	Contains the Data Element Tag of the Attribute that was overridden.
>>>Parameter Item Index	(3008,0063)	1	Contains the Sequence Item index (monotonically increasing from 1) of the overriden Attributes within it's parent Sequence. The value is limited in scope to the Treatment Session Ion Beam Sequence (3008,0021) and all nested Sequences therein.
>>>Parameter Value Number	(3008,0067)	3	Positive integer identifying which value of a multi-valued Attribute identified by Override Parameter Pointer (3008,0062) is referenced. The value 1 identifies the first value.
>>>Operators' Name	(0008,1070)	2	Name of operator who authorized override.
>>>Operator Identification Sequence	(0008,1072)	3	Identification of the operator who authorized override. Only a single Item is permitted in this Sequence.
>>>>*Include Table 10-1 “Person Identification Macro Attributes Description”*			

Attribute Name	Tag	Type	Description
>>>Override Reason	(3008,0066)	3	User-defined description of reason for override of parameter specified by Override Parameter Pointer (3008,0062).

Note

Recording an extra tuning spot is considered reordering, even if the spots were delivered in the prescribed order. If re-painted spots (i.e., Number of Paintings (300A,039A) > 1) are recorded separately, then this is also considered reordering.

C.8.8.26.1 Specified and Delivered Meterset Values

Specified and Delivered Meterset values on beam and control point level shall be handled as specified for RT Beams Session records in Section C.8.8.21.2.

C.8.8.26.2 Scan Spot Prescribed Indices

Scan Spot Prescribed Indices (300A,0391) are used to associate each delivered spot with its corresponding prescribed spot. If the ordering information is unknown, both Scan Spot Reordered (300A,0393) and Scan Spot Prescribed Indices (300A,0391) shall be absent.

There are various cases how the scan spots are delivered in comparison with the prescribed spot order.

Following are various examples specifying how the scan spot prescribed index shall be used.

C.8.8.26.2.1 Content of RT Ion Plan for following Use Cases

It is assumed that the RT Ion Plan contains the following spot positions in the Scan Spot Position Map (300A,0394) and related Scan Spot Meterset Weights (300A,0396).

The following table is a representation of the prescription where “w” represents the Scan Spot Meterset Weight.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)
x0,y0	w0
x1,y1	w1
x2,y2	w2
x3,y3	w3
x4,y4	w4

The prescription does not contain an explicit index for the scan spot order. The index is defined implicitly by the order of the spots within the prescribed map. The implicit index starts at 0.

The following examples specify some different cases of delivered scan spot order that can then be supported using the spot index in the RT Ion Beams Treatment Record.

C.8.8.26.2.2 Treatment Recording Use Cases

The following tables contain 3 columns as follows:

First column: The delivered Scan Spot Position in the Scan Spot Position Map (300A,0394). In this column the spot positions are annotated as they have been delivered. The index following the coordinate character refers to the index in the RT Ion Plan. If the index is appended, it shows that 2 or more delivered scan spots refer to the same Scan Spot Position in the RT Ion Plan.

Second column: The Scan Spot Meterset Delivered (3008,0047). The Meterset Delivered is indicated by 'm'.

Third column: The Scan Spot Prescribed Indices (300A,0391) referring to the position in the Scan Spot Meterset Weights (300A,0396) of the referenced RT Ion Plan are indicated as they are recorded in the RT Ion Beams Treatment Record.

C.8.8.26.2.3 Use Case 1: No pause, no spot reordering, no spot splitting, no repainting

This use case is an example where the spots are treated in the exact order as prescribed in the RT Ion Plan.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)
x1,y1	m1
x2,y2	m2
x3,y3	m3
x4,y4	m4

Since there was no re-ordering, Scan Spot Reordered (300A,0393) is absent or NO and Scan Spot Prescribed Indices (300A,0391) shall be absent.

C.8.8.26.2.4 Use Case 2: Pause

This use case is an example of a spot broken up into two reported spots due to a pause in the middle of treatment.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)	Scan Spot Prescribed Indices (300A,0391)
x1,y1	m1	1
x2,y2	m2	2
x3a,y3a	m3a	3
x3b,y3b	m3b	3
x4,y4	m4	4

The pause occurred during the delivery of the 3rd spot. When the delivery resumed, the spot was not located at the same position prior to the pause. The notations x3a,y3a represent the position of the spot prior to the pause. x3b,y3b represent the position of the resumed spot. Both spots refer to the same prescribed spot. The Meterset m3a represents the measured Meterset prior to the pause and m3b represents the measured Meterset after resumption.

C.8.8.26.2.5 Use Case 3: Tuning Spot

Some delivery systems use a tuning spot (aka pulse) to adjust the different beam parameters. This tuning spot can be delivered at the beginning of the beam or at any time during the beam. The tuning spot may not reach exactly the same position as a prescribed spot.

The suffix 't' indicates a tuning spot.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)	Scan Spot Prescribed Indices (300A,0391)
x4t,y4t	m4t	4
x1,y1	m1	1
x2,y2	m2	2
x3,y3	m3	3
x4,y4	m4	4
x5,y5	m5	5

A tuning spot was delivered at the beginning of a control point. The tuning spot will be present in the treatment record. As it is the first one being delivered for that control point, it will be the first one in the record.

The tuning spot in this example was targeting the 4th spot of the prescription. In the record the Scan Spot Prescribed Indices will refer to the 4th position. As the tuning spot may not match the prescribed position, it will have its own coordinates represented by the suffix 't'.

C.8.8.26.2.6 Use Case 4: Repainting

Use case demonstrating how re-paints of the spot map within the same control point can be represented.

The suffix 'p<n>' indicates a painting iteration.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)	Scan Spot Prescribed Indices (300A,0391)
x1p1,y1p1	m1p1	1
x2p1,y2p1	m2p1	2
x3p1,y3p1	m3p1	3
x4p1,y4p1	m4p1	4
x5p1,y5p1	m5p1	5
x1p2,y1p2	m1p2	1
x2p2,y2p2	m2p2	2
x3p2,y3p2	m3p2	3
x4p2,y4p2	m4p2	4
x5p2,y5p2	m5p2	5
x1p3,y1p3	m1p3	1
x2p3,y2p3	m2p3	2
x3p3,y3p3	m3p3	3
x4p3,y4p3	m4p3	4
x5p3,y5p3	m5p3	5

When repainting is requested (Number of Paintings (300A,039A) is greater than 1), the record shall contain each of the delivered paintings.

In the example, painting was performed three times. Each repainted spot is described by the Scan Spot Position, the Delivered Metersets of the specific painting, and the Scan Spot Prescribed Indices.

C.8.8.26.2.7 Use Case 5: Spot Reordering

In this use case, the number of spots remains the same, but they are simply treated in a different order than planned.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)	Scan Spot Prescribed Indices (300A,0391)
x4,y4	m4	4
x2,y2	m2	2
x5,y5	m5	5
x3,y3	m3	3
x1,y1	m1	1

When Scan Spot Re-Ordering is allowed, the spots are listed in the order of the delivery and reference the Scan Spot Prescribed Indices.

C.8.8.26.2.8 Use Case 6: Combination

This use case is a combination of all the above including tuning spots, repaints, and additional re-ordering.

The suffix 't' indicates a tuning spot.

The suffix 'p<n>' indicates a painting iteration.

The suffix '(r)' in Scan Spot Prescribed Indices (300A,0391) indicates that the spot has been re-ordered.

Scan Spot Position Map (300A,0394)	Scan Spot Metersets Delivered (3008,0047)	Scan Spot Prescribed Indices (300A,0391)
x4t,y4t	m4t	4
x2p1,y2p1	m2p1	2 (r)
x5p1,y5p1	m5p1	5 (r)
x1p1,y1p1	m1p1	1 (r)
x4p1,y4p1	m4p1	4
x3p1,y3p1	m3p1	3 (r)
x3t,y3t	m3t	3
x2p2,y2p2	m2p2	2 (r)
x5p2,y5p2	m5p2	5 (r)
x1p2,y1p2	m1p2	1 (r)
x4p2,y4p2	m4p2	4
x3p2,y3p2	m3p2	3 (r)
x2p3,y2p3	m2p3	2 (r)
x5p3,y5p3	m5p3	5 (r)
x1p3,y1p3	m1p3	1 (r)
x3p3,y3p3	m3p3	3 (r)

The repainting is represented by recording the spot multiple times and referencing to the same scan spot prescribed index.

The tuning pulse is recorded for the first two paintings and references the scan spot prescribed index of the spot being used for tuning.

The order of the spots is the spot order actually delivered.

The third painting did not deliver all the prescribed spots because some of the spot Metersets were below the minimum deliverable Meterset of the machine.

C.8.8.27 Beam Limiting Device Position Macro

Table C.8.8.27-1 specifies the Attributes that specify the Beam Limiting Device Sequence.

Table C.8.8.27-1. Beam Limiting Device Position Macro Attributes

Attribute Name	Tag	Type	Description
Beam Limiting Device Position Sequence	(300A,011A)	1C	Sequence of beam limiting device (collimator) jaw or leaf (element) positions. One or more Items shall be included in this Sequence. Required if Ion Beam Limiting Device Sequence (300A,03A4) or Beam Limiting Device Leaf Pairs Sequence (3008,00A0) is included in this SOP Instance and for first Item of Ion Control Point Sequence, or if Beam Limiting Device changes during Beam.

Attribute Name	Tag	Type	Description
>RT Beam Limiting Device Type	(300A,00B8)	1	Type of beam limiting device (collimator). The value of this Attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an Item of Ion Beam Limiting Device Sequence (300A,03A4). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>Leaf/Jaw Positions	(300A,011C)	1	Positions of beam limiting device (collimator) leaf (element) or jaw pairs (in mm) in IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) in Ion Beam Limiting Device Sequence (300A,03A4). Values shall be listed in IEC leaf (element) subscript order 101, 102, … 1N, 201, 202, … 2N. See Section C.8.8.25.3.

C.8.8.28 Patient Support Identification Macro

Table C.8.8.28-1 specifies the Attributes that identify the Patient Support System.

Table C.8.8.28-1. Patient Support Identification Macro Attributes

Attribute Name	Tag	Type	Description
Patient Support Type	(300A,0350)	1	Defined Terms: **TABLE** Treatment delivery system table **CHAIR** Treatment delivery system chair See Section C.8.8.25.6.3.
Patient Support ID	(300A,0352)	3	User-specified identifier for manufacturer specific patient support devices.
Patient Support Accessory Code	(300A,0354)	3	A Patient Support accessory identifier to be read by a device such as a bar code reader.

C.8.8.29 RT Beams Delivery Instruction Module

The RT Beams Delivery Instruction Module contains additional information required by a Treatment Delivery System (TDS) when specifying delivery of an external beam radiotherapy treatment. This information is supplied by a Treatment Management System (TMS) when it creates an RT Beams Delivery Instruction SOP Instance, a composite SOP Instance in turn referenced by a Unified Procedure Step (UPS) in the Unified Procedure Step model.

The RT Beams Delivery Instruction Module consists of a sequence of one or more beam tasks, where each beam task may also specify one or more Delivery Verification images to be acquired prior to, during, or after the treatment delivery.

Table C.8.8.29-1. RT Beams Delivery Instruction Module Attributes

Attribute Name	Tag	Type	Description
Referenced RT Plan Sequence	(300C,0002)	1	Reference to a single RT Plan or RT Ion Plan SOP Instance (whose UID is also supplied in the Input Information Sequence - see PS3.4) containing all the Beams and the Fraction Group referenced in this SOP Instance. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Description
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Beam Task Sequence	(0074,1020)	1	Specification of beams to be delivered and/or used for verification of the patient position. One or more Items shall be included in this Sequence.
>Beam Task Type	(0074,1022)	1	Whether the beam is used to verify patient position, deliver treatment, or both. Enumerated Values: **VERIFY** Verification of the patient position **TREAT** Beam treatment only **VERIFY_AND_TREAT** Patient position verification and treatment
>Treatment Delivery Type	(300A,00CE)	1	Delivery Type of treatment. Enumerated Values: **TREATMENT** normal patient treatment **CONTINUATION** continuation of interrupted treatment
>Primary Dosimeter Unit	(300A,00B3)	1C	Measurement unit of machine dosimeter. Enumerated Values: **MU** Monitor Unit **MINUTE** minute **NP** Number of Particles This value shall be the same as in the referenced RT Plan. It applies only to the Continuation Start Meterset (0074,0120) and Continuation End Meterset (0074,0121). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Continuation Start Meterset	(0074,0120)	1C	Meterset within Beam referenced by Referenced Beam Number (300C,0006) at which treatment delivery starts, in units specified by Primary Dosimeter Unit (300A,00B3). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Continuation End Meterset	(0074,0121)	1C	Meterset within Beam referenced by Referenced Beam Number (300C,0006) at which treatment delivery ends, in units specified by Primary Dosimeter Unit (300A,00B3). Required if Treatment Delivery Type (300A,00CE) is CONTINUATION.
>Current Fraction Number	(3008,0022)	1	The index of the fraction that is to be delivered or completed in this session. See Section C.8.8.29.1.
>Referenced Fraction Group Number	(300C,0022)	1C	Indicates which fraction group of the referenced plan is to be treated in the treatment session. Only one Fraction Group shall be specified per Delivery Instruction SOP Instance. Required if the referenced plan has more than one Fraction Group Sequence (300A,0070) Item.
>Referenced Beam Number	(300C,0006)	1	Uniquely identifies the Beam that is specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module of referenced RT Plan or within Ion Beam Sequence (300A,03A2) in RT Ion Beams Module of the referenced RT Ion Plan.

Attribute Name	Tag	Type	Description
>Beam Order Index	(0074,1324)	3	Identifies required ordering of beam delivery, monotonically increasing by 1, starting from 1. See Section C.8.8.29.5.
>Autosequence Flag	(0074,1025)	3	Enumerated Values: **YES** The current beam shall be automatically treated following the preceding beam as defined by the Beam Order Index (0074,1324). **NO** The current beam shall not be auto-sequenced. See Section C.8.8.29.6.
>Table Top Vertical Adjusted Position	(0074,1026)	2	Adjusted Table Top Vertical position in the IEC TABLE TOP coordinate system in mm for patient setup. See Section C.8.8.29.2.
>Table Top Longitudinal Adjusted Position	(0074,1027)	2	Adjusted Table Top Longitudinal position in the IEC TABLE TOP coordinate system in mm for patient setup. See Section C.8.8.29.2.
>Table Top Lateral Adjusted Position	(0074,1028)	2	Adjusted Table Top Lateral position in the IEC TABLE TOP coordinate system in mm for patient setup. See Section C.8.8.29.2.
>Patient Support Adjusted Angle	(0074,102A)	2	Adjusted Patient Support angle for patient setup, i.e., orientation of the IEC PATIENT SUPPORT coordinate system with respect to the IEC FIXED REFERENCE coordinate system in degrees. See Section C.8.8.29.2.
>Table Top Eccentric Adjusted Angle	(0074,102B)	2	Adjusted Table Top (non-isocentric) angle for patient setup, i.e., orientation of the IEC TABLE TOP ECCENTRIC coordinate system with respect to the IEC PATIENT SUPPORT system in degrees. See Section C.8.8.29.2.
>Table Top Pitch Adjusted Angle	(0074,102C)	2	Adjusted Table Top Pitch Angle for patient setup, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system in degrees. See Section C.8.8.29.2.
>Table Top Roll Adjusted Angle	(0074,102D)	2	Adjusted Table Top Roll Angle for patient setup, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system in degrees. See Section C.8.8.29.2.
>Table Top Vertical Setup Displacement	(300A,01D2)	2	Vertical Displacement in the IEC TABLE TOP coordinate system in mm relative to initial Setup Position, i.e., vertical offset between patient positioning performed using setup and treatment position.
>Table Top Longitudinal Setup Displacement	(300A,01D4)	2	Longitudinal Displacement in the IEC TABLE TOP coordinate system in mm relative to initial Setup Position, i.e., longitudinal offset between patient positioning performed using setup and treatment position.
>Table Top Lateral Setup Displacement	(300A,01D6)	2	Lateral Displacement in the IEC TABLE TOP coordinate system in mm relative to initial Setup Position, i.e., lateral offset between patient positioning performed using setup and treatment position.
>Include Table 10-28 “Device Motion Control Macro Attributes Description”			
>Delivery Verification Image Sequence	(0074,1030)	2C	Patient position verification images to be acquired for current beam. Required if Beam Task Type (0074,1022) is VERIFY or VERIFY_AND_TREAT. Zero or one Item shall be included in this Sequence if Beam Task Type (0074,1022) is VERIFY. Zero or more Items shall be included in this Sequence if Beam Task Type (0074,1022) is VERIFY_AND_TREAT.

Attribute Name	Tag	Type	Description
>>Verification Image Timing	(0074,1032)	1	Indicates the temporal relationship of the verification image with respect to the current treatment beam delivery. Value shall be DURING_BEAM for Beams with a Beam Task Type (0074,1022) of VERIFY. Enumerated Values: **BEFORE_BEAM** **DURING_BEAM** **AFTER_BEAM**
>>Start Cumulative Meterset Weight	(300C,0008)	1C	Cumulative Meterset Weight within current Beam at which image acquisition will start. Required if Verification Image Timing (0074,1032) is DURING_BEAM.
>>Meterset Exposure	(3002,0032)	2C	Treatment machine Meterset duration over which image is to be acquired, specified in Monitor units (MU) or minutes as defined by Primary Dosimeter Unit (300A,00B3) specified in the Referenced RT Plan Sequence (300C,0002). Required if Verification Image Timing (0074,1032) is BEFORE_BEAM or AFTER_BEAM. See Section C.8.8.29.3.
>>End Cumulative Meterset Weight	(300C,0009)	2C	Cumulative Meterset Weight within current Beam at which image acquisition will end. Required if Verification Image Timing (0074,1032) is DURING_BEAM.
>>Double Exposure Flag	(0074,1034)	1	Indicates whether the current verification image is a single or double exposure. Enumerated Values: **SINGLE** single exposure **DOUBLE** double exposure
>>Double Exposure Ordering	(0074,1036)	1C	Indicates the ordering of the open (double exposure) field with respect to the primary (collimated) field in a double exposure. Defined Terms: **OPEN_FIRST** Open field first **OPEN_SECOND** Open field second Required if Double Exposure Flag (0074,1034) is DOUBLE.
>>Double Exposure Meterset	(0074,1338)	2C	If this field is present, an additional exposure with the indicated Meterset is requested. Required if Double Exposure Flag (0074,1034) is DOUBLE.
>>Double Exposure Field Delta	(0074,133A)	2C	Offsets of field-defining edges in mm for the double exposure in the IEC BEAM LIMITING DEVICE coordinate system in the IEC order X1, X2, Y1, Y2. Negative values for X1 and Y1 indicate an enlarged field, negative values for X2 and Y2 indicate a reduced field. Required if Double Exposure Flag (0074,1034) is DOUBLE. See Section C.8.8.29.4.
>>X-Ray Image Receptor Translation	(3002,000D)	2	Position in (x,y,z) coordinates in mm of origin of the IEC X-RAY IMAGE RECEPTOR System in the IEC GANTRY coordinate system.

Attribute Name	Tag	Type	Description
>>Related Reference RT Image Sequence	(0074,1040)	3	Uniquely identifies Reference Images to which planned verification image is related. All Items in this Sequence shall be RT Image SOP Instances. One or more Items are permitted in this Sequence.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Omitted Beam Task Sequence	(300C,0111)	3	Beams not to be delivered and/or used for patient position verification. One or more Items are permitted in this Sequence.
>Referenced Beam Number	(300C,0006)	1	Uniquely identifies the Beam that is specified by Beam Number (300A,00C0) within Beam Sequence (300A,00B0) in RT Beams Module of referenced RT Plan or within Ion Beam Sequence (300A,03A2) in RT Ion Beams Module of the referenced RT Ion Plan.
>Reason for Omission	(300C,0112)	1	Reason why the referenced beam is not to be delivered and/or verified: Defined Terms: **ALREADY_TREATED** The beam has been already treated in an earlier treatment session
>Reason for Omission Description	(300C,0113)	3	Description of reason for omission.

C.8.8.29.1 Current Fraction Number

For beams with a Treatment Delivery Type (300A,00CE) of CONTINUATION, the Current Fraction Number (3008,0022) is that of the original fraction to be completed by the current beam.

C.8.8.29.2 Adjusted Table Positions and Angles

Adjusted Table positions and angles serve as a facility to communicate a shift (often systematic) that has been detected from previous treatments. They define a new initial patient position, which is near and aligned to the actual patient position during beam delivery. These Attributes do not affect the original relationship between the beams and the planning image patient anatomy.

C.8.8.29.3 Meterset Exposure

Meterset Exposure (3002,0032) can be interpreted as the 'maximum' Meterset duration in cases where an automatic exposure is taken.

C.8.8.29.4 Double Exposure Field Delta

The following diagram illustrates the case where the second X aperture in a double exposure is larger than the initial aperture. In this case $\Delta X1$ is negative and $\Delta X2$ is positive. If a field edge is defined by a multileaf collimator, then the field delta is to be applied to the most open leaf, such that all leaves can be moved to that position.

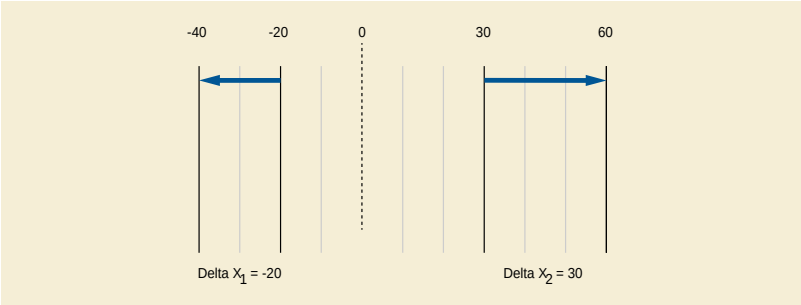


Figure C.8.8.29-1. Double Exposure Field Delta

C.8.8.29.5 Beam Order Index

If the Beam Order Index (0074,1324) is present for any Item in the Beam Task Sequence (0074,1020), it shall be provided for all Items in that Sequence.

C.8.8.29.6 Autosequence Flag

Autosequence Flag (0074,1025) shall not be present when the Beam Order Index (0074,1324) is not present. The first treatment Beam (Beam Task Type (0074,1022) is not VERIFY) as specified by the Beam Order Index (0074,1324), shall have an Autosequence Flag (0074,1025) value of NO.

C.8.8.30 RT Brachy Application Setup Delivery Instruction Module

The RT Brachy Application Setup Delivery Instruction Module contains additional information required by a Treatment Delivery System (TDS) when specifying delivery of a brachytherapy treatment.

This Module references the RT Plan to be delivered and specifies the treatment tasks to be performed for the Application Setups of the RT Plan.

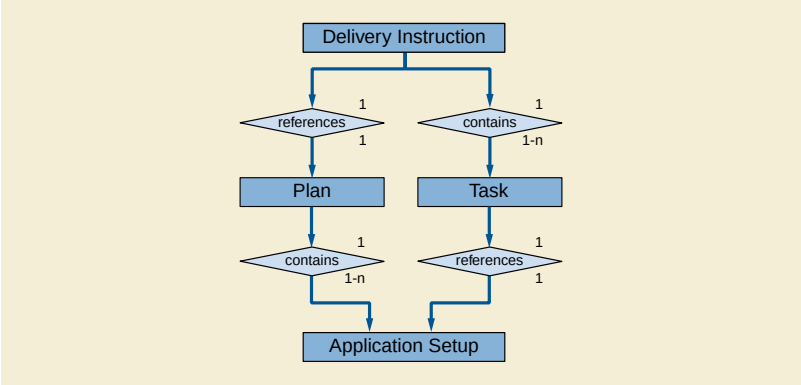


Figure C.8.8.30-1. Relationship of brachytherapy treatment plan and delivery instruction

The RT Brachy Application Setup Delivery Instruction Module consists of a Sequence of one or more tasks.

Table C.8.8.30-1. RT Brachy Application Setup Delivery Instruction Module Attributes

Attribute Name	Tag	Type	Description
Referenced RT Plan Sequence	(300C,0002)	1	Reference to a single RT Plan SOP Instance containing all the brachy application setups and the fraction group referenced in this SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Referenced Fraction Group Number	(300C,0022)	1	Indicates which fraction group of the referenced RT Plan in the Referenced RT Plan Sequence (300C,0002) is to be treated in the treatment session.
Current Fraction Number	(3008,0022)	1	The index of the fraction that is to be delivered or completed in this treatment session. See Section C.8.8.30.3.
Continuation Pulse Number	(0074,1404)	1C	The index of the pulse that is to be delivered or completed in this treatment session. Required if Brachy Treatment Type (300A,0202) of the referenced RT Plan in the Referenced RT Plan Sequence (300C,0002) is PDR and if Treatment Delivery Type (300A,00CE) is CONTINUATION in any of the Items in the Brachy Task Sequence (0074,1401). See Section C.8.8.30.4.
Brachy Task Sequence	(0074,1401)	1	Specification of Brachy Application Setups to be delivered. One or more Items shall be included in this Sequence. See Section C.8.8.30.1.
>Treatment Delivery Type	(300A,00CE)	1	Delivery Type of treatment. Enumerated Values: **TREATMENT** normal patient treatment **CONTINUATION** continuation of interrupted treatment See Section C.8.8.30.2.
>Continuation Start Total Reference Air Kerma	(0074,1402)	1C	Total Reference Air ~~KermawithinKerma~~ within the Application Setup referenced by Referenced Brachy Application Setup Number (300C,000C) at which treatment delivery starts. Required if Delivery Type (300A,00CE) is CONTINUATION.
>Continuation End Total Reference Air Kerma	(0074,1403)	1C	Total Reference Air ~~KermawithinKerma~~ within the Application Setup referenced by Referenced Brachy Application Setup Number (300C,000C) at which treatment delivery ends. Required if Delivery Type (300A,00CE) is CONTINUATION.
>Referenced Brachy Application Setup Number	(300C,000C)	1	Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in the referenced RT Plan. One or more Items shall be included in this Sequence.
>Channel Delivery Order Sequence	(0074,1405)	3	The order in which the channels are to be delivered. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Description
>>Referenced Channel Number	(0074,1406)	1	The channel to be delivered, specified by the value of Channel Number (300A,0282) in referenced RT Plan.
>>Channel Delivery Order Index	(0074,140C)	1	The order of delivery of this channel, monotonically increasing by 1, starting from 1, where number 1 is the first channel to be delivered.
>Channel Delivery Continuation Sequence	(0074,140D)	1C	The treatment time weights for channels to be delivered to complete a previously interrupted fraction. Required if Delivery Type (300A,00CE) is CONTINUATION. One or more Items shall be included in this Sequence.
>>Referenced Channel Number	(0074,1406)	1	The channel to be delivered, specified by the value of Channel Number (300A,0282) in referenced RT Plan.
>>Start Cumulative Time Weight	(0074,1407)	1	Cumulative Time Weight where to start/continue the delivery of the referenced channel. See Section C.8.8.15.6.
>>End Cumulative Time Weight	(0074,1408)	1	Cumulative Time Weight where to stop the delivery of the referenced channel. See Section C.8.8.15.6.
Omitted Application Setup Sequence	(0074,140E)	1C	Application Setups of the current RT Plan containing channels not to be delivered. Required if Delivery Type (300A,00CE) is CONTINUATION and one or more channels of any Application Setup are omitted. One or more Items shall be included in this Sequence.
>Referenced Brachy Application Setup Number	(300C,000C)	1	Brachy Application Setup Number (300A,0234) within Brachy Application Setup Sequence (300A,0230) in referenced RT Plan.
>Omitted Channel Sequence	(0074,1409)	1	Channels defined for this Application Setup not to be delivered. One or more Items shall be included in this Sequence.
>>Referenced Channel Number	(0074,1406)	1	Channel to be omitted, specified by the value of Channel Number (300A,0282) in the referenced RT Plan.
>>Reason for Channel Omission	(0074,140A)	1	Reason why the referenced channel is not to be delivered. Defined Terms: **ALREADY_TREATED** The channel has been already delivered. **OTHER** This channel is not to be delivered for other reasons.
>>Reason for Channel Omission Description	(0074,140B)	3	Description of reason for omission.

C.8.8.30.1 Brachy Task Sequence

The Brachy Task Sequence (0074,1401) contains instructions for the delivery of a single treatment session. A treatment session is the time that the patient is connected to the treatment delivery system. During a treatment session, one fraction of the referenced plan is delivered. If the value of Brachy Treatment Type (300A,0202) in the reference RT Plan is HDR, the entire fraction is delivered at one time. If the value is PDR, the fraction is divided into a number of pulses which are delivered periodically during the treatment session.

The Application Setup groups together the channels to be delivered. The task Sequence can also contain the delivery order of the channels. The Omitted Application Setup Sequence (0074,140E) contains the channels to skip in the case of continuation of an interrupted treatment.

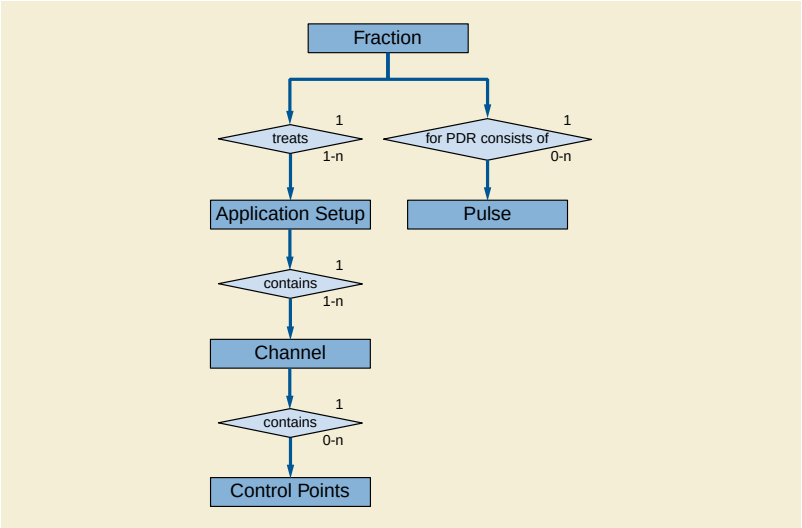


Figure C.8.8.30-2. Relation of the Fraction, Pulse and Channels within the RT Brachy Task Sequence

The following scenarios demonstrate the usage of the RT Brachy Application Setup Delivery Instruction Module for the Treatment Management System (TMS) to instruct the Treatment Delivery System (TDS) to initiate brachytherapy treatment and continue an interrupted delivery.

C.8.8.30.1.1 Usage Scenario 1: HDR Treatment, Interruption Skipping Remainder of the Interrupted Delivery

Brachytherapy plan overview:

Plan1, HDR, 2 fractions;

Channel1, two dwell positions, 10 sec + 10 sec

Channel2, two dwell positions, 10 sec + 10 sec

Treatment session 1:

Treatment Management System (TMS):

Requests the delivery of the first fraction of the plan:

RT Brachy Application Setup Delivery Instruction:

Referenced RT Plan Sequence (300C,0002) = UID of "Plan1"

Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 1

Brachy Task Sequence (0074,1401):

Treatment Delivery Type (300A,00CE) = TREATMENT

Referenced Brachy Application Setup Number (300C,000C) = 1

Treatment Delivery System (TDS):

Delivers the first fraction and returns a RT Brachy Treatment Record that describes interruption at channel 2 after 9 seconds of the second dwell position is being delivered.

Treatment session 2:

It has been decided to proceed to fraction 2 without delivering the remainder of fraction 1. This is not a continuation case.

Treatment Management System (TMS):

Requests the delivery of the second fraction of the plan:

RT Brachy Application Setup Delivery Instruction:

Referenced RT Plan Sequence (300C,0002) = UID of "Plan1"

Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 2

Brachy Task Sequence (0074,1401):

Treatment Delivery Type (300A,00CE) = TREATMENT

Referenced Brachy Application Setup Number (300C,000C) = 1

Treatment Delivery System (TDS) :

Delivers the second fraction and returns a RT Brachy Treatment Record that describes a complete delivery of that fraction.

C.8.8.30.1.2 Usage Scenario 2: PDR Treatment, Interruption and Continuation

Brachytherapy plan overview:

Plan2, PDR, 10 pulses;

Channel1, two dwell positions, 50 sec + 50 sec

Channel2, two dwell positions, 50 sec + 50 sec

Treatment Session 1

Treatment Management System (TMS):

Requests the delivery of the first fraction of the plan:

RT Brachy Application Setup Delivery Instructions:

Referenced RT Plan Sequence (300C,0002) = UID of "Plan2"

Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 1

Brachy Task Sequence (0074,1401):

Treatment Delivery Type (300A,00CE) = TREATMENT

Referenced Brachy Application Setup Number (300C,000C) = 1

Treatment Delivery System (TDS) :

Delivers the first fraction and returns a RT Brachy Treatment Record that ~~that~~ describes interruption at pulse 5 of the first fraction at channel 2, after 25 seconds of the first dwell position was delivered. Total Reference Air Kerma Delivered was 100.

Treatment Session 2

It has been decided to proceed to fraction 2 to deliver the remainder of the interrupted plan as instructed by the following task transmitted inside the delivery instruction:

The remainder is defined as to skip 25 sec of the first dwell position of channel 2 and continue with the second dwell position.

Treatment Management System (TMS):

Requests the continuation of the delivery of the first fraction of the plan:

Referenced RT Plan Sequence (300C,0002) = UID of "Plan2"

Referenced Fraction Group Number (300C,0022) = 1

Current Fraction Number (3008,0022) = 1

Continuation Pulse Number (0074,1404) = 5

Brachy Task Sequence (0074,1401):

Treatment Delivery Type (300A,00CE) = CONTINUATION

Continuation Start Total Reference Air Kerma (0074,1402) = 100

Continuation End Total Reference Air Kerma (0074,1403) = 1000

Referenced Brachy Application Setup Number (300C,000C) = 1

Channel Delivery Order Sequence (0074,1405):

Referenced Channel Number (0074,1406) = 2

Channel Delivery Order Index (0074,140C) = 1

Channel Delivery Continuation Sequence (0074,140D):

Referenced Channel Number (0074,1406) =2

Start Cumulative Time Weight (0074,1407) = 50

End Cumulative Time Weight (0074,1408) = 100

Omitted Application Setup Sequence (0074,140E):

Referenced Brachy Application Setup Number (300C,000C) = 1

Omitted Channel Sequence (0074,1409):

Referenced Channel Number (0074,1406) = 1

Reason for Channel Omission (0074,140A) = ALREADY_TREATED

Treatment Delivery System (TDS):

Delivers the first fraction and returns RT Brachy Treatment Record that describes that the treatment first fraction was continued and the reminder was delivered fully (including the rest of the pulses from 6-10).

C.8.8.30.2 Treatment Delivery Type

For RT Brachy Application Setup Delivery Instructions with a Treatment Delivery Type (300A,00CE) of CONTINUATION in an RT Plan with a Treatment Type (300A,0202) of PDR, instructions in the Task Sequence apply only to the continuation pulse. The pulses following the continuation pulse will be fully delivered.

C.8.8.30.3 Current Fraction Number

For RT Brachy Application Setup Delivery Instruction of Treatment Delivery Type (300A,00CE) of CONTINUATION, the Current Fraction Number (3008,0022) is that of the fraction to be completed.

C.8.8.30.4 Current Pulse Number

For RT Brachy Application Setup Delivery Instruction with a Treatment Delivery Type (300A,00CE) of CONTINUATION and the Treatment Type (300A,0202) of PDR of the Referenced RT Plan, the Continuation Pulse Number (0074,1404) is that of the original pulse to be completed by the current application setup.

C.8.9 PET Information Module Definitions

This Section describes Positron Emission Tomography Series and Image Modules. These Modules contain Attributes that are specific to Positron Emission Tomography images.

C.8.9.1 PET Series Module

Table C.8-60 contains IOD Attributes that describe a PET Series.

Table C.8-60. PET Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Series Date	(0008,0021)	1	Date the Series started. See Section C.8.9.1.1.2 for specialization.
Series Time	(0008,0031)	1	Time the Series started. See Section C.8.9.1.1.2 for specialization.
Units	(0054,1001)	1	Pixel value units. See Section C.8.9.1.1.3 for Defined Terms.
SUV Type	(0054,1006)	3	Type of Standardized Uptake Value (SUV). Enumerated Values: **BSA** body surface area **BW** body weight **LBM** lean body mass by James method **LBMJAMES128** lean body mass by James method using a multiplier of 128 for males **LBMJANMA** lean body mass by Janmahasatian method **IBW** ideal body weight If absent, and the Units (0054,1001) are GML, then the type of SUV shall be assumed to be BW. Note The type of SUV cannot reliably be deduced from the units alone, i.e., SUVbw, SUVibw and SUVlbm (James or Janmahasatian) all have units of GML.
Counts Source	(0054,1002)	1	The primary source of counts. The primary source leads to the underlying image Units (0054,1001), as opposed to secondary sources that are used during reconstruction correction. Enumerated Values: **EMISSION** **TRANSMISSION**

Attribute Name	Tag	Type	Attribute Description
Series Type	(0054,1000)	1	A multi-valued indicator of the type of Series. See Section C.8.9.1.1.4 for explanation. Value 1 Enumerated Values: **STATIC** **DYNAMIC** **GATED** **WHOLE BODY** Value 2 Enumerated Values: **IMAGE** **REPROJECTION**
Reprojection Method	(0054,1004)	2C	Method for projecting volumetric data onto planar projection. Required if Series Type (0054,1000), Value 2 is REPROJECTION. Defined Terms: **SUM** **MAX PIXEL**
Number of R-R Intervals	(0054,0061)	1C	The maximum number of R-R Intervals that may exist in this Series. Required if Series Type (0054,1000), Value 1 is GATED.
Number of Time Slots	(0054,0071)	1C	The maximum number of Time Slots that may exist in this Series. Required if Series Type (0054,1000), Value 1 is GATED.
Number of Time Slices	(0054,0101)	1C	The maximum number of Time Slices that may exist in this Series. Required if Series Type (0054,1000), Value 1 is DYNAMIC.
Number of Slices	(0054,0081)	1	The maximum number of Slices that may exist in this Series.
Corrected Image	(0028,0051)	2	One or more values that indicate which, if any, corrections have been applied to the images in this Series. Defined Terms: **DECY** decay corrected **ATTN** attenuation corrected **SCAT** scatter corrected **DTIM** dead time corrected **MOTN** gantry motion corrected (e.g., wobble, clamshell) **PMOT** patient motion corrected **CLN** count loss normalization (correction for count loss in gated Time Slots) **RAN** randoms corrected **RADL** non-uniform radial sampling corrected **DCAL** sensitivity calibrated using dose calibrator **NORM** detector normalization
Randoms Correction Method	(0054,1100)	3	Type of randoms correction processing. Defined Terms: **NONE** no randoms correction **DLYD** delayed event subtraction **SING** singles estimation
Attenuation Correction Method	(0054,1101)	3	A textual description of the attenuation correction processing. e.g., measured vs. calculated, transmission source type (ring, line, point), assumed patient geometry (polygon, ellipse, segmented, attenuation coefficient, skull thickness), post-injection transmission, smoothing.

Attribute Name	Tag	Type	Attribute Description
Scatter Correction Method	(0054,1105)	3	A textual description of the scatter correction processing. e.g., convolution-subtraction, dual energy window, model-based, use of attenuation data.
Decay Correction	(0054,1102)	1	The real-world event to which images in this Series were decay corrected. See Section C.8.9.1.1.5 for explanation. Defined Terms: **NONE** no decay correction **START** acquisition start time **ADMIN** radiopharmaceutical administration time
Reconstruction Diameter	(0018,1100)	3	Diameter, in mm, of the region within which the data was used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011).
Convolution Kernel	(0018,1210)	3	Textual description of the convolution kernel(s) used to reconstruct the data (e.g., name, cutoff, radial/axial/angular, mathematical form, DC handling)
Reconstruction Method	(0054,1103)	3	Textual description of reconstruction processing, e.g., 2D filtered backprojection, 2D iterative, 3D PROMIS, 3D FAVOR, 3D iterative.
Detector Lines of Response Used	(0054,1104)	3	Textual description of which detector lines of response were used, mashed, or otherwise processed during tomographic reconstruction.
Acquisition Start Condition	(0018,0073)	3	Description of how the data collection was started. Defined Terms: **DENS** density (counts/sec) **RDD** relative density difference (change in counts/sec) **MANU** manual **TIME** time **AUTO** automatic, when ready **TRIG** physiological trigger See Section C.8.9.1.1.6 for explanation.
Acquisition Start Condition Data	(0018,0074)	3	Count density, change in count density, or physiological triggers causing data collection to start.

Attribute Name	Tag	Type	Attribute Description
Acquisition Termination Condition	(0018,0071)	3	Description of how the data collection for the Series was stopped. Defined Terms: **CNTS** counts **DENS** density (counts/sec) **RDD** relative density difference (change in counts/sec) **MANU** manual **OVFL** data overflow **TIME** time **TRIG** physiological trigger See Section C.8.4.9.1.3 for explanation.
Acquisition Termination Condition Data	(0018,0075)	3	Number of counts, count density, change in count density, or physiological triggers causing the termination.
Field of View Shape	(0018,1147)	3	Shape of the field of view of the PET camera. Defined Terms: **CYLINDRICAL RING** **HEXAGONAL** **MULTIPLE PLANAR**
Field of View Dimensions	(0018,1149)	3	Dimensions of the field of view, in mm. Transverse detector diameter followed by axial width.
Gantry/Detector Tilt	(0018,1120)	3	Angle of tilt in degrees of the gantry. See Section C.8.9.1.1.7 for explanation.
Gantry/Detector Slew	(0018,1121)	3	Angle of slew in degrees of the gantry. Positive slew is moving the gantry on the patient's left toward the patient's superior, when the patient is supine.
Type of Detector Motion	(0054,0202)	3	Describes the detector motion during acquisition. Defined Terms: **NONE** stationary gantry **STEP AND SHOOT** Interrupted motion, acquire only while stationary **CONTINUOUS** Gantry motion and acquisition are simultaneous and continuous **WOBBLE** wobble motion **CLAMSHELL** clamshell motion
Collimator Type	(0018,1181)	2	Collimator Type. Defined Terms: **NONE** no collimator **RING** transverse septa
Collimator/Grid Name	(0018,1180)	3	Label describing the collimator used.
Axial Acceptance	(0054,1200)	3	Maximum axial angle accepted, in degrees.
Axial Mash	(0054,1201)	3	Number of adjacent axial lines of response mashed together. See Section C.8.9.1.1.8 for explanation.
Transverse Mash	(0054,1202)	3	Number of adjacent transverse lines of response mashed together. See Section C.8.9.1.1.9 for explanation.
Detector Element Size	(0054,1203)	3	Size of an individual detector element, in mm. Transverse dimension followed by axial dimension. For a discrete crystal, this is the crystal size. For a continuous detector, this is the pixel bin size.

Attribute Name	Tag	Type	Attribute Description
Coincidence Window Width	(0054,1210)	3	The width of the coincidence timing window, in nsec. The maximum time difference accepted between two single events.
Energy Window Range Sequence	(0054,0013)	3	Sequence of Items that describes the energy windows used for this Series. One or more Items are permitted in this Sequence. See Section C.8.9.1.1.10 for explanation.
>Energy Window Lower Limit	(0054,0014)	3	The lower limit of the energy window, in KeV.
>Energy Window Upper Limit	(0054,0015)	3	The upper limit of the energy window, in KeV.
Secondary Counts Type	(0054,1220)	3	Array defining the type of additional counts accumulated during acquisition. Defined Terms: **DLYD** delayed events **SCAT** scattered events in secondary window **SING** singles **DTIM** events lost due to deadtime
Scan Progression Direction	(0054,0501)	3	The anatomical order in which the slices were acquired. Enumerated Values: **FEET_TO_HEAD** Slices closest to the patient's feet were acquired first. **HEAD_TO_FEET** Slices closest to the patient's head were acquired first.

Note

The formulas for the determination of SUVbw, SUVbsa, SUVlbm (James) and SUVibw are defined in Sugawara et al. *Reevaluation of the Standardized Uptake Value for FDG: Variations with Body Weight and Methods for Correction.* Radiology, 1999 at http://radiology.rsna.org/content/213/2/521.

Unfortunately, Sugawara used a parameter of 120 rather than 128 for males, propagating an error in Morgan DJ, Bray KM. Lean Body Mass as a Predictor of Drug Dosage: Implications for Drug Therapy. Clinical Pharmacokinetics. 1994;26(4):292–307, which misquoted the original LBM definition that used 128 in James WPT, Waterlow JC. Research on Obesity: A Report of the DHSS/MRC Group. London: Her Majesty's Stationery Office; 1976. Implementations differ in whether they have used 120 or 128 when the DICOM Defined Term is LBM. See Kelly M. SUV: Advancing Comparability and Accuracy. Siemens; 2009. Available from: http://www.mpcphysics.com/documents/SUV_Whitepaper_Final_11.17.09_59807428_2.pdf.

The Janmahasatian LBM formula is defined in *Janmahasatian et al. Quantification of Lean Bodyweight. Clin Pharmacokinet. 2005 Oct 1;44(10):1051–65.* at http://dx.doi.org/10.2165/00003088-200544100-00004 and its role in SUVlbm(Janma) calculation is discussed in *Tahari et al. Optimum Lean Body Formulation for Correction of Standardized Uptake Value in PET Imaging. Journal of Nuclear Medicine. 2014 Sep 1;55(9):1481–4.* at http://jnm.snmjournals.org/content/55/9/1481. See also CID 85 "SUV Units" in PS3.16.

C.8.9.1.1 PET Series Attribute Descriptions

Note

The meaning of a General Series in DICOM is determined by the Attributes in the General Series Module and by the Source Entities (Patient, Study, Frame of Reference, Equipment) that originate the Series. The Source Entities are the single-valued entities of the 1->n relationship, where the Series is the multi-valued entity. Therefore, a Series is a group of images that: are from the same patient and Study; are from the same Equipment; and, are from the same spatial Frame of Reference.

The PET Image IOD further refines a PET Series IE by the Attributes in the PET Series Module, the PET Isotope Module, the PET Multi-gated Acquisition Module and the Acquisition Context Module. These are the Attributes that shall not change from Image to Image. Therefore, in addition to the criteria above for a General Series (same patient, Study, Frame of Reference, equipment), the Attributes in the PET Series IE define a PET Series as a group of images that: are from the same temporal Frame of Reference; have

the same fundamental meaning (e.g., same units: either activity density, metabolism, or attenuation); are derived from the same activity source (emission or transmission); are from the same isotope and radiopharmaceutical; were derived from the same reconstruction processing; and, originated from the same acquisition setup and parameters, including the patient conditions (cardiac stress or rest) if applicable.

C.8.9.1.1.1 Specialization of Image Plane Module and Image Pixel Module Attributes

For PET Series, the following Image Pixel Module Attributes shall not vary from Image to Image:

- Photometric Interpretation (0028,0004)
- Rows (0028,0010)
- Columns (0028,0011)
- Bits Allocated (0028,0100)
- Bits Stored (0028,0101)
- Pixel Representation (0028,0103)

For PET Series, the following Image Plane Module Attributes shall not vary from Image to Image:

- Pixel Spacing (0028,0030)

For PET Series where Series Type (0054,1000), Value 2 is IMAGE, the following Image Plane Module Attributes shall not vary from Image to Image:

- Image Orientation (Patient) (0020,0037)

  Note

  This means that for a Series Type (0054,1000) Value 2 of IMAGE, all images in the PET Series lie on parallel planes. The images, however, may have non-uniform spacing along the normals to the planes.

For PET Series where Series Type (0054,1000), Value 2 is REPROJECTION, Image Orientation (0020,0037) shall vary such that the images rotate about a single axis. Geometrically, the normal to each image plane is defined by the cross product of its row and column vectors. Each reprojection image has one Center Normal that passes through the center of the image. Reprojection images within a PET Series shall have their Center Normals be co-planar and pass through a single point.

C.8.9.1.1.2 Series Date, Series Time

For PET Series, Series Date (0008,0021) and Series Time (0008,0031) are specified to be Type 1. Series Date (0008,0021) and Series Time (0008,0031) are used as the reference time for all PET Image Attributes that are temporally related, including activity measurements. Series Date (0008,0021) and Series Time (0008,0031) are not tied to any real-world event (e.g., acquisition start, radiopharmaceutical administration) and their real-world meaning are implementation dependent.

C.8.9.1.1.3 Units

The units of the pixel values obtained after conversion from the stored pixel values (SV) (Pixel Data (7FE0,0010)) to pixel value units (U), as defined by Rescale Intercept (0028,1052) and Rescale Slope (0028,1053).

Defined Terms:

CNTS	counts ({counts}, UCUM, "Counts")
NONE	unitless (1, UCUM, "no units")
CM2	centimeter**2 (cm2, UCUM, "Centimeter**2")
CM2ML	centimeter**2/milliliter (cm2/ml, UCUM, "Centimeter**2/milliliter")
PCNT	percent (%, UCUM, "Percent")
CPS	counts/second ({counts}/s, UCUM, "Counts per second")
BQML	Becquerels/milliliter (Bq/ml, UCUM, "Becquerels/milliliter")
MGMINML	milligram/minute/milliliter (mg/min/ml, UCUM, "Milligrams/minute/milliliter")
UMOLMINML	micromole/minute/milliliter (umol/min/ml, UCUM, "Micromole/minute/milliliter")

MLMING	milliliter/minute/gram (ml/min/g, UCUM, "Milliliter/minute/gram")
MLG	milliliter/gram (ml/g, UCUM, "Milliliter/gram")
1CM	1/centimeter (/cm, UCUM, "/Centimeter")
UMOLML	micromole/milliliter (umol/ml, UCUM, "Micromole/milliliter")
PROPCNTS	proportional to counts ({propcounts}, UCUM, "Proportional to counts")
PROPCPS	proportional to counts/sec ({propcounts}/s, UCUM, "Proportional to counts per second")
MLMINML	milliliter/minute/milliliter (ml/min/ml, UCUM, "Milliliter/minute/milliliter")
MLML	milliliter/milliliter (ml/ml, UCUM, "Milliliter/milliliter")
GML	grams/milliliter (g/ml, UCUM, "Gram/milliliter")
STDDEV	standard deviations

Note

The majority of these defined terms are equivalent to CID 84 “PET Units”. Those that are used for SUV are not qualified by the type of SUV, which is encoded separately as SUV Type (0054,1006).

C.8.9.1.1.4 Series Type

Series Type (0054,1000) Value 1 is used to identify the spatial location and temporal nature of the images within a PET Series.

Enumerated Values for Value 1:

STATIC	a group of images at varying spatial locations at the same time
DYNAMIC	a group of images at a set of spatial locations (e.g., slices) at varying time slices, with all spatial locations acquired at all time slices
GATED	a group of images at the same spatial location, same starting and ending time, but acquired in different time slots of (possibly) different R-R intervals
WHOLE BODY	same as STATIC, except covering multiple transverse fields of view (and therefore acquired at a different time)

Note

1. Using this definition and the comments in Section C.8.9.1.1.1, here are some examples of PET Series and the encoding of Series Type (0054,1000) Value 1.

   - Static acquisition: a group of n transverse images at varying superior<->inferior locations, all acquired between the same starting and ending time. Series Type = STATIC.
   - Dynamic acquisition: a group of n*m transverse images at n superior<->inferior locations, acquired with m different starting and ending times. Series Type = DYNAMIC.
   - Gated acquisition: a group of n*m*p transverse images at n superior<->inferior locations, all acquired between the same starting and ending time, acquired in m different R-R Intervals (as determined by Low R-R Value (0018,1081) and High R-R Value (0018,1082)), and acquired in p time slots of a given R-R Interval (as determined by Trigger Time (0054,1000)). Series Type = GATED.
   - Whole body acquisition: a group of n transverse images at varying superior<->inferior locations covering a significant fraction of the entire body. Series Type = WHOLE BODY.
   - Multiple transverse fields of view: a group of n transverse images at varying superior<->inferior locations. Series Type = WHOLE BODY.
   - Interleaved: group of 2*n transverse images acquired at overlapped ~~AFOVs~~axial fields of view (AFOVs) to increase transverse sampling. Series Type = WHOLE BODY.
   - Sagittal (Coronal, Oblique): sagittal (coronal, oblique) re-sliced images derived by reformatting transverse images. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.
   - Arithmetic: images derived by an arithmetic operation on operand images. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.
   - Metabolic: images derived by a metabolic model. The Series Type is STATIC, DYNAMIC, GATED, or WHOLE BODY depending on source Series Type.

2. Using this definition, here are some images that are not stored in the same PET Series:
   - Two images from the same scan that were reconstructed differently.
   - Emission and transmission images for the same Patient and Study, even if acquired simultaneously (because emission and transmission images have different reconstruction processing).
   - Two images of same patient, one after NH3 injection and one after FDG injection.
   - Two images: an original image created from reconstructed scan data and its derived image based on a metabolic model.

Series Type (0054,1000) Value 2 is used to identify the volumetric meaning of the images within a PET Series.

Enumerated Values for Value 2:

IMAGE a tomographic image slice
REPROJECTION a projection image derived from forward projection through slices of tomographic images, using the algorithm defined in Reprojection Method (0054,1004)

C.8.9.1.1.5 Decay Correction

Decay Correction (0054,1102) is the real-world event to which images in this Series were decay corrected. If decay correction is applied, all images in the Series shall be decay corrected to the same time.

Defined Terms:

NONE no decay correction
START acquisition start time, Acquisition Time (0008,0032)
ADMIN radiopharmaceutical administration time, Radiopharmaceutical Start Time (0018,1072)

The time to which images have been decay corrected can be derived from Decay Factor (0054,1321), Frame Reference Time (0054,1300), Radionuclide Half Life (0018,1075), Series Date (0008,0021) and Series Time (0008,0031).

C.8.9.1.1.6 Acquisition Start Condition

Acquisition Start Condition (0018,0073) is the method of starting acquisition data collection.

Defined Terms:

DENS preset count density (counts/sec) was reached
RDD preset relative count density difference (change in counts/sec) was reached
MANU acquisition was started manually
TIME preset time limit was reached
AUTO start automatically, when ready
TRIG preset number of physiological triggers was reached

C.8.9.1.1.7 Gantry/Detector Tilt

Gantry/Detector Tilt (0018,1120) for PET Image data is the angle in degrees of the gantry relative to the patient's major (Head to Feet) axis (or the table supporting the patient). Positive tilt is moving the top of the gantry towards the patient's feet.

C.8.9.1.1.8 Axial Mash

Axial Mash (0054,1201) is multi-valued and is defined as the number of unique axial Lines of Response (LOR) that were mashed together (center of the axial field of view only). Value 1 is the number of LORs mashed for an odd slice. Value 2 is the number of LORs mashed for an even slice. For discrete crystal scanners, each unique LOR corresponds to a pair of crystals. For continuous detectors whose bin size is variable, the number of LORs mashed is determined by the actual bin size divided by the Detector Element Size (0054,1203), Value 2. The value of Axial Mash (0054,1201) is the same regardless of whether the mashing was done during acquisition or reconstruction.

Note

As an example on a discrete crystal scanner, if a ring difference of -2,0,+2 are binned as an odd slice and a ring difference of -1,+1 are binned as an even slice, then Axial Mash (0054,1201) is equal to 3\2.

C.8.9.1.1.9 Transverse Mash

Transverse Mash (0054,1202) is defined as the number of unique transverse Lines of Response (LOR) that were mashed together. For discrete crystal scanners, each unique LOR corresponds to a pair of crystals. For continuous detectors whose bin size is variable, the number of LORs mashed is determined by the actual bin size divided by the Detector Element Size (0054,1203), Value 1. The value of Transverse Mash (0054,1202) is the same regardless of whether the mashing was done during acquisition or reconstruction.

C.8.9.1.1.10 Energy Window Range Sequence

Multiple energy windows are allowed in order to allow coincidence events based on additional Energy Windows (e.g., Compton events scattered in the detector). All energy windows are assumed to contribute to all images in the PET Series.

C.8.9.1.1.11 Temporal Relationships of Images in PET Series

Figure C.8.9.1.1.11-1a and Figure C.8.9.1.1.11-1b show the temporal relationships of images within a PET Series.

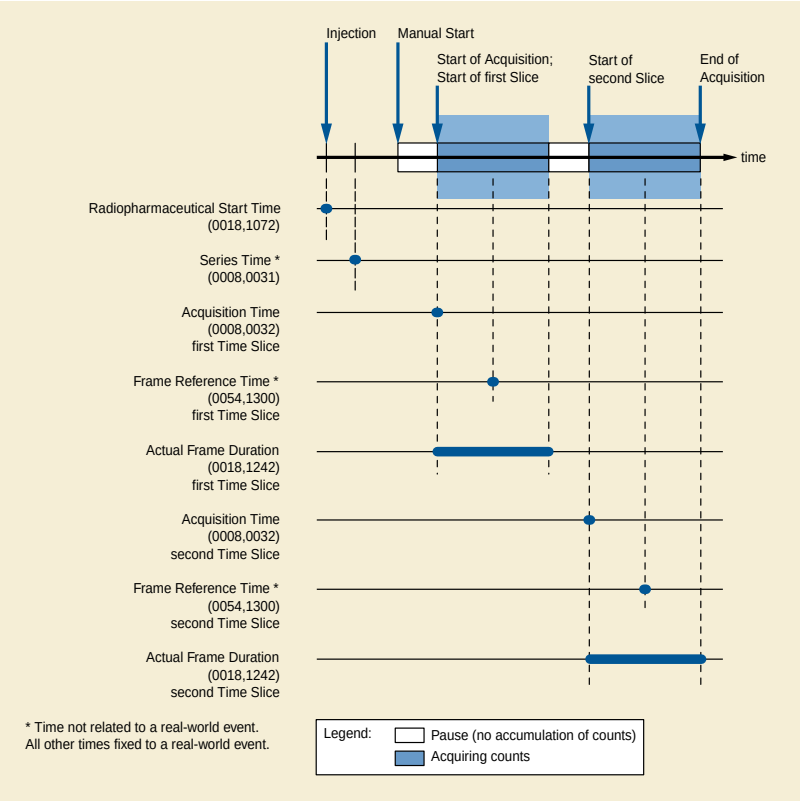


Figure C.8.9.1.1.11-1a. Example DYNAMIC PET Series

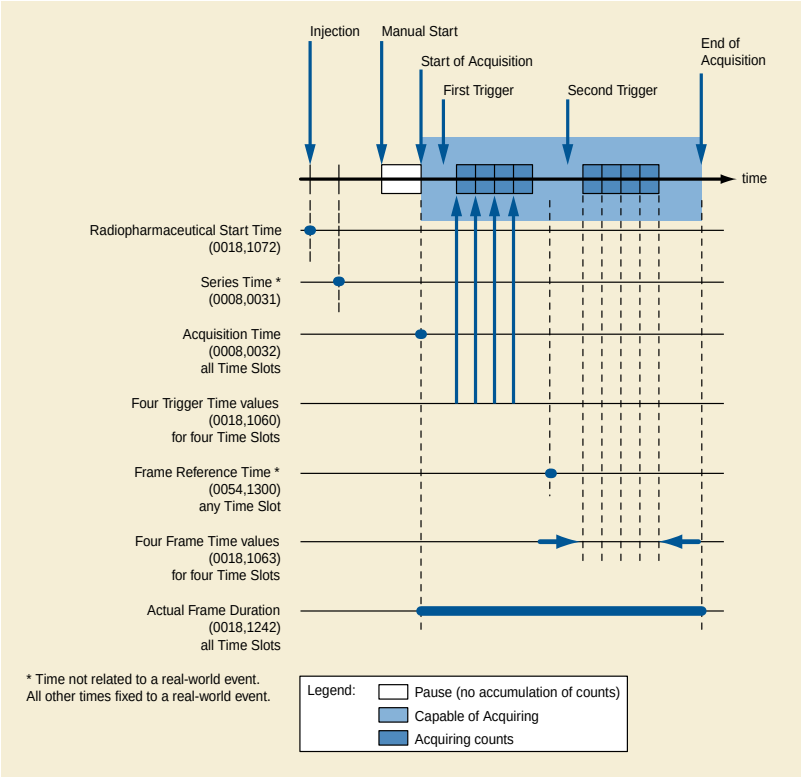


Figure C.8.9.1.1.11-1b. Example GATED PET Series

C.8.9.2 PET Isotope Module

Table C.8-61 contains IOD Attributes that describe a PET Isotope.

Table C.8-61. PET Isotope Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiopharmaceutical Information Sequence	(0054,0016)	2	Sequence of Items that describe isotope information. Zero or more Items shall be included in this Sequence.
>Radionuclide Code Sequence	(0054,0300)	2	Sequence that identifies the radionuclide. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4020 “PET Radionuclide”.*
>Radiopharmaceutical Route	(0018,1070)	3	Route of administration.
>Administration Route Code Sequence	(0054,0302)	3	Sequence that identifies the administration route of the radiopharmaceutical. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 11 “Route of Administration”.*
>Radiopharmaceutical Volume	(0018,1071)	3	Volume of administered radiopharmaceutical in cubic cm.

Attribute Name	Tag	Type	Attribute Description
>Radiopharmaceutical Start Time	(0018,1072)	3	Time of start of administration. The actual time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031). The use of this Attribute is deprecated in favor of Radiopharmaceutical Start DateTime (0018,1078). Note The use of a time alone can cause confusion when the procedure spans midnight.
>Radiopharmaceutical Start DateTime	(0018,1078)	3	Date and time of start of administration. The actual date and time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031).
>Radiopharmaceutical Stop Time	(0018,1073)	3	Time of end of administration. The actual ending time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031). The use of this Attribute is deprecated in favor of Radiopharmaceutical Stop DateTime (0018,1079). Note The use of a time alone can cause confusion when the procedure spans midnight.
>Radiopharmaceutical Stop DateTime	(0018,1079)	3	Date and time of end of administration. The actual ending date and time of radiopharmaceutical administration to the patient for imaging purposes, using the same time base as Series Time (0008,0031).
>Radionuclide Total Dose	(0018,1074)	3	The radiopharmaceutical dose administered to the patient measured in Becquerels (Bq) at the Radiopharmaceutical Start Time (0018,1072). Note In other IODs, such as the NM IOD, this same Attribute is specified in MegaBecquerels (MBq).
>Radiopharmaceutical Administration Event UID	(0008,3012)	3	Unique identification of the administration of the radiopharmaceutical to the patient. Note The UID is the same Radiopharmaceutical Administration Event UID that is in the Radiopharmaceutical Radiation Dose Report.
>Radionuclide Half Life	(0018,1075)	3	The radionuclide half life, in seconds, that was used in the correction of this image.
>Radionuclide Positron Fraction	(0018,1076)	3	The radionuclide positron fraction (fraction of decays that are by positron emission) that was used in the correction of this image.
>Radiopharmaceutical Specific Activity	(0018,1077)	3	The activity per unit mass of the radiopharmaceutical, in Bq/micromole, at the Radiopharmaceutical Start Time (0018,1072).

Attribute Name	Tag	Type	Attribute Description
>Radiopharmaceutical	(0018,0031)	3	Name of the radiopharmaceutical.
>Radiopharmaceutical Code Sequence	(0054,0304)	3	Sequence that identifies the radiopharmaceutical. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4021 "PET Radiopharmaceutical".*
Intervention Drug Information Sequence	(0018,0026)	3	Sequence of Items that describes the intervention drugs used. One or more Items are permitted in this Sequence.
>Intervention Drug Name	(0018,0034)	3	Name of the intervention drug.
>Intervention Drug Code Sequence	(0018,0029)	3	Sequence that identifies the intervention drug name. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 10 "Interventional Drug".*
>Intervention Drug Start Time	(0018,0035)	3	Time of administration of the intervention drug, using the same time base as for Series Time (0008,0031).
>Intervention Drug Stop Time	(0018,0027)	3	Time of completion of administration of the intervention drug, using the same time base as for Series Time (0008,0031).
>Intervention Drug Dose	(0018,0028)	3	Intervention drug dose, in mg.

C.8.9.3 PET Multi-gated Acquisition Module

Table C.8-62 contains IOD Attributes that describe a PET Multi-gated Acquisition.

Table C.8-62. PET Multi-Gated Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Beat Rejection Flag	(0018,1080)	2	Heart beat duration sorting has been applied. Enumerated Values: **Y** yes **N** no
Trigger Source or Type	(0018,1061)	3	Text indicating trigger source. Defined Terms: **EKG**
PVC Rejection	(0018,1085)	3	Description of the type of PVC rejection criteria used.
Skip Beats	(0018,1086)	3	Number of beats skipped after a detected arrhythmia.
Heart Rate	(0018,1088)	3	Average number of heart beats per minute for the collection period for this image. This shall include all accepted beats as well as rejected beats.
Cardiac Framing Type	(0018,1064)	3	Description of type of framing performed. See Section C.7.6.18.1.1.1 for description and Defined Terms.

C.8.9.4 PET Image Module

Table C.8-63 contains IOD Attributes that describe PET images.

Table C.8-63. PET Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.9.4.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.9.4.1.2 for specialization.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. The value shall be the same as the value in Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and pixel value units (U) defined in Units (0054,1001): U = m*SV+b. The Rescale Intercept is always zero for PET images.
Rescale Slope	(0028,1053)	1	m in the equation specified in Rescale Intercept (0028,1052).
Frame Reference Time	(0054,1300)	1	The time that the pixel values in the image occurred. Frame Reference Time is the offset, in msec, from the Series reference time. See explanation in Section C.8.9.4.1.5.
Trigger Time	(0018,1060)	1C	Time interval, in msec, from the start of the trigger to the beginning of data acquisition for this image. Required if Series Type (0054,1000), Value 1 is GATED.
Frame Time	(0018,1063)	1C	Nominal duration per individual frame, in msec. Required if Series Type (0054,1000), Value 1 is GATED. See Section C.8.9.4.1.3 for explanation.
Low R-R Value	(0018,1081)	1C	R-R interval lower limit for beat rejection, in msec. Required if Series Type (0054,1000), Value 1 is GATED and Beat Rejection Flag (0018,1080) is Y.
High R-R Value	(0018,1082)	1C	R-R interval upper limit for beat rejection, in msec. Required if Series Type (0054,1000), Value 1 is GATED and Beat Rejection Flag (0018,1080) is Y.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5. Required if Lossy Compression has been performed on the image. May be present otherwise.
Image Index	(0054,1330)	1	An index identifying the position of this image within a PET Series. See Section C.8.9.4.1.9 for explanation.
Acquisition Date	(0008,0022)	2	The date the acquisition of data that resulted in this image started. See Section C.8.9.4.1.4 for specialization.
Acquisition Time	(0008,0032)	2	The time the acquisition of data that resulted in this image started. See Section C.8.9.4.1.4 for specialization.
Actual Frame Duration	(0018,1242)	2	Elapsed time of the data acquisition for this image, in msec. See Section C.8.9.4.1.6 for explanation.
Nominal Interval	(0018,1062)	3	Average duration of accepted beats, in msec, of the R-R interval.
Intervals Acquired	(0018,1083)	3	Number of heartbeats that fall within Low R-R Value (0018,1081) and High R-R Value (0018,1082), and were therefore accepted and contribute coincidence events to this R-R Interval.
Intervals Rejected	(0018,1084)	3	Number of heartbeats that fall outside Low R-R Value (0018,1081) and High R-R Value (0018,1082), and do not contribute coincidence events to this R-R Interval. However, they may contribute coincidence events to other R-R Intervals.
Primary (Prompts) Counts Accumulated	(0054,1310)	3	The sum of events that occur in the primary event channel. The counts include Trues +Scatter+ Randoms if Randoms Correction Method (0054,1100) is NONE; otherwise the counts are Trues +Scatter.
Secondary Counts Accumulated	(0054,1311)	3	Sum of counts accumulated in secondary channels. See Section C.8.9.4.1.7 for explanation.
Slice Sensitivity Factor	(0054,1320)	3	The slice-to-slice sensitivity correction factor that was used to correct this image. The value shall be one if no slice sensitivity correction was applied.
Decay Factor	(0054,1321)	1C	The decay factor that was used to scale this image. Required if Decay Correction (0054,1102) is other than NONE. If decay correction is applied, all images in the Series shall be decay corrected to the same time.
Dose Calibration Factor	(0054,1322)	3	Factor that was used to scale this image from counts/sec to Bq/ml using a dose calibrator. The value shall be one if no dose calibration was applied. See Section C.8.9.4.1.8 for explanation.
Scatter Fraction Factor	(0054,1323)	3	An estimate of the fraction of acquired counts that were due to scatter and were corrected in this image. The value shall be zero if no scatter correction was applied.
Dead Time Factor	(0054,1324)	3	The average dead time correction factor that was applied to this image. The value shall be one if no dead time correction was applied.
Include Table 10-7 “General Anatomy Optional Macro Attributes”			*No CID for the Anatomic Region Sequence is defined.*

Attribute Name	Tag	Type	Attribute Description
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.

Note

Referenced Overlay Sequence (0008,1130) and Referenced Curve Sequence (0008,1145) were previously included in this Module as optional Attributes but have been retired. See PS3.3-2004.

C.8.9.4.1 PET Image Module Attribute Descriptions

C.8.9.4.1.1 Image Type

For PET Images, Image Type (0008,0008) is specified to be Type 1.

Note

For PET images, Image Type (0008,0008) Value 1 will be ORIGINAL for reconstructed images. DERIVED may be appropriate for some other results images. For PET images, Image Type (0008,0008) Value 2 will be PRIMARY.

C.8.9.4.1.2 Photometric Interpretation

Enumerated Values:

MONOCHROME2

See Section C.7.6.3.1.2 for definition of this term.

C.8.9.4.1.3 Frame Time

Frame Time (0018,1063) is the explicit duration of the gated frame when Cardiac Framing Type (0018,1064) is equal to FORW or BACK. Frame Time (0018,1063) is the nominal duration of the gated frame when Cardiac Framing Type (0018,1064) is equal to PCNT.

C.8.9.4.1.4 Acquisition Date, Acquisition Time

For PET Images, Acquisition Date (0008,0022) and Acquisition Time (0008,0032) are specified to be Type 2. Acquisition Date (0008,0022) and Acquisition Time (0008,0032) use the same time base as Series Time (0008,0031).

For Series Type (0054,1000) Value 1 equal to STATIC, WHOLE BODY, or DYNAMIC, Acquisition Time (0008,0032) is the real-world beginning of the accumulation of events into this Image. For STATIC, WHOLE BODY, or DYNAMIC Series, Acquisition Time (0008,0032) may vary from Image to Image within a PET Series.

For Series Type (0054,1000) Value 1 equal to GATED, Acquisition Time (0008,0032) is the real-world beginning of the *capability* of accumulating events into this Image. (The *actual* accumulation of events has only occurred during an R-R Interval.) For GATED Series, Acquisition Time (0008,0032) shall not vary from Image to Image within a PET Series.

C.8.9.4.1.5 Frame Reference Time

Frame Reference Time (0054,1300) is the time that the pixel values in the Image occurred. Frame Reference Time is defined as the time offset, in msec, from the Series Reference Time, where the Series Reference Time is defined by the combination of Series Date (0008,0021) and Series Time (0008,0031).

Note

Frame Reference Time (0054,1300) is implementation dependent and may or may not be tied to any real-world event. To illustrate the meaning of Frame Reference Time (0054,1300), the following are some examples of possible implementations:

- Example 1: For a long-lived radionuclide and a non-time-varying radiopharmaceutical distribution, an implementation sets the Frame Reference Time (0054,1300) to the midpoint of the Actual Frame Duration (0018,1242).
- Example 2: For a short-lived radionuclide and a non-time-varying radiopharmaceutical distribution, an implementation sets the Frame Reference Time (0054,1300) to the time at which the average activity occurs for a decaying radionuclide, T_{ave}. If image acquisition started at the Series Reference Time and the image has not been decay corrected, then T_{ave} will be:

  $$T_{ave} = \frac{1}{\lambda} \ln \frac{\lambda T}{1 - e^{-\lambda T}}$$

  where:

  - lambda = decay constant = (ln 2) / $T_{1/2}$
  - $T_{1/2}$ = Radionuclide Half Life (0018,1075)
  - T = Actual Frame Duration (0018,1242)

  Note that T_{ave} will be sooner than the midpoint of the Actual Frame Duration (0018,1242).
- Example 3: For a short-lived radionuclide and a time-varying radiopharmaceutical distribution, an implementation with supplementary data (e.g., scanner count rates or blood sample data) sets the Frame Reference Time (0054,1300) to a derived time determined to be its best estimate of the time that the pixel values occurred.

C.8.9.4.1.6 Actual Frame Duration

The accumulation of counts for a PET Image shall occur entirely between:

1. the acquisition starting time (as specified by Acquisition Date (0008,0022) and Acquisition Time (0008,0032)), and
2. the acquisition ending time, which is equal to the acquisition starting time in (1) plus the Actual Frame Duration (0018,1242).

If Series Type (0054,1000) Value 1 is GATED, then the actual accumulation of counts has only occurred during an R-R Interval.

C.8.9.4.1.7 Secondary Counts Accumulated

Secondary Counts Accumulated (0054,1311) is multi-valued and, if supplied, has Values corresponding to the Secondary Counts Type (0054,1220). The number and order of the Values in Secondary Counts Accumulated (0054,1311) shall be the same as Secondary Counts Type (0054,1220).

C.8.9.4.1.8 Dose Calibration Factor

The Dose Calibration Factor (0054,1322) is the factor that was used to scale this image from counts/sec to Bq/ml using an external dose calibrator. The value shall be one if no dose calibration was applied. The application of a dose calibration correction is specified by Corrected Image (0028,0051) equal to DCAL.

Note

Dose Calibration Factor (0054,1322) is not equal to the inverse of the sensitivity (kcps/Bq/ml) of the scanner, which is usually measured for a given radiopharmaceutical distribution and excluding the effects of attenuation.

C.8.9.4.1.9 Image Index

Image Index (0054,1330) is an index identifying the position of this image within a PET Series.

Note

The scheme for encoding Image Index (0054,1330) is as follows. Images within a PET Series can be viewed as a multi-dimensional array whose possible dimensions include R-R Intervals, Time Slots, Time Slices, and Slices. The dimensions of the array are defined by Series Type (0054,1000) Value 1. Each dimension of the array has an index that identifies the position of this image in the array. The indices are: R-R Interval Index, Time Slot Index, Time Slice Index, Slice Index. The indices are calculated as follows:

Index	Range of Index	Order of Images along that Dimension
R-R Interval Index	1 to Number of R-R Intervals (0054,0061)	Increasing Low R-R Value (0018,1081)
Time Slot Index	1 to Number of Time Slots (0054,0071)	Increasing Trigger Time (0018,1060)
Time Slice Index	1 to Number of Time Slices (0054,0101)	Increasing Frame Reference Time (0054,1300)
Slice Index	1 to Number of Slices (0054,0081)	If Series Type (0054,1000) Value 2 is IMAGE:Order is in increasing position along the normal, where the normal is determined by the cross product of the direction cosines of the row and column of the image. See Image Orientation (0020,0037) in the Image Plane Module. If Series Type (0054,1000) Value 2 is REPROJECTION:Order is in increasing or decreasing angle of the normal, where the normal is determined by the cross product of the direction cosines of the row and column of the image. See Image Orientation (0020,0037) in the Image Plane Module. (Note that reprojection images rotate about only a single axis as described in Section C.8.9.1.1.1. Therefore, all normals are co-planar and make a single angle with respect to each other.)

Using these index values the position of this image within the multi-dimensional array (Image Index (0054,1330)) is calculated as follows:

Series Type (0054,1000), Value 1	Dimensions of Array (Last dimension is most rapidly changing)	Encoding of Image Index (0054,1330)
STATIC	Slice	Slice Index
WHOLE BODY	Slice	Slice Index
DYNAMIC	Time Slice \Slice	((Time Slice Index - 1) * (Number of Slices (0054,0081))) + Slice Index
GATED	R-R Interval \Time Slot \Slice	((R-R Interval Index - 1) * (Number of Time Slots (0054,0071)) * (Number of Slices (0054,0081))) + ((Time Slot Index - 1) * (Number of Slices (0054,0081))) + Slice Index

C.8.9.5 PET Curve Module

Retired. See PS3.3-2004.

C.8.10 Hardcopy Modules

Retired. See PS3.3-2004.

C.8.11 DX Modules

C.8.11.1 DX Series Module

The Digital X-Ray IODs use the General Series Module described in Section C.7.3.1, specialized by the DX Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of projection Digital X-Ray.

Note

In an abstract sense, a Series may be viewed from the perspective of an acquisition device or a display device.

In the former case, it is convenient to group images related by commonality of acquisition parameters, such as the imaging subject's physical relationship to the equipment (such as a patient lying in a particular position with respect to the equipment), a single acquis-

ition initiation (such as an MR pulse sequence or spiral CT run), or a single workflow action on the part of the operator (such as the reading of a collection of CR plates from the same examination).

In the latter case, it is often convenient to organize images for viewing or browsing into Series based upon other criteria such as physical or temporal proximity that may not necessarily correspond with the order or grouping in which the images were acquired.

This conflict is most apparent in the existing CR Image IOD Section C.8.1, where the definition of View Position at the Series Level in CR Series Section C.8.1.1 implies, for example, that a Lateral and PA Chest X-Ray may not be grouped into a single Series. While this may be in keeping with the traditional CT and MR notions that a change in an imaging subject's physical orientation with respect to the imaging equipment implies a new Series, it is most unnatural from the point of view of a reader viewing or browsing a collection of projection radiographic images.

A similar example pertains in the case of the traditional set of views of the maxillary and mandibular dentition, in which all the images are logically grouped in one sequence, but the imaging equipment moves with respect to the imaging subject, and the size of the detector may vary between images.

Accordingly, the constraint (apparent from the CT, MR and CR IODs) that a change in position, detector, body part or laterality implies a new Series has been relaxed in the DX IODs, through the use of the DX Anatomy Imaged Module and the DX Positioning Module, which define Attributes at the Image level that specify these concepts with finer granularity. This approach is consistent with that used in the XA, XRF, US and NM IODs.

Images within a Series are still required, if the Condition for the inclusion of the Frame of Reference Module is met, to be relative to the same Frame of Reference.

Table C.8-68 specifies the Attributes that identify and describe general information about the DX Series.

Table C.8-68. DX Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **DX** **PX** **IO** **MG** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Presentation Intent Type	(0008,0068)	1	Identifies the intent of the images that are contained within this Series. Enumerated Values: **FOR PRESENTATION** **FOR PROCESSING** See Section C.8.11.1.1.1 for further explanation.

C.8.11.1.1 DX Series Attribute Descriptions

C.8.11.1.1.1 Presentation Intent Type

Presentation Intent Type (0008,0068) shall identify the intent for the purposes of display or other presentation of all Images within this Series.

Note

1. Since this is a Series level Attribute, all Images within a Series have the same value for this Attribute.
2. The intent of this restriction is to ensure that FOR PRESENTATION and FOR PROCESSING images are placed in separate Series, so that no confusion can arise as to which images are suitable for diagnostic reading as determined by local policy.

A Series of Images intended for viewing by an observer, after application of any grayscale transformations specified in the image object such as VOI LUT, shall have an Enumerated Value of FOR PRESENTATION.

Note

1. These images may still be of Image Type (0008,0008) ORIGINAL rather than DERIVED despite the possibility that they may have undergone some processing, such as unsharp masking. In this case a DERIVED image would have undergone yet further processing to make it substantially different from the original. See Figure C.8-13.
2. These images may still be subjected to processing or further processing, if appropriate, depending on the application.
3. These images are intended for display on a device, without (further) processing, since that device may not be capable of image processing. The quality of the displayed image or its suitability for any purpose is beyond the scope of the DICOM Standard.

Images that have been corrected to account for characteristics of the detector but are intended to be further processed before being displayed, shall have an Enumerated Value of FOR PROCESSING.

Note

This type is provided to allow the functions of image acquisition and image processing for presentation to be separated and yet have images conveyed between the two processes using a DICOM object. Individual sites or users may choose to substitute their own specialized processing in place of that supplied by the implementer.

Images available at this stage of processing may be useful for quality control and problem solving purposes, as well as academic research.

Images of this type may also be archived, retrieved and processed with different algorithms or parameters in order to alter the appearance of specific features for clinical purposes.

The nature of the detector correction that may have been applied before sending an image of type FOR PROCESSING is not specified. In particular, acquisitions that acquire several sets of matrices of pixel values (such as image data, gain offset and a defect map) must perform some processing (detector correction) before a DX Image object can be instantiated.

The nature of the processing that may have been applied before sending an image of type FOR PRESENTATION is also not specified.

It is expected that individual implementers will use Private Attributes to convey specifics of the processing applied that may be of use for further processing by those aware of the parameters and algorithms. The diversity of detector types and processing algorithms make it undesirable to standardize such parameters.

Whether or not the spatial locations of all pixels are preserved during the processing of the source image that resulted in the current image can be indicated by Spatial Locations Preserved (0028,135A) in a Source Image Sequence (0008,2112) reference from the FOR PRESENTATION image to a FOR PROCESSING predecessor.

If images from the same exposure exist with different Values of Presentation Intent Type (0008,0068), then they shall have different SOP Instance UIDs.

Note

1. Source Image Sequence (0008,2112) may be used to relate these images.
2. The SOP Class UIDs of the two images will also be different.

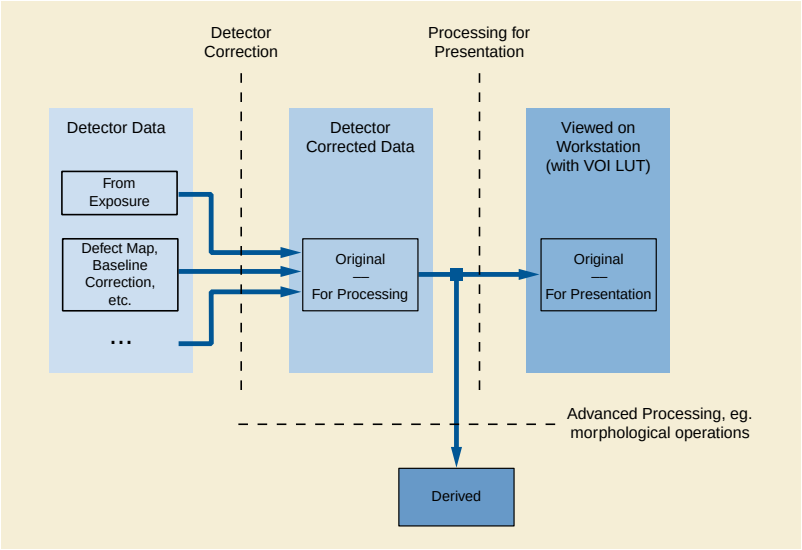


Figure C.8-13. Explanation of Presentation Intent Type

C.8.11.2 DX Anatomy Imaged Module

Table C.8-69 contains IOD Attributes that describe the anatomy contained in a DX IOD.

Table C.8-69. DX Anatomy Imaged Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Laterality	(0020,0062)	1	Laterality of (possibly paired) body part (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right Note This Attribute is mandatory, in order to ensure that images may be positioned correctly relative to one another for display. Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series.

Attribute Name	Tag	Type	Attribute Description
Include Table 10-6 "General Anatomy Required Macro Attributes"			*Anatomic Region Sequence DCID 4009 "DX Anatomy Imaged" for humans, and CID 7482 "DX Anatomy Imaged for Animals" for animals. This is the anatomic region that is placed on the table or bucky for examination.* Note It is strongly recommended that Anatomic Region Sequence (0008,2218) be present with a value, in order to ensure that images may be positioned correctly relative to one another for display.

C.8.11.2.1 DX Anatomy Imaged Attribute Descriptions

The Attributes in this Module extend the function of Body Part Examined (0018,0015) as used in other IODs, and are intended to be used to facilitate the management of images and Series in terms of routing, storage and display, as well as to dictate certain Conditions on Attributes and Modules in the DX IOD.

C.8.11.3 DX Image Module

Table C.8-70 contains IOD Attributes that describe a DX Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional Attributes.

Table C.8-70. DX Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.11.3.1.1 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME1** **MONOCHROME2**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Enumerated Values: **8** **16**

Attribute Name	Tag	Type	Attribute Description
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Enumerated Values: **6** **7** **8** **9** **10** **11** **12** **13** **14** **15** **16**
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Shall be one less than the value in Bit Stored (0028,0101).
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Enumerated Values: **0000H** Unsigned Integer
Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel sample values and the X-Ray beam intensity. Enumerated Values: **LIN** Linearly proportional to X-Ray beam intensity **LOG** Logarithmically proportional to X-Ray beam intensity See Section C.8.11.3.1.2 for further explanation.
Pixel Intensity Relationship Sign	(0028,1041)	1	The sign of the relationship between the Pixel sample values stored in Pixel Data (7FE0,0010) and the X-Ray beam intensity. Enumerated Values: **+1** Lower pixel values correspond to less X-Ray beam intensity **-1** Higher pixel values correspond to less X-Ray beam intensity See Section C.8.11.3.1.2 for further explanation.
Rescale Intercept	(0028,1052)	1	The value b in the relationship between stored values (SV) in Pixel Data (7FE0,0010) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Enumerated Values: **0** See Section C.8.11.3.1.2 for further explanation.
Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052). Enumerated Values: **1** See Section C.8.11.3.1.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Enumerated Values: **US** Unspecified See Section C.8.11.3.1.2 for further explanation.
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT, other than to account for the value of Photometric Interpretation (0028,0004), such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME2. **INVERSE** output after inversion is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME1. See Section C.8.11.3.1.2 for further explanation.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See Section C.8.11.3.1.4 for further explanation.
Acquisition Device Processing Description	(0018,1400)	3	Indicates any visual processing performed on the images prior to exchange. See Section C.8.11.3.1.3 for further explanation.
Acquisition Device Processing Code	(0018,1401)	3	Code representing the device-specific processing associated with the image (e.g., Organ Filtering code) Note This Code is manufacturer specific but provides useful annotation information to the knowledgeable observer.
Patient Orientation	(0020,0020)	1C	Patient direction of the rows and columns of the image. See Section C.7.6.1.1.1 for further explanation. Required if View Code Sequence (0054,0220) is not present or is present with an Item value other than (119376003, SCT, "tissue specimen") or (127457009, SCT, "tissue specimen from breast"). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: **YES** **NO** Device is identified using the Device Module. See Section C.7.6.12 for further explanation.
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **YES** **NO**
VOI LUT Sequence	(0028,3010)	1C	Defines a Sequence of VOI LUTs. See Section C.8.11.3.1.5 for further explanation. One or more Items shall be included in this Sequence. Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION and Window Center (0028,1050) is not present. May also be present if Window Center (0028,1050) is present.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.8.11.3.1.5 for further explanation.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
Window Center	(0028,1050)	1C	Defines a Window Center for display. See Section C.8.11.3.1.5 for further explanation. Required if Presentation Intent Type (0008,0068) is FOR PRESENTATION and VOI LUT Sequence (0028,3010) is not present. May also be present if VOI LUT Sequence (0028,3010) is present.
Window Width	(0028,1051)	1C	Window Width for display. See Section C.8.11.3.1.5 for further explanation. Required if Window Center (0028,1050) is present.
Window Center & Width Explanation	(0028,1055)	3	Free form explanation of the meaning of the Window Center and Width. Multiple values correspond to multiple Window Center and Width values.

C.8.11.3.1 DX Image Attribute Descriptions

C.8.11.3.1.1 Image Type

Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2 where the Enumerated Values are defined to be ORIGINAL or DERIVED.

Note

DX images may still be of type ORIGINAL rather than DERIVED despite the possibility that they may have undergone some processing. In this case a DERIVED image would have undergone yet further processing to make it substantially different from the original.

Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2 where the Enumerated Values are defined to be PRIMARY or SECONDARY.

Note

DX images generally use PRIMARY value for images captured from patient exposure.

If images from the same exposure exist with different Values of Image Type, then they shall have different SOP Instance UIDs.

Note

Source Image Sequence (0008,2112) may be used to relate these images.

Value 3 (which is specific to the IOD) shall be present and have zero length (null value).

Other Values (4 and beyond) are optional and implementation specific.

C.8.11.3.1.2 Pixel Intensity Relationship and Grayscale Transformations

Pixel Intensity Relationship (0028,1040) and Pixel Intensity Relationship Sign (0028,1041) describe how the stored pixel values in Pixel Data (7FE0,0010) are related to the X-Ray beam intensity incident on the detector.

They do not define a transformation intended to be applied to the pixel data for presentation.

Note

For example, if Pixel Intensity Relationship (0028,1040) is LIN and Pixel Intensity Relationship Sign (0028,1041) is -1, then lower values of Pixel Data (7FE0,0010) indicate higher X-Ray beam intensities corresponding to less radiographically dense regions projected on the image such as through air, and higher values of Pixel Data (7FE0,0010) indicate lower X-Ray beam intensities corresponding to more radiographically dense regions projected on the image such as through bone and radio-opaque contrast agents.

The transformation to be applied to the pixel data for presentation is defined by the successive application of the conceptual Modality LUT, the VOI Attributes and the conceptual Presentation LUT. This shall result in the output of P-Values.

Rescale Slope (0028,1053) and Rescale Intercept (0028,1052) define a linear subset of a conceptual Modality LUT transformation. For IODs that include this Module, these Attributes define an identity transformation. IODs that include the DX Image Module shall not include the Modality LUT Module.

The Presentation LUT Shape (2050,0020) defines a subset of a conceptual Presentation LUT. For IODs that include this Module, this Attribute defines an identity transformation or inverse identity transformation. IODs that include the DX Image Module shall not include the Presentation LUT Module.

Photometric Interpretation (0028,0004) indicates whether lower values that are the output of the VOI Attributes should be displayed as darker or lighter. Since the output of the equivalent of a conceptual Presentation LUT is in P-Values, which are defined in PS3.14 such that lower values correspond to lower luminance levels, then the definition of the Presentation LUT Shape (2050,0020), otherwise intended to be an identity transformation, must take into account the effect of the value specified for Photometric Interpretation (0028,0004).

Note

Regardless of the values of Pixel Intensity Relationship (0028,1040) and Pixel Intensity Relationship Sign (0028,1041), the grayscale transformations to be applied to Pixel Data (7FE0,0010) are defined by the equivalent of the Modality LUT (Rescale Slope (0028,1053) and Rescale Intercept (0028,1052)), Value of Interest Attributes, Photometric Interpretation (0028,0004) and the equivalent of the Presentation LUT (Presentation LUT Shape (2050,0020)). However, the combination of the grayscale transformations and the description of the pixel intensity relationship, together define whether, for example, air is expected to be displayed as black or white.

C.8.11.3.1.3 Acquisition Device Processing Description

Acquisition Device Processing Description (0018,1400) provides some indication in human readable text of the digital processing on the images before exchange. Examples of this processing are: edge enhanced, subtracted, time filtered, gamma corrected, convolved (spatially filtered).

C.8.11.3.1.4 Derivation Description

If an Image is identified to be a Derived image in Image Type (0008,0008), Derivation Description (0008,2111) is an optional and implementation specific text description of the way the image was derived from an original image. As applied to DX images, it may be used to describe derivation operations such as edge enhancement, temporal filtering, digital subtraction, or other linear and non-linear transformations.

C.8.11.3.1.5 VOI Attributes

The Attributes of the VOI LUT Module are specialized in the DX Image Module.

Window Center (0028,1050) and Window Width (0028,1051) specify a linear conversion (unless otherwise specified by the value of VOI LUT Function (0028,1056); See Section C.11.2.1.3) from the output of the (conceptual) Modality LUT values to the input to the (conceptual) Presentation LUT. Window Center contains the value that is the center of the window. Window Width contains the width of the window.

The application of Window Center (0028,1050) and Window Width (0028,1051) shall not produce a signed result.

Note

If the Presentation LUT Shape (2050,0020) is IDENTITY, then the result of applying Window Center (0028,1050) and Window Width (0028,1051) is P-Values.

If multiple values are present, both Attributes shall have the same number of values and shall be considered as pairs. Multiple values indicate that multiple alternative views should be presented.

The VOI LUT Sequence specifies a (potentially non-linear) conversion from the output of the (conceptual) Modality LUT values to the input to the (conceptual) Presentation LUT.

If multiple Items are present in VOI LUT Sequence (0028,3010), only one shall be applied. Multiple Items indicate that multiple alternative views should be presented.

If any VOI LUT Attributes are included by an Image, a Window Width and Window Center or the VOI LUT Table, but not both, shall be applied to the Image for display. Inclusion of both indicates that multiple alternative views should be presented.

The three values of LUT Descriptor (0028,3002) describe the format of LUT Data (0028,3006).

The first value is the number of entries in the lookup table.

The second value is the first stored pixel value mapped. This pixel value is mapped to the first entry in the LUT. All image pixel values less than the first value mapped are also mapped to the first entry in the LUT Data. An image pixel value one greater than the first value mapped is mapped to the second entry in the LUT Data. Subsequent image pixel values are mapped to the subsequent entries in the LUT Data up to an image pixel value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. Image pixel values greater than number of entries + first value mapped are also mapped to the last entry in the LUT Data.

The third value specifies the number of bits for each entry in the LUT Data (analogous to "bits stored"). It shall be between 10-16. The LUT Data shall be stored in a format equivalent to 16 "bits allocated" and "high bit" equal to "bits stored" - 1. The third value conveys the range of LUT entry values. These unsigned LUT entry values shall range between 0 and 2^n-1, where n is the third value of the LUT Descriptor.

Note

1. The third value is restricted in the VOI LUT Module to 8 or 16 but is specialized here.
2. The first and second values are not specialized and are the same as in the VOI LUT Module.

LUT Data (0028,3006) contains the LUT entry values.

C.8.11.4 DX Detector Module

Table C.8-71 contains IOD Attributes that describe a DX detector.

Table C.8-71. DX Detector Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-71b "Digital X-Ray Detector Macro Attributes"			
Detector Active Time	(0018,7014)	3	Time in mSec that the detector is active during acquisition of this image. Note This activation window overlaps the time of the X-Ray exposure as defined by Exposure Time (0018,1150) and Detector Activation Offset From Exposure (0018,7016).
Detector Activation Offset From Exposure	(0018,7016)	3	Offset time in mSec that the detector becomes active after the X-Ray beam is turned on during acquisition of this image. May be negative.
Field of View Shape	(0018,1147)	3	Shape of the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010). Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL**
Field of View Dimension(s)	(0018,1149)	3	Dimensions in mm of the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010). If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of a circumscribed circle.
Field of View Origin	(0018,7030)	1C	Offset of the TLHC of a rectangle circumscribing the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010), before rotation or flipping, from the TLHC of the physical detector area measured in physical detector pixels as a row offset followed by a column offset. Required if Field of View Rotation (0018,7032) or Field of View Horizontal Flip (0018,7034) is present. See Section C.8.11.4.1.1 for further explanation.
Field of View Rotation	(0018,7032)	1C	Clockwise rotation in degrees of Field of View, that is the image pixels stored in Pixel Data (7FE0,0010), relative to the physical detector. Enumerated Values: **270** **180** **90** **0** Required if Field of View Horizontal Flip (0018,7034) is present. See Section C.8.11.4.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Field of View Horizontal Flip	(0018,7034)	1C	Whether or not a horizontal flip has been applied to the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010), after rotation relative to the physical detector as described in Field of View Rotation (0018,7032). Enumerated Values: **YES** **NO** Required if Field of View Rotation (0018,7032) is present. See Section C.8.11.4.1.1 for further explanation.
Imager Pixel Spacing	(0018,1164)	1	Physical distance measured at the front plane of the detector housing between the center of each image pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm. See Section 10.7.1.3 for further explanation of the value order. The value of this Attribute shall never be adjusted to account for correction for the effect of geometric magnification or calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose.
Include Table 10-10 "Basic Pixel Spacing Calibration Macro Attributes"			
Cassette ID	(0018,1007)	3	Identifier of the cassette that contains the photostimulable phosphor plate, for CR acquisitions.
Plate ID	(0018,1004)	3	Identifier of the photostimulable phosphor plate, for CR acquisitions.

Table C.8-71b contains common Attributes that describe digital X-Ray detector.

Table C.8-71b. Digital X-Ray Detector Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Detector Type	(0018,7004)	2	The type of detector used to acquire this image. Defined Terms: **DIRECT** X-Ray photoconductor **SCINTILLATOR** Phosphor used **STORAGE** Storage phosphor **FILM** Scanned film/screen
Detector Configuration	(0018,7005)	3	The physical configuration of the detector. Defined Terms: **AREA** single or tiled detector **SLOT** scanned slot, slit or spot
Detector Description	(0018,7006)	3	Free text description of detector.
Detector Mode	(0018,7008)	3	Text description of operating mode of detector (implementation specific).
Detector ID	(0018,700A)	3	The ID or serial number of the detector used to acquire this image.
Date of Last Detector Calibration	(0018,700C)	3	The date on which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
Time of Last Detector Calibration	(0018,700E)	3	The time at which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
Exposures on Detector Since Last Calibration	(0018,7010)	3	Total number of X-Ray exposures that have been made on the detector used to acquire this image as identified in Detector ID (0018,700A) since it was calibrated.

Attribute Name	Tag	Type	Attribute Description
Exposures on Detector Since Manufactured	(0018,7011)	3	Total number of X-Ray exposures that have been made on the detector used to acquire this image as identified in Detector ID (0018,700A) since it was manufactured.
Detector Time Since Last Exposure	(0018,7012)	3	Time in Seconds since an exposure was last made on this detector prior to the acquisition of this image.
Detector Binning	(0018,701A)	3	Number of active detectors used to generate a single pixel. Specified as number of row detectors per pixel then column.
Detector Manufacturer Name	(0018,702A)	3	Name of the manufacturer of the detector component of the acquisition system
Detector Manufacturer's Model Name	(0018,702B)	3	Model name of the detector component of the acquisition system
Detector Conditions Nominal Flag	(0018,7000)	3	Whether or not the detector is operating within normal tolerances during this image acquisition. Enumerated Values: **YES** **NO** Note This flag is intended to indicate whether or not there may have been some compromise of the diagnostic quality of the image due to some condition such as over-temperature, etc.
Detector Temperature	(0018,7001)	3	Detector temperature during exposure in degrees Celsius.
Sensitivity	(0018,6000)	3	Detector sensitivity in manufacturer specific units. Note 1. This value is intended to provide a single location where manufacturer specific information can be found for annotation on a display or film, that has meaning to a knowledgeable observer. 2. This value is manufacturer-specific. DICOM specifies Standard Attributes in Table 10-23 'Exposure Index Macro', which are recommended.
Detector Element Physical Size	(0018,7020)	3	Physical dimensions of each detector element that comprises the detector matrix, in mm. Expressed as row dimension followed by column. Note This may not be the same as Detector Element Spacing (0018,7022) due to the presence of spacing material between detector elements.
Detector Element Spacing	(0018,7022)	3	Physical distance between the center of each detector element, specified by a numeric pair - row spacing value(delimiter) column spacing value in mm. See Section 10.7.1.3 for further explanation of the value order. Note This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.

Attribute Name	Tag	Type	Attribute Description
Detector Active Shape	(0018,7024)	3	Shape of the active area. Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL** Note This may be different from the Field of View Shape (0018,1147), and should not be assumed to describe the stored image.
Detector Active Dimension(s)	(0018,7026)	3	Dimensions in mm of the active area. If Detector Active Shape (0018,7024) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of a circumscribed circle. Note This may be different from the Field of View Dimensions (0018,1149), and should not be assumed to describe the stored image.
Detector Active Origin	(0018,7028)	3	Offset of the TLHC of a rectangle circumscribing the active detector area from the TLHC of a rectangle circumscribing the physical detector area, measured in physical detector pixels as a row offset followed by a column offset. See Section C.8.11.4.1.1 for further explanation.
Include Table 10-23 “Exposure Index Macro Attributes”			

C.8.11.4.1 DX Detector Attribute Descriptions

C.8.11.4.1.1 Physical, Active, Field of View, Exposed and Displayed Areas

The relationship between the Physical Detector Area, the Active Detector Area, the Field of View (what is stored in Pixel Data (7FE0,0010)), the Exposed Area (after X-Ray Collimation) and the Displayed Area is illustrated in the following diagrams.

Note

Some of these Attributes relate the image data to manufacturer specific characteristics of the detector that may be used for quality control purposes, e.g., correlation of image artifacts with a detector defect map, analysis of noise performance, etc.

The Displayed Area is defined in pixel coordinates relative to the stored image pixel values by the Attributes of the Display Shutter Module (see Section C.7.6.11). If this Module is not present or supported, then the Displayed Area is equal to the Field of View.

The Exposed Area is defined in pixel coordinates relative to the stored image pixel values by the Attributes of the X-Ray Collimator Module (see Section C.8.7.3).

For the Digital X-Ray IODs, the Field of View is usually rectangular in shape and usually has the same size as the stored Pixel Data (7FE0,0010). The shape and size of the Field of View and the spacing of the pixels are defined by the following Attributes:

- Field of View Shape (0018,1147),
- Field of View Dimensions (0018,1149),

- Imager Pixel Spacing (0018,1164),
- Rows (0028,0010),
- Columns (0028,0011).

In the case where the Field of View has the same size as the stored Pixel Data (7FE0,0010) the following relationships are verified:

If the Field of View Shape (0018,1147) Attribute equals RECTANGLE:

- Field of View $\text{Dimensions}_{\text{row dimension}}$ = Imager Pixel $\text{Spacing}_{\text{row spacing}}$ * Rows
- Field of View $\text{Dimensions}_{\text{column dimension}}$ = Imager Pixel $\text{Spacing}_{\text{column spacing}}$ * Columns

If the Field of View Shape (0018,1147) Attribute equals ROUND or HEXAGONAL:

- Field of View $\text{Dimensions}_{\text{diameter}}$ = Imager Pixel $\text{Spacing}_{\text{row spacing}}$ * Rows
- Field of View $\text{Dimensions}_{\text{diameter}}$ = Imager Pixel $\text{Spacing}_{\text{column spacing}}$ * Columns

The following Attributes define the relationship of the Field of View to the Physical Detector Area:

- Field of View Origin (0018,7030),
- Field of View Rotation (0018,7032),
- Field of View Horizontal Flip (0018,7034).

For the Digital X-Ray IODs, the Active Area, i.e., that part of the detector matrix that was activated for this exposure, is usually rectangular in shape. The shape and size of the Active Area and the size and spacing of the detectors are defined by the following Attributes:

- Detector Active Shape (0018,7024),
- Detector Active Dimensions (0018,7026),
- Detector Element Physical Size (0018,7020),
- Detector Element Spacing (0018,7022).

Note

1. The Detector Element Physical Size (0018,7020) and Detector Element Spacing (0018,7022) may be different if there are insensitive regions between each detector.
2. This model of description is not able to accurately describe multiple matrices of detectors that are "tiled" to produce a single image.

The following optional Attribute defines the relationship of the Active Area to the Physical Detector Area:

- Detector Active Origin (0018,7028).

In the case where the Field of View has the same size as the stored Pixel Data (7FE0,0010), the relationship between detectors and stored image pixels is defined by Detector Binning (0018,701A), which specifies how many detectors, in each of the row and column directions, contribute to (are pooled or averaged to form) a single stored image pixel.

Note

1. Detector Binning (0018,701A) may have values less than one if sub-sampling is used to derive an image with higher spatial resolution than the detector matrix.
2. The detector binning results in the size of a stored image pixel being different from the contributing physical detector pixels. In this case it is important to notice that the Field Of View Origin (0018,7030) is defined with respect to the center of the detector element located at the TLHC of the Field of View.

3. For images where the Field of View describes an area not equal to the size (rows and columns) of the stored Pixel Data (7FE0,0010), Detector Binning (0018,701A) does not fully specify the relationship between the contributing physical detector pixels and the stored image pixels.

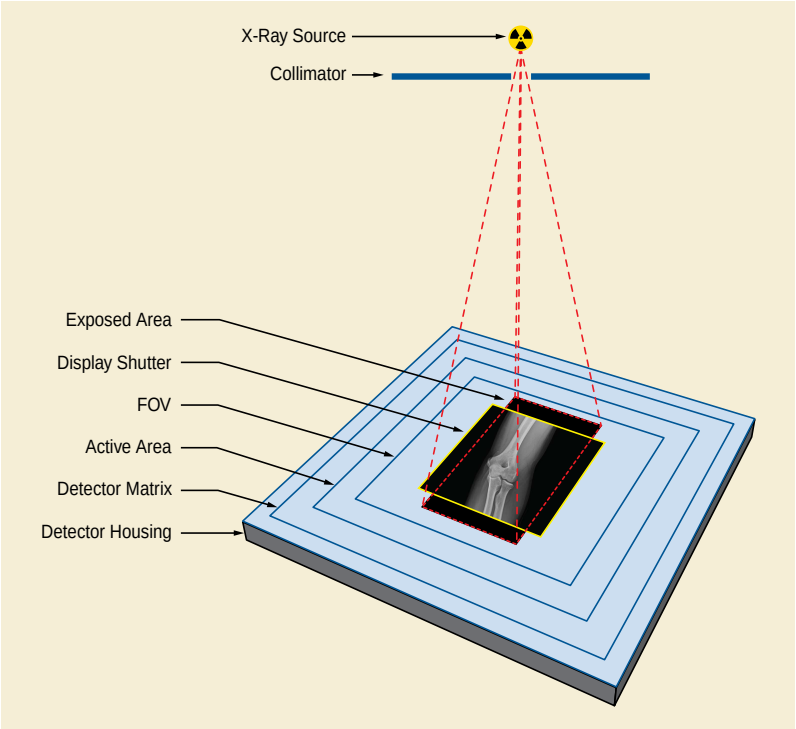


Figure C.8-14. Explanation of Digital Detector Attributes

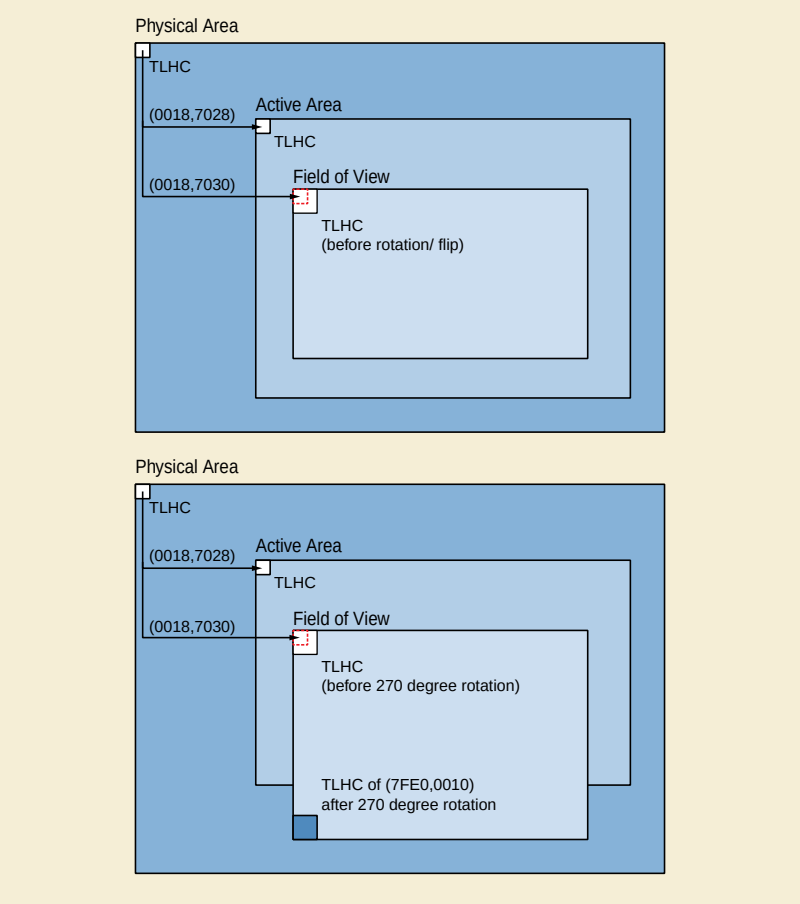


Figure C.8-15. Explanation of Digital Detector Attributes

C.8.11.5 DX Positioning Module

Table C.8-72 contains IOD Attributes that describe the positioning used in acquiring Digital X-Ray Images.

Table C.8-72. DX Positioning Module Attributes

Attribute Name	Tag	Type	Attribute Description
Projection Eponymous Name Code Sequence	(0018,5104)	3	A Sequence that describes the radiographic method of patient, tube and detector positioning to achieve a well described projection or view. Only a single Item is permitted in this Sequence. Shall be consistent with the other Attributes in this Module, if present, but may more specifically describe the image acquisition.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*BCID 4012 “Projection Eponymous Name”.*
Patient Position	(0018,5100)	3	Description of imaging subject's position relative to the equipment. See Section C.7.3.1.1.2 for Defined Terms and further explanation. If present, shall be consistent with Patient Gantry Relationship Code Sequence (0054,0414) and Patient Orientation Modifier Code Sequence (0054,0412).

Attribute Name	Tag	Type	Attribute Description
View Position	(0018,5101)	3	Radiographic view of the image relative to the imaging subject's orientation. Shall be consistent with View Code Sequence (0054,0220). See Section C.8.11.5.1.1 for further explanation.
View Code Sequence	(0054,0220)	3	Sequence that describes the projection of the anatomic region of interest on the image receptor. Note It is strongly recommended that this Attribute be present, in order to ensure that images may be positioned correctly relative to one another for display. Shall be consistent with View Position (0018,5101). See Section C.8.11.5.1.1 for further explanation. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*BCID 4010 “DX View”.*
>View Modifier Code Sequence	(0054,0222)	3	View modifier. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4011 “DX View Modifier”.*
Patient Orientation Code Sequence	(0054,0410)	3	Sequence that describes the orientation of the patient with respect to gravity. See Section C.8.11.5.1.2 for further explanation. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*BCID 19 “Patient Orientation”.*
>Patient Orientation Modifier Code Sequence	(0054,0412)	3	Patient Orientation Modifier. Required if needed to fully specify the orientation of the patient with respect to gravity. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 20 “Patient Orientation Modifier”.*
Patient Gantry Relationship Code Sequence	(0054,0414)	3	Sequence that describes the orientation of the patient with respect to the gantry. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*BCID 21 “Patient Equipment Relationship”.*

Attribute Name	Tag	Type	Attribute Description
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to the table, support or bucky side that is closest to the Imaging Subject, as measured along the central ray of the X-Ray beam. Note 1. This definition is less useful in terms of estimating geometric magnification than a measurement to a defined point within the Imaging Subject, but accounts for what is realistically measurable in an automated fashion in a clinical setting. 2. This measurement does not take into account any air gap between the Imaging Subject and the "front" of the table or bucky. 3. If the detector is not mounted in a table or bucky, then the actual position relative to the patient is implementation or operator defined. 4. This value is traditionally referred to as Source Object Distance (SOD). See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center. Note This value is traditionally referred to as Source Image Receptor Distance (SID). See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Estimated Radiographic Magnification Factor	(0018,1114)	3	Ratio of Source Image Receptor Distance (SID) over Source Object Distance (SOD).
Positioner Type	(0018,1508)	2	Defined Terms: **CARM** **COLUMN** **MAMMOGRAPHIC** **PANORAMIC** **CEPHALOSTAT** **RIGID** **NONE** Note 1. The term CARM can apply to any positioner with 2 degrees of freedom of rotation of the X-Ray beam about the Imaging Subject. 2. The term COLUMN can apply to any positioner with 1 degree of freedom of rotation of the X-Ray beam about the Imaging Subject.

Attribute Name	Tag	Type	Attribute Description
Positioner Primary Angle	(0018,1510)	3	Position of the X-Ray beam about the patient from the RAO to LAO direction where movement from RAO to vertical is positive, if Positioner Type (0018,1508) is CARM. See Section C.8.7.5 for further explanation if Positioner Type (0018,1508) is CARM. See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Positioner Secondary Angle	(0018,1511)	3	Position of the X-Ray beam about the patient from the CAU to CRA direction where movement from CAU to vertical is positive, if Positioner Type (0018,1508) is CARM. See Section C.8.7.5 for further explanation if Positioner Type (0018,1508) is CARM. See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Detector Primary Angle	(0018,1530)	3	Angle of the X-Ray beam in the row direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted toward higher numbered columns. Negative values indicate that the X-Ray beam is tilted toward lower numbered columns. See Section C.8.7.5 for further explanation. See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Detector Secondary Angle	(0018,1531)	3	Angle of the X-Ray beam in the column direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted toward lower numbered rows. Negative values indicate that the X-Ray beam is tilted toward higher numbered rows. See Section C.8.7.5 for further explanation. See Section C.8.11.7 for explanation if Positioner Type (0018,1508) is MAMMOGRAPHIC.
Column Angulation	(0018,1450)	3	Angle of the X-Ray beam in degree relative to an orthogonal axis to the detector plane. Positive values indicate that the tilt is toward the head of the table. Note The detector plane is assumed to be parallel to the table plane. Only meaningful if Positioner Type (0018,1508) is COLUMN.
Table Type	(0018,113A)	3	Defined Terms: **FIXED** **TILTING** **NONE**
Table Angle	(0018,1138)	3	Angle of table plane in degrees relative to horizontal plane [Gravity plane]. Positive values indicate that the head of the table is upward. Only meaningful if Table Type (0018,113A) is TILTING.
Body Part Thickness	(0018,11A0)	3	The average thickness in mm of the body part examined when compressed, if compression has been applied during exposure.

Attribute Name	Tag	Type	Attribute Description
Compression Force	(0018,11A2)	3	The compression force applied to the body part during exposure, measured in Newtons.
Compression Pressure	(0018,11A3)	3	The average compression pressure applied to the body part during exposure, calculated in kPa.
Compression Contact Area	(0018,11A5)	3	The area of the body part to which compression has been applied during exposure, measured in mm2. Note Area information is useful in addition to the Compression Pressure (0018,11A3) and Compression Force (0018,11A2) in the event that unusual values are encountered.
Paddle Description	(0018,11A4)	3	Description of the compression paddle, if compression was applied to the body part during exposure.

C.8.11.5.1 DX Positioning Attribute Descriptions

C.8.11.5.1.1 View Code Sequence

View Code Sequence (0054,0220) replaces the function of View Position (0018,5101), and describes the radiographic view of the image relative to the real-world patient orientation as described in Annex A “Explanation of Patient Orientation (Normative)” in PS3.17.

C.8.11.5.1.2 Patient Orientation Code Sequence

This Attribute is not related to Patient Orientation (0020,0020) and conveys a different concept entirely.

C.8.11.6 Mammography Series Module

Table C.8-73 specifies the Attributes that identify and describe general information about a Digital Mammography Series.

Table C.8-73. Mammography Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **MG** See Section C.7.3.1.1.1 for further explanation.
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.
~~>*Include* Table 10-9 “Request Attributes Macro Attributes”~~			~~*Reason for Requested Procedure Code Sequence (0040,100A) B*CID 6051 “Breast Procedure Reason” *and B*CID 6055 “Breast Clinical Finding or Indicated Problem”.~~ ~~*No Baseline CIDs are defined for other Attributes.*~~ ~~Note~~ ~~For example, Reason for Requested Procedure Code Sequence (0040,100A) may be used to convey whether the images in the Series were taken for screening or diagnostic purposes, if the information cannot be found in Reason For Performed Procedure Code Sequence (0040,1012) in the General Study Module.~~

Attribute Name	Tag	Type	Attribute Description
>*Include* Table 10-9 “Request Attributes Macro Attributes”			*Reason for Requested Procedure Code Sequence (0040,100A) B*CID 6051 “Breast Procedure Reason” *and B*CID 6055 “Breast Clinical Finding or Indicated Problem”. *No Baseline CIDs are defined for other Attributes.* Note For example, Reason for Requested Procedure Code Sequence (0040,100A) may be used to convey whether the images in the Series were taken for screening or diagnostic purposes, if the information cannot be found in Reason For Performed Procedure Code Sequence (0040,1012) in the General Study Module.

C.8.11.7 Mammography Image Module

Table C.8-74 contains IOD Attributes that describe a Digital Mammography X-Ray Image including its acquisition and positioning.

Table C.8-74. Mammography Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.11.7.1.4 for specialization.
Positioner Type	(0018,1508)	1	Enumerated Values: **MAMMOGRAPHIC** **NONE**
Distance Source to Detector	(0018,1110)	3	Distance in mm from source to detector center on the chest wall line Note 1. This value is traditionally referred to as Source Image Distance (SID). 2. See Section C.8.11.7.1.1.
Distance Source to Patient	(0018,1111)	3	Distance in mm from source to the breast support side that is closest to the Imaging Subject, as measured along the X-Ray beam vector. Note 1. This value is traditionally referred to as Source Object Distance (SOD). 2. See notes for this Attribute in Section C.8.11.5 DX Positioning Module. 3. See Section C.8.11.7.1.1 for description of X-Ray beam vector.
Positioner Primary Angle	(0018,1510)	3	Signed position in degrees of the X-Ray beam vector in the coronal anatomical plane as if the patient were standing facing the equipment where vertical is zero.

Attribute Name	Tag	Type	Attribute Description
Positioner Primary Angle Direction	(0018,9559)	3	The interpretation of the sign of the Positioner Primary Angle (0018,1510). Enumerated Values: **CW** Clockwise. Positioner Primary Angle movement is positive when movement is from vertical to the patient's right (with patient standing, facing equipment). **CC** Counter clockwise. Positioner Primary Angle is positive when movement is from vertical to the patient's left (with patient standing, facing the equipment). See Section C.8.31.2.1.
Positioner Secondary Angle	(0018,1511)	3	Position in degrees of the X-Ray beam vector in the sagittal anatomical plane as if the patient were standing where movement of the X-Ray source from anterior to posterior is positive, and vertical is zero.
Image Laterality	(0020,0062)	1	Laterality of the region examined. Enumerated Values: **R** right **L** left **B** both (e.g., cleavage) Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230) and/or Laterality (0020,0060), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series.
Organ Exposed	(0040,0318)	1	Organ to which Organ Dose (0040,0316) applies. Enumerated Values: **BREAST** Note In the Mammography IOD, Organ Dose (0040,0316) refers to the mean glandular dose.
Breast Implant Present	(0028,1300)	3	Whether or not the imaged breast contains a breast implant regardless of the visibility of a breast implant in the Pixel Data. Enumerated Values: **YES** **NO** Note The value is expected to be YES for all images acquired on a breast that contains a breast implant, even when a breast implant is displaced during image acquisition.

Attribute Name	Tag	Type	Attribute Description
Partial View	(0028,1350)	3	Indicates whether this image is a partial view, that is a subset of a single view of the breast. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not be a partial view. Note This may occur when a breast is larger than the active area of the detector. If this Attribute is present, its value shall be NO if there is a View Modifier Code Sequence (0054,0222) Item of value (399163009, SCT, "Magnification") or (399055006, SCT, "Spot Compression").
Partial View Description	(0028,1351)	3	Free text description of the portion of the breast captured in a partial view image. This Attribute shall not be present if there is a View Modifier Code Sequence (0054,0222) Item of value (399163009, SCT, "Magnification") or (399055006, SCT, "Spot Compression").
Partial View Code Sequence	(0028,1352)	3	Sequence that describes the portion or section of the breast captured in a partial view image. Only one or two Items are permitted in this Sequence. See Section C.8.11.7.1.3. If this Attribute is absent, then the image may or may not be a partial view. This Attribute shall not be present if there is a View Modifier Code Sequence (0054,0222) Item of value (399163009, SCT, "Magnification") or (399055006, SCT, "Spot Compression").
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4005 “Partial View Section for Mammography”.*
Include Table 10-5 “General Anatomy Mandatory Macro Attributes”			*Anatomic Region Sequence DCID 4013 “Anatomic Region for Mammography”.*
View Code Sequence	(0054,0220)	1	Sequence that describes the projection of the anatomic region of interest on the image receptor. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*DCID 4014 “View for Mammography”.*
>View Modifier Code Sequence	(0054,0222)	2	View modifier. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4015 “View Modifier for Mammography”.*
Biopsy Target Sequence	(0018,2041)	3	Sequence that identifies the targets of a biopsy procedure. One or more Items are permitted in this Sequence, where the coordinate system is the same for all Items within a pair of stereo images.

Attribute Name	Tag	Type	Attribute Description
>Target UID	(0018,2042)	1	Unique identifier for the target. Note To identify the same target in corresponding minus and plus stereo images.
>Localizing Cursor Position	(0018,2043)	1	Coordinates of localizing cursor position with respect to pixels in the image specified by a column (delimiter) row pair. The values shall be in the range 0\0 (TLHC) to Columns\Rows (BRHC).
>Calculated Target Position	(0018,2044)	1	The calculated target position (x, y, z) in mm in an equipment relative right-handed coordinate system where the origin is under the central X-Ray beam at the chest wall, and a z value of zero is located at the surface that the breast is in contact with that is closest to the detector. X is parallel to the chest wall, y is positive toward the patient's nipple, and z is positive toward the X-Ray source.
>Displayed Z Value	(0018,2046)	1	The z value in mm displayed to the user at the time of biopsy. Note 1. This may be the same as the z value of Calculated Target Position or different in direction or reference point, such as relative to the compression paddle. 2. This is not the distance that the needle was inserted, particularly for a lateral (parallel) approach.
>Target Label	(0018,2045)	3	Target description.

C.8.11.7.1 Mammography Image Attribute Descriptions

C.8.11.7.1.1 Mammography X-Ray Beam and X-Ray Beam Vector Definition

Figure C.8.11.7-1 shows the X-Ray beam for a digital mammography system. The X-Ray beam vector is defined from the Focal Spot to the center of the chest wall line of the Image Detection device.

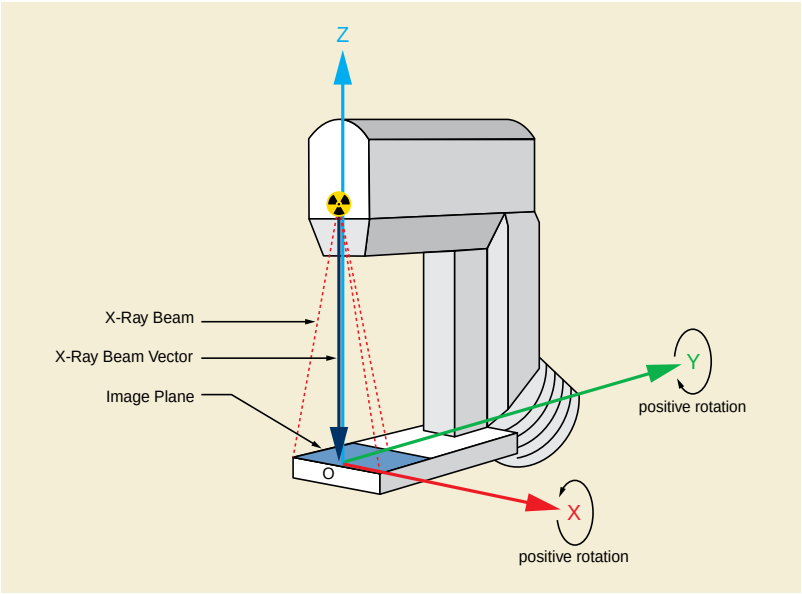


Figure C.8.11.7-1. X-Ray Beam for a Digital Mammography System

C.8.11.7.1.2 Detector Primary and Secondary Angles

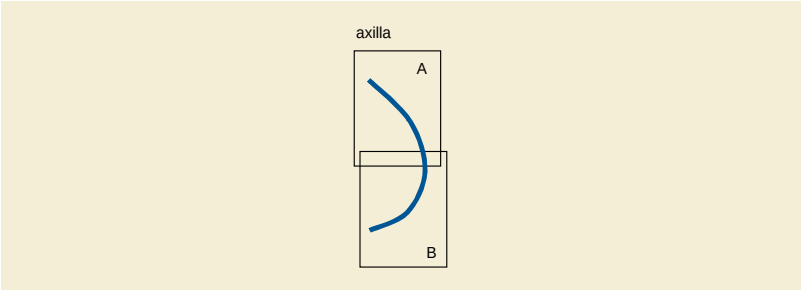
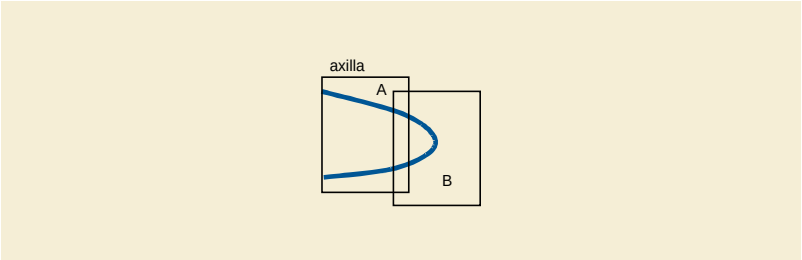
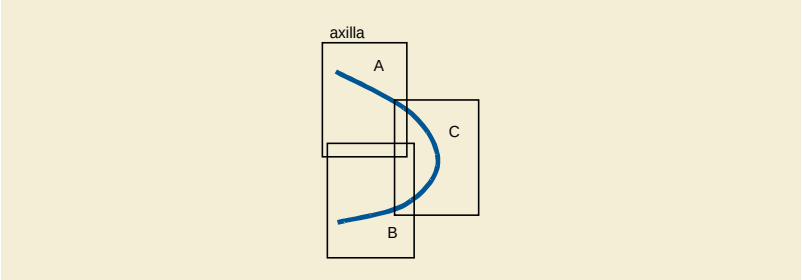
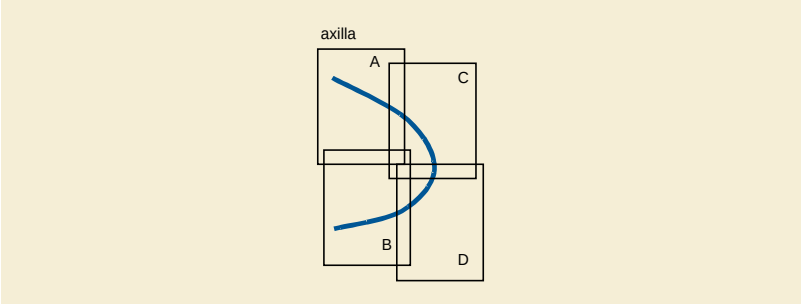
Detector Angles are defined in a fashion similar to the positioner angles, except that the angle of the X-Ray beam vector is relative to the detector plane rather than the patient plane. Zero degrees is referenced to the normal of the detector plane pointing toward the X-Ray source. The valid range of the Detector Angles is -90 to + 90 degrees.

The Primary Axis of rotation is defined along the line in the column direction of the detector plane that intersects the X-Ray beam vector. The Detector Primary Angle is defined in the plane perpendicular to the Primary Axis of rotation at the point where the X-Ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane and +90 in the direction of the higher numbered columns of the detector in that plane. The valid range of Detector Primary Angle is -90 to +90 degrees.

The Secondary Axis is in the detector plane and is perpendicular to the Primary Axis at the intersection of the beam vector with the detector plane (i.e., it is along the row direction). The Detector Secondary Angle is defined in the plane perpendicular to the Secondary Axis at the point where the X-Ray beam vector intersects the detector plane, with zero degrees in the direction normal to the detector plane. +90 degrees corresponds to the direction of the lower numbered rows of the detector in that plane. The Detector Secondary Angle range is -90 to + 90 degrees.

C.8.11.7.1.3 Partial View Code Sequence

Combinations of coded terms may be used in the Partial View Code Sequence (0028,1352) to express the breast section imaged. Figure C.8.11.7-2 shows examples for the right and left FB, XCC, XCCL and XCCM views, and Figure C.8.11.7-3 shows examples for the right and left ML, MLO, LM, LMO, SIO and ISO views.

Partial View Code Sequence Items (Code Meaning)	Partial View Images (A, B, C, D, E)
A) Item 1 = Lateral B) Item 1 = Medial	
A) Item 1 = Posterior B) Item 1 = Anterior	
A) Item 1 = Lateral, Item 2 = Posterior B) Item 1 = Medial, Item 2 = Posterior C) Item1 = Anterior	
A) Item 1 = Lateral, Item 2 = Posterior B) Item 1 = Medial, Item 2 = Posterior C) Item 1 = Lateral, Item 2 = Anterior D) Item 1 = Medial, Item 2 = Anterior	

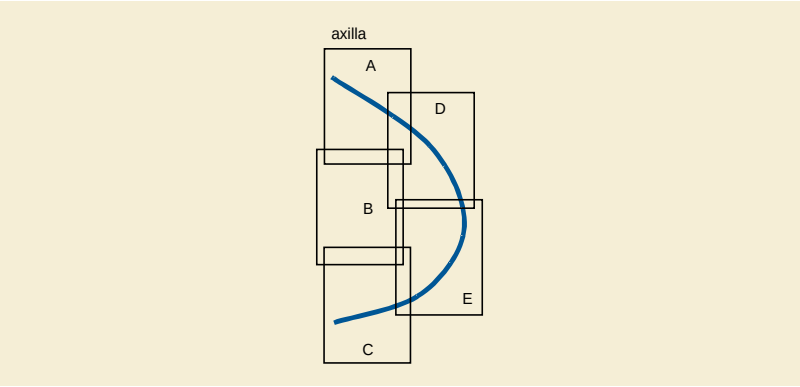
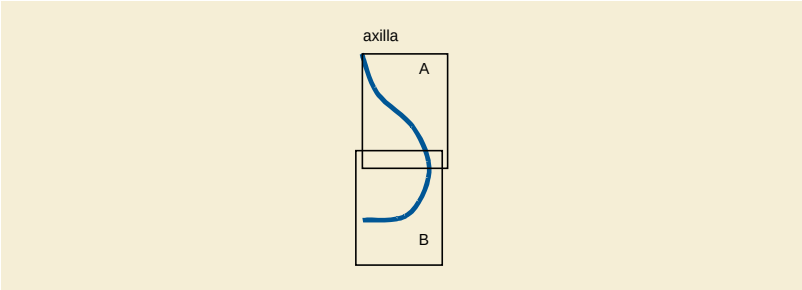
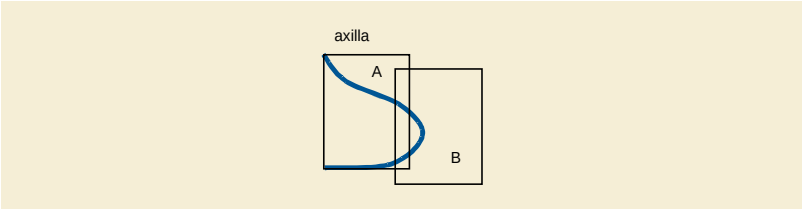
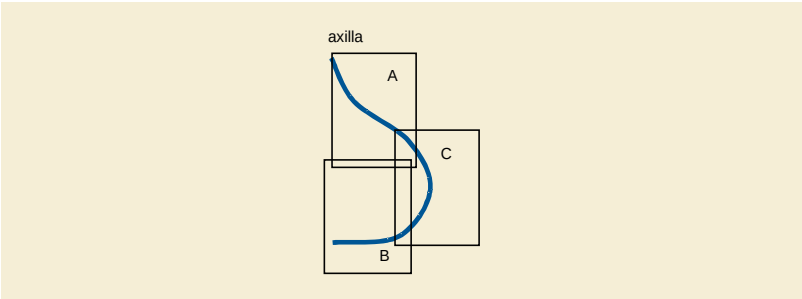
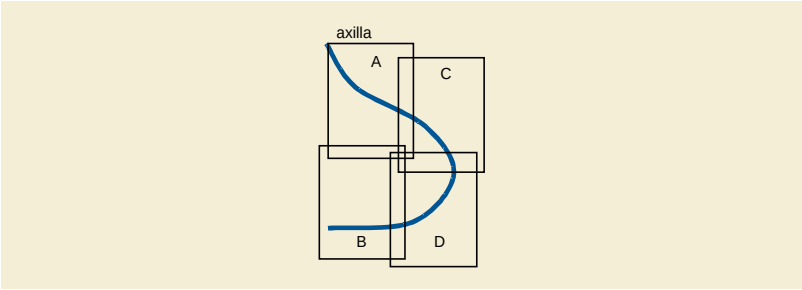
Partial View Code Sequence Items (Code Meaning)	Partial View Images (A, B, C, D, E)
A) Item 1 = Lateral, Item 2 = Posterior B) Item 1 = Central, Item 2 = Posterior C) Item 1 = Medial, Item 2 = Posterior D) Item 1 = Lateral, Item 2 = Anterior E) Item 1 = Medial, Item 2 = Anterior	

Figure C.8.11.7-2. CC, FB, XCCL and XCCM partial views

Note

If six images are required, then the "Central, Anterior" combination would be added.

Partial View Code Sequence Items (Code Meaning)	Partial View Images (A, B, C, D, E)
A) Item 1 = Superior B) Item 1 = Inferior	
A) Item 1 = Posterior B) Item 1 = Anterior	
A) Item 1 = Superior, Item 2 = Posterior B) Item1 = Inferior, Item 2 = Posterior C) Item 1 = Anterior	
A) Item 1 = Superior, Item 2 = Posterior B) Item 1 = Inferior, Item 2 = Posterior C) Item 1 = Superior, Item 2 = Anterior D) Item 1 = Inferior, Item 2 = Anterior	

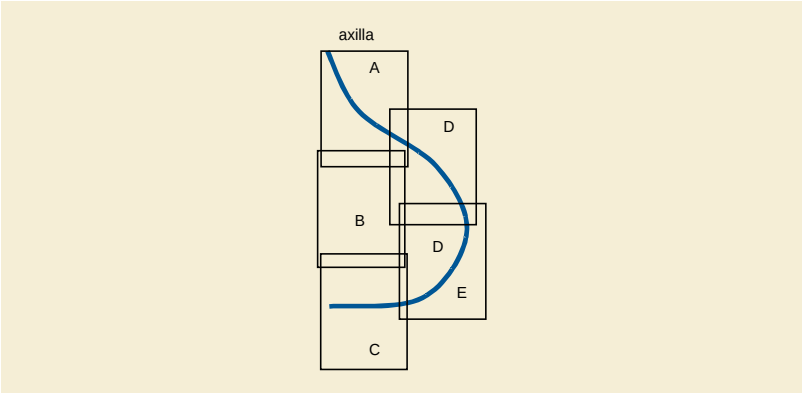
Partial View Code Sequence Items (Code Meaning)	Partial View Images (A, B, C, D, E)
A) Item 1 = Superior, Item 2 = Posterior B) Item 1 = Central, Item 2 = Posterior C) Item 1 = Inferior, Item 2 = Posterior D) Item 1 = Superior, Item 2 = Anterior E) Item 1 = Inferior, Item 2 = Anterior	

Figure C.8.11.7-3. ML, MLO, LM, LMO, SIO and ISO partial views

Note

If six images are required, then the "Central, Anterior" combination would be added.

C.8.11.7.1.4 Image Type

Image Type (0008,0008) Value 1 and Value 2 shall identify the Pixel Data Characteristics in accordance with Section C.8.11.3.1.1.

Value 3 shall be present and have zero length (null value), except when used to identify a stereotactic mammography image, digital breast tomosynthesis projection or generated 2D image, or contrast enhanced image.

Note

In a previous version of PS3.3, Value 3 was required to be zero length (null value). If Value 3 is zero length, the image may or may not be a stereotactic mammography image, digital breast tomosynthesis projection or generated 2D image, or contrast enhanced image, if the Instance was created before these terms were defined.

The Enumerated Values for Value 3 of stereotactic mammography images are listed in Table C.8-74a.

Table C.8-74a. Enumerated Values of Image Type (0008,0008) Value 3 for Stereotactic Mammography

Enumerated Value	Definition	ACR MQCM Equivalent
STEREO_SCOUT	A localizer image for a stereotactic acquisition.	…SC
STEREO_MINUS	The paired image obtained with the X-Ray source angle decreased from the scout position, to determine positioning coordinates prior to needle positioning.	…ST-
STEREO_PLUS	The paired image obtained with the X-Ray source angle increased from the scout position, to determine positioning coordinates prior to needle positioning.	…ST+
PREFIRE_MINUS	The paired image obtained with the X-Ray source angle decreased from the scout position, with the biopsy needle in position prior to needle deployment.	…PRF-
PREFIRE_PLUS	The paired image obtained with the X-Ray source angle increased from the scout position, with the biopsy needle in position prior to needle deployment.	…PRF+
POSTFIRE_MINUS	The paired image obtained with the X-Ray source angle decreased from the scout position, with the biopsy needle in position following needle deployment through the targeted lesion.	…POF-

Enumerated Value	Definition	ACR MQCM Equivalent
POSTFIRE_PLUS	The paired image obtained with the X-Ray source angle increased from the scout position, with the biopsy needle in position following needle deployment through the targeted lesion.	…POF+
POSTBIOPSY_MINUS	The image obtained following tissue acquisition with the X-Ray source angle decreased from the scout position.	…POB-
POSTBIOPSY_PLUS	The image obtained following tissue acquisition with the X-Ray source angle increased from the scout position.	…POB+
POSTBIOPSY	The image obtained following tissue acquisition with the X-Ray source in the scout position.	…POB
POSTMARKER_MINUS	The image obtained following micromarker placement with the X-Ray source angle decreased from the scout position.	…POM-
POSTMARKER_PLUS	The image obtained following micromarker placement with the X-Ray source angle increased from the scout position.	…POM+
POSTMARKER	The image obtained following micromarker placement with the X-Ray source in the scout position.	…POM

The Enumerated Values for Value 3 of digital breast tomosynthesis projection images and mathematically generated 2D images are:

Table C.8-74b. Enumerated Values of Image Type (0008,0008) Value 3 for Digital Breast Tomosynthesis Projection and Generated 2D Images

Enumerated Value	Definition	ACR MQCM Equivalent
TOMO_PROJ	Identifies the image as a digital breast tomosynthesis projection image.	n/a
TOMOSYNTHESIS	Identifies the image as digital breast tomosynthesis; shall be used only for generated 2D images when no other Value 3 takes precedence.	n/a
TOMO_SCOUT	A localizer image that may be used to determine positioning coordinates prior to needle positioning.	…SC
PREFIRE	The image obtained with the biopsy needle in position prior to needle deployment.	…PRF
POSTFIRE	The image obtained with the biopsy needle in position following needle deployment through the targeted lesion.	…POF
POSTBIOPSY	The image obtained following tissue acquisition with the X-Ray source in the scout position.	…POB
POSTMARKER	The image obtained following micromarker placement with the X-Ray source in the scout position.	…POM

Note

Digital breast tomosynthesis projection images acquired as part of a biopsy procedure (and resulting derived images such as mathematically generated 2D) omit the _MINUS and _PLUS endings because a single digital breast tomosynthesis acquisition produces a set of projection images that replaces the _MINUS and _PLUS image pair used in conventional 2D breast biopsy imaging.

The Enumerated Values for Value 3 of contrast enhanced images are:

Table C.8-74c. Enumerated Values of Image Type (0008,0008) Value 3 for Contrast Enhanced Images

Enumerated Value	Definition
PRE_CONTRAST	Collected before contrast was administered.
POST_CONTRAST	Collected during or after contrast was administered.

If more than one characteristic (biopsy, tomosynthesis, contrast enhanced) applies to an image, Value 3 shall contain the biopsy image type. If biopsy is not involved, Value 3 shall contain the tomosynthesis image type.

Note

For example, Attributes of the Contrast/Bolus Module may be used to identify contrast enhanced characteristics of a biopsy and/or tomosynthesis projection or generated 2D image that is also contrast enhanced.

Value 4 shall be present for images acquired using contrast enhanced digital X-Ray imaging of the breast (but may be empty if none of the Defined Terms applies), and for mathematically generated 2D images. For other images Value 4 remains optional and implementation specific.

Table C.8-74d. Defined Terms of Image Type (0008,0008) Value 4 for Contrast Enhanced and Generated 2D Images

Enumerated Value	Definition
GENERATED_2D	Mathematically generated 2D view.
ADDITION	Created through Pixel by pixel addition operation.
SUBTRACTION	Created through Pixel by pixel subtraction operation.

If more than one characteristic (contrast enhanced, tomosynthesis) applies to an image, Value 4 shall contain the contrast enhanced image type. If contrast enhanced is not involved, Value 4 shall contain the generated 2D image type.

Value 5 shall be present for images acquired using contrast enhanced digital X-Ray imaging of the breast, but may be empty if none of the Defined Terms applies. For non-contrast images Value 5 remains optional and implementation specific.

Table C.8-74e. Defined Terms of Image Type (0008,0008) Value 5 for Contrast Enhanced 2D Images

Enumerated Value	Definition
LOW_ENERGY	Low energy image.
HIGH_ENERGY	High energy image.

Note

A recipient may use the different values for biopsy, tomosynthesis and contrast views to determine how to display them, for example in hanging protocols:

	Image Type Value 3	Image Type Value 4	Image Type Value 5
Conventional 2D mammography	empty	-	-
Stereotactic post-biopsy	POSTBIOPSY	-	-
Pre-contrast 2D	PRE_CONTRAST	empty	empty
Post-contrast 2D low energy	POST_CONTRAST	-	LOW_ENERGY
Post-contrast 2D addition	POST_CONTRAST	ADDITION	empty
Stereotactic scout pre-contrast	STEREO_SCOUT	empty	empty
Stereotactic stereo post-contrast high energy	STEREO_PLUS	empty	HIGH_ENERGY
Stereotactic post-fire post-contrast subtraction	POSTFIRE_MINUS	SUBTRACTION	empty
Tomosynthesis generated 2D	TOMOSYNTHESIS	GENERATED_2D	-
Tomosynthesis biopsy scout generated 2D	TOMO_SCOUT	GENERATED_2D	-
Tomosynthesis generated 2D post-contrast low energy	TOMOSYNTHESIS	GENERATED_2D	LOW_ENERGY

	Image Type Value 3	Image Type Value 4	Image Type Value 5
Tomosynthesis generated 2D post-contrast subtraction	TOMOSYNTHESIS	SUBTRACTION	empty
Tomosynthesis projection	TOMO_PROJ	-	-
Tomosynthesis projection post-biopsy	POSTBIOPSY	-	-
Tomosynthesis projection post-biopsy post-contrast subtraction	POSTBIOPSY	SUBTRACTION	empty

C.8.11.8 Intra-Oral Series Module

Table C.8-75 specifies the Attributes that identify and describe general information about a Digital Intra-Oral X-Ray Series.

Table C.8-75. Intra-Oral Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **IO** See Section C.7.3.1.1.1 for further explanation.

C.8.11.9 Intra-Oral Image Module

Table C.8-76 contains IOD Attributes that describe a Digital Intra-Oral X-Ray Image including its acquisition and positioning.

Table C.8-76. Intra-Oral Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Positioner Type	(0018,1508)	1	Enumerated Values: **NONE** **CEPHALOSTAT** **RIGID**
Image Laterality	(0020,0062)	1	Laterality of the region examined. Enumerated Values: **R** right **L** left **B** both (i.e., midline) Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230) and/or Laterality (0020,0060), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series.
Anatomic Region Sequence	(0008,2218)	1	Sequence that identifies the anatomic region of interest in this image. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 8.8-1 "Code Sequence Macro Attributes" .			*DCID 4016 "Anatomic Region for Intra-oral Radiography".*
>Anatomic Region Modifier Sequence	(0008,2220)	1C	Sequence that refines the anatomic region of interest in this image. Required if Primary Anatomic Structure Sequence (0008,2228) is not present. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4017 "Anatomic Region Modifier for Intra-oral Radiography".*
Primary Anatomic Structure Sequence	(0008,2228)	1C	Sequence that describes the primary anatomic structures of interest in this image. See Section C.8.11.9.1.1 for further explanation. Required if Anatomic Region Modifier Sequence (0008,2220) is not present. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes" .			*DCID 4026 "Primary Anatomic Structure for Intra-oral and Craniofacial Radiography - Teeth". See Section C.8.11.9.1.1 for further explanation.*

C.8.11.9.1 Intra-Oral Image Attribute Descriptions

C.8.11.9.1.1 Primary Anatomic Structure Sequence

DCID 4026 "Primary Anatomic Structure for Intra-oral and Craniofacial Radiography - Teeth". This Context Group includes DCID 4018 "Primary Anatomic Structure for Intra-oral Radiography (Permanent Dentition - Designation of Teeth)", for permanent dentition, DCID 4019 "Primary Anatomic Structure for Intra-oral Radiography (Deciduous Dentition - Designation of Teeth)" for deciduous dentition and DCID 4025 "Primary Anatomic Structure for Intra-oral Radiography (Supernumerary Dentition - Designation of Teeth)" for supernumerary dentition.

These Context Groups contain concepts that are mapped to ISO 3950-2010, which describes a designation of permanent and deciduous dentition using a two digit code, the first digit of which designates a quadrant, and the second digit a tooth.

The teeth imaged shall be listed as multiple Items in the Primary Anatomic Structure Sequence (0008,2228).

C.8.11.10 Enhanced Mammography Series Module

The Breast Tomosynthesis Image IOD uses the General Series Module, specialized by the Enhanced Mammography Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of a Breast Tomosynthesis device.

Table C.8-76b specifies the Attributes that identify and describe general information about the Enhanced Mammography Series.

Table C.8-76b. Enhanced Mammography Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **MG** See Section C.7.3.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.
~~*>Include* Table 10-9 "Request Attributes Macro Attributes"~~			~~*Reason for Requested Procedure Code Sequence (0040,100A) B*CID 6051 "Breast Procedure Reason" *and B*CID 6055 "Breast Clinical Finding or Indicated Problem".~~ ~~*No Baseline CIDs are defined for other Attributes.*~~ ~~Note~~ ~~For example, Requested Procedure Code Sequence (0040,100A) may be used to convey whether the images in the Series were taken for screening or diagnostic purposes.~~
>Include Table 10-9 "Request Attributes Macro Attributes"			*Reason for Requested Procedure Code Sequence (0040,100A) B*CID 6051 "Breast Procedure Reason" *and B*CID 6055 "Breast Clinical Finding or Indicated Problem". *No Baseline CIDs are defined for other Attributes.* Note For example, Requested Procedure Code Sequence (0040,100A) may be used to convey whether the images in the Series were taken for screening or diagnostic purposes.

C.8.12 VL Modules and Functional Group Macros

C.8.12.1 VL Image Module

Table C.8-77 specifies the Attributes that describe a VL Image produced by Endoscopy (ES), General Microscopy (GM), Automated-Stage Microscopy (SM), External-camera Photography (XC), or other VL imaging Modalities.

Table C.8-77. VL Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.12.1.1.6 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.12.1.1.1 for specialization of this Attribute.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. See Section C.8.12.1.1.3 for specialization of this Attribute.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) per image. See Section C.8.12.1.1.4 for specialization of this Attribute.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.8.12.1.1.5 for specialization of this Attribute.
Content Time	(0008,0033)	1C	The time the image pixel data creation started. Required if the Image is part of a Series in which the images are temporally related. Note This Attribute was formerly known as Image Time.
Lossy Image Compression	(0028,2110)	2	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5
Referenced Image Sequence	(0008,1140)	1C	A Sequence that references other images significantly related to this image. One or more Items are permitted in this Sequence. Required if Image Type (0008,0008) Value 3 is present and has a value of "STEREO L" or "STEREO R". May also be present otherwise. See Section C.8.12.1.1.7.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	2	Describes the purpose for which the reference is made. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7201 “Referenced Image Purposes of Reference”.*
Window Center	(0028,1050)	3	Window Center for display. See Section C.11.2.1.2 for further explanation. Meaningful only if Photometric Interpretation (0028,0004) is MONOCHROME2.

Attribute Name	Tag	Type	Attribute Description
Window Width	(0028,1051)	1C	Window Width for display. See Section C.11.2.1.2 for further explanation. Required if Window Center (0028,1050) is present.
Image Laterality	(0020,0062)	3	Laterality of (possibly paired) body part (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), Anatomic Region Modifier Sequence (0008,2220), and/or Laterality (0020,0060), if present. Note 1. Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series. 2. There is no value for median, for which Primary Anatomic Structure Modifier Sequence (0008,2230) or Anatomic Region Modifier Sequence (0008,2220) may be used instead.
Anatomic Region Sequence	(0008,2218)	1C	Sequence that identifies the anatomic region of interest in this image (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence. Required if Number of Frames (0028,0008) is present and Specimen Description Sequence (0040,0560) is absent. May be present otherwise.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4040 “Endoscopy Anatomic Regions” for the Video Endoscopic IOD.* *BCID 4029 “Dermatology Anatomic Sites” for the VL Photographic Image IOD for dermatology applications.* *BCID 4031 “Common Anatomic Regions” for humans and BCID 7483 “Common Anatomic Regions for Animals” for animals.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this image One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 2 “Anatomic Modifier”.* *BCID 245 “Laterality with Median” is defined for the VL Photographic Image IOD for dermatology applications.*
Include Table 10-8 “Primary Anatomic Structure Macro Attributes”			*No CID is defined. These Type 3 Attributes are not appropriate when Specimen Description Sequence (0040,0560) is present, as it includes the Primary Anatomic Structure Macro for each specimen in the image.*

Attribute Name	Tag	Type	Attribute Description
Channel Description Code Sequence	(0022,001A)	3	Describes the light color used for each channel to generate the image. If Photometric Interpretation (0028,0004) has one of the YBR values, the meaning is for pixel data in an equivalent RGB encoding. Note Interpretation and representation of RGB images rely on the assumption that the red channel really contains the red wavelength range of illumination light, the blue channel the blue wavelength range, etc. Some modalities use the RGB Photometric Interpretation as a container representing 3 channels of any illumination wavelength. Shall have the same number of Items as the value of Samples per Pixel (0028,0002). The channels shall be described in the order in which the channels are encoded.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4206 "Ophthalmic Channel Description".*
Pixel Spacing	(0028,0030)	3	Physical distance in the imaging target (patient or specimen) between the center of each pixel, specified as a numeric pair - adjacent row spacing \ adjacent column spacing, in mm. See Section 10.7.1.3.
Imager Pixel Spacing	(0018,1164)	3	Physical distance measured at the front plane of the Image Receptor housing between the center of each pixel. Specified by a numeric pair - row spacing value (delimiter) column spacing value - in mm. In the case of a photographic camera, the front plane is defined to be the focal plane.

C.8.12.1.1 VL Image Module Attribute Descriptions

C.8.12.1.1.1 Photometric Interpretation

Enumerated Values:

MONOCHROME2
RGB
YBR_FULL_422
YBR_PARTIAL_420
YBR_RCT
YBR_ICT

Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT for irreversible JPEG 2000 Transfer Syntaxes, YBR_RCT for reversible JPEG 2000 Transfer Syntaxes, YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264 and HEVC/H.265 Transfer Syntaxes and YBR_FULL_422 for JPEG lossy compressed Transfer Syntaxes.

Note

1. The YBR_FULL Photometric Interpretation (0028,0004), such as might be used with the RLE Transfer Syntax, is not permitted.
2. There is no formal color space defined, hence "false" color applications that encode near-visible light images may be encoded, for example, as RGB.

C.8.12.1.1.2 Bits Allocated, Bits Stored, and High Bit

Enumerated Values of Bits Allocated (0028,0100):

8

Enumerated Values of Bits Stored (0028,0101):

8

Enumerated Values of High Bit (0028,0102):

7

C.8.12.1.1.3 Pixel Representation

Enumerated Values:

0

C.8.12.1.1.4 Samples Per Pixel

Enumerated Values when Photometric Interpretation (0028,0004) is MONOCHROME2:

1

Enumerated Values when Photometric Interpretation (0028,0004) is RGB or YBR_FULL_422 or YBR_PARTIAL_420 or YBR_RCT or YBR_ICT:

3

C.8.12.1.1.5 Planar Configuration

This value shall be present if Samples per Pixel (0028,0002) has a value greater than 1.

Enumerated Values:

0

C.8.12.1.1.6 Image Type

The Image Type Attribute identifies important image characteristics in a multiple valued Data Element. For Visible Light, Image Type is specialized as follows:

- Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values:
  ORIGINAL
  DERIVED

- Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values:
  PRIMARY
  SECONDARY

- Value 3 may be absent, but if present shall identify the members of a stereo pair, in which case Referenced Image Sequence (0008,1140) is used to identify the other member of the pair.

  Enumerated Values:
  STEREO L Image is the left image (relative to the observer's left) of a stereo pair acquisition
  STEREO R Image is the right image (relative to the observer's right) of a stereo pair acquisition

- Other Values are implementation specific (optional).

C.8.12.1.1.7 Referenced Image Sequence

When Image Type (0008,0008) Value 3 is STEREO L or STEREO R, Referenced Image Sequence (0008,1140) shall be used to identify the corresponding SOP Instance of the Stereoscopic acquisition. In this case, either:

- only a single Item shall be present, or

- multiple Items may be present, each with the Purpose of Reference Code Sequence (0040,A170) present, and only the first Item having the Purpose of Reference value (121315, DCM, "Other image of stereoscopic pair").

C.8.12.2 Slide Coordinates Module

The table in this Section contains Attributes that describe Slide Coordinates. Slide Coordinates provide a means to locate an image within a given Frame of Reference.

Note

1. A Frame of Reference (identified by a Frame of Reference UID) typically only applies to a single mounting of a slide on a particular microscope stage; there is no guarantee that a subsequent mounting of the slide, even on the same equipment, will allow reproducible positioning to the exact same location. These Attributes allow consistent location of multiple images within the Series of a single Frame of Reference.

2. There is no a priori correspondence of pixels to Slide Coordinates. Therefore, the geometrical symmetry point through the pixel plane of the digital microscope may not correspond to the center of a pixel. The geometrical symmetry point could be between pixels.

3. This Module formerly included a Type 3 Attribute Pixel Spacing Sequence (0040,08D8), and subsidiary Attributes; see PS3.3-2009. Pixel Spacing is an Attribute of the image acquisition, not the slide coordinates, and is inappropriate for this Module. It is now conveyed by Pixel Spacing (0028,0030) in the VL Image Module or the Pixel Measures Functional Group (see Section C.7.6.16.2.1).

Table C.8-78. Slide Coordinates Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Center Point Coordinates Sequence	(0040,071A)	2	The coordinates of the center point of the Image in the Slide Coordinate System Frame of Reference. Zero or one Item shall be included in this Sequence. See Section C.8.12.2.1.1 for further explanation.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Z Offset in Slide Coordinate System	(0040,074A)	2	The Z offset in microns from the image substrate reference plane (i.e., utilized surface of a glass slide).

C.8.12.2.1 Slide Coordinates Attribute Descriptions

C.8.12.2.1.1 Image Center Point Coordinates Sequence

This Section defines the Slide Coordinate System and specifies the Attributes that shall be used to describe the location of the center point of the Image pixel plane (as captured through a microscope) in the Slide Coordinate System Frame of Reference.

Note

In Slide Microscopy (SM), the Microscope is equipped with a moveable Stage and position sensors that enable storage of the location of the center point of the displayed image with respect to the examined Specimen.

The Stage is the part of the Microscope to which the Slide is attached for viewing. The Objective Lens is the lens that is closest to the Specimen. The Top Surface of the Slide is the surface of the Slide on which the Specimen is mounted. The Bottom Surface of the Slide is the opposite surface. This Specification presumes that: 1) the Slide is rectangular; 2) the Top Surface of the Slide is oriented toward the Objective Lens of the Microscope; and 3) the Bottom Surface of the Slide is in perfect contact with the Microscope Stage when the Slide is attached to the Stage for viewing.

Note

1. The Label of the Slide is presumed to be mounted-on or written-on the Top Surface of the Slide.

2. Specification of the mechanical form, function, or tolerances of the Microscope are outside the scope of this Standard.

Figure C.8-16 depicts the Top Surface of the Slide on the Microscope Stage from the perspective of the Objective Lens. This is Reference Slide Orientation. The X, Y, and Z axes of the Slide Coordinate System in Reference Slide Orientation are defined as follows. The Y-axis is a line that nominally represents the Left Edge of the Slide. The X-axis is a line that is orthogonal to the Y-axis and nominally represents the Specimen Edge of the Slide. The Z-axis is a line that passes through the intersection of the X-axis and Y-axis and is orthogonal to the Microscope Stage. The Origin (0,0,0) of the Slide Coordinate System is the point of intersection of the X, Y, and Z axes.

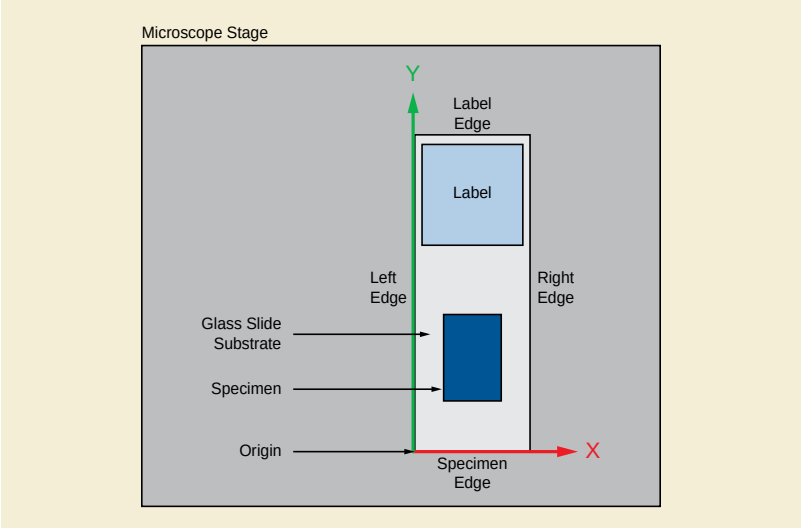


Figure C.8-16. Reference Slide Orientation

Note

1. An improperly-placed coverslip or Specimen that overlaps an Edge of a Slide is not considered part of the Edge a Slide for purposes of defining the Slide Coordinate System. However, such objects may cause inaccurate positioning of the Slide on the Stage.

2. If the Left Edge and Specimen Edge of the Slide are not orthogonal (e.g., the Slide is damaged or defective or the Specimen Edge is curvilinear), then the lower left-hand corner of the Slide may not be located at the Origin.

3. The definitions of X, Y, and Z axes are the same for inverted microscopes, with the Top Surface of the slide (i.e., Specimen side of the Slide) still being closest to the Objective Lens.

4. The origin of a Frame of Reference is arbitrary (see Section C.7.4.1), but its nominal location for consistency of slide coordinates is defined in this section.

Figure C.8-17 depicts the Z-axis center point location. The X Offset in Slide Coordinate System (0040,072A) shall increase from the Origin toward the Right Edge in Reference Slide Orientation. The Y Offset in Slide Coordinate System (0040,073A) shall increase from the Origin toward the Label Edge in Reference Slide Orientation. The Z Offset in Slide Coordinate System (0040,074A) shall be nominally referenced as zero at the image substrate reference plane (i.e., the top surface of a glass slide) and shall increase in a positive fashion coincident with increased distance from the substrate surface.

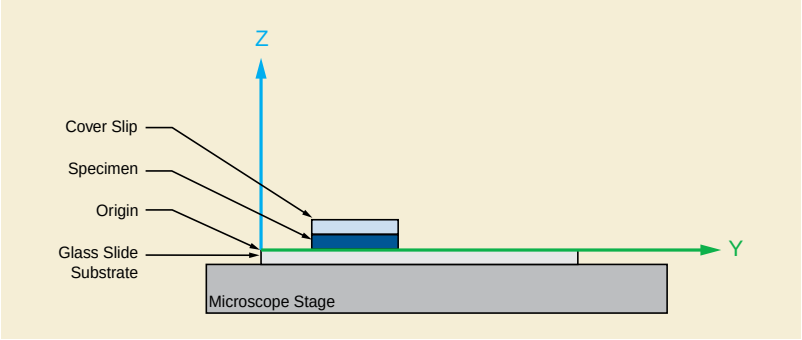


Figure C.8-17. Z-Axis Center Point Location, View From Right Edge of Slide

C.8.12.3 Whole Slide Microscopy Series Module

Table C.8.12.3-1 specifies Attributes for the Whole Slide Microscopy Series Module, including specialization of Attributes in the General Series Module for use in the Whole Slide Microscopy Series Module.

Table C.8.12.3-1. Whole Slide Microscopy Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **SM** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.12.4 Whole Slide Microscopy Image Module

Table C.8.12.4-1 specifies the Attributes that describe the Whole Slide Microscopy Image Module.

Table C.8.12.4-1. Whole Slide Microscopy Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.12.4.1.1 for specialization.
Imaged Volume Width	(0048,0001)	1	Width of total imaged volume (distance in the direction of rows in each frame) in mm. See Section C.8.12.4.1.2
Imaged Volume Height	(0048,0002)	1	Height of total imaged volume (distance in the direction of columns in each frame) in mm. See Section C.8.12.4.1.2
Imaged Volume Depth	(0048,0003)	1	Depth of total imaged volume (distance in the Z direction of focal planes) in µm. See Section C.8.12.4.1.2

Attribute Name	Tag	Type	Attribute Description
Total Pixel Matrix Columns	(0048,0006)	1	Total number of columns in pixel matrix; i.e., width of total imaged volume in pixels. See Section C.8.12.4.1.3
Total Pixel Matrix Rows	(0048,0007)	1	Total number of rows in pixel matrix; i.e., height of total imaged volume in pixels. See Section C.8.12.4.1.3
Total Pixel Matrix Focal Planes	(0048,0303)	1C	Total number of focal planes (Z locations) in the pixel matrix; i.e., depth of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise. Note Total Pixel Matrix Focal Planes (0048,0303) describes the number of focal planes separately encoded, and is distinct from Number of Focal Planes (0048,0013), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).
Total Pixel Matrix Origin Sequence	(0048,0008)	1	Location of pixel 1\1 of the total pixel matrix in the Slide Coordinate System Frame of Reference. Only a single Item shall be included in this Sequence. See Section C.8.12.4.1.4 and Section C.8.12.2.1.1 for further explanation.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in millimeters from the Origin of the Slide Coordinate System.
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in millimeters from the Origin of the Slide Coordinate System.
Image Orientation (Slide)	(0048,0102)	1	The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4
Samples Per Pixel	(0028,0002)	1	Number of samples (color planes) per frame in this image. Enumerated Values: **3** **1** See Section C.8.12.4.1.5 for further explanation.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.12.4.1.5 for Enumerated Values.
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. Enumerated Values: **0** color-by-pixel
Number of Frames	(0028,0008)	1	Number of frames in a multi-frame image. Enumerated Values if Image Type (0008,0008) Value 3 is LOCALIZER or LABEL: **1**

Attribute Name	Tag	Type	Attribute Description
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Shall be equal to Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0** unsigned integer
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started.
Acquisition Duration	(0018,9073)	3	Duration of the image acquisition in seconds.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values. Required if Photometric Interpretation (0028,0004) is MONOCHROME2.

Attribute Name	Tag	Type	Attribute Description
Rescale Intercept	(0028,1052)	1C	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b. Required if Photometric Interpretation (0028,0004) is MONOCHROME2. Enumerated Values: **0**
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Photometric Interpretation (0028,0004) is MONOCHROME2. Enumerated Values: **1**
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See Section C.8.16.2.1.2. Enumerated Values: **VOLUME** pixels represent the volume specified for the image, and may be geometrically manipulated
Specimen Label in Image	(0048,0010)	1	Indicates whether the specimen label is captured in the image. Enumerated Values: **YES** **NO**
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient. Enumerated Values: **YES** **NO** Note If Specimen Label in Image (0048,0010) value is YES, Burned In Annotation (0028,0301) might be NO if the label includes only a specimen identifier and not patient identifying data.
Focus Method	(0048,0011)	1	Method of focusing image Enumerated Values: **AUTO** autofocus **MANUAL** includes any human adjustment or verification of autofocus
Extended Depth of Field	(0048,0012)	1	Image pixels were created through combining of image acquisition at multiple focal planes (focus stacking). Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Number of Focal Planes	(0048,0013)	1C	Number of acquisition focal planes used for extended depth of field. Required if Extended Depth of Field (0048,0012) value is YES Note Total Pixel Matrix Focal Planes (0048,0303) describes the number of focal planes separately encoded, and is distinct from Number of Focal Planes (0048,0013), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).
Distance Between Focal Planes	(0048,0014)	1C	Distance between acquisition focal planes used for extended depth of field, in µm. Required if Extended Depth of Field (0048,0012) value is YES. Note Spacing Between Slices (0018,0088) describes the spacing of focal planes separately encoded, and is distinct from Distance Between Focal Planes (0048,0014), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).
Acquisition Device Processing Description	(0018,1400)	3	Description of visual processing performed on the image prior to exchange. Examples of this processing are: edge enhanced, gamma corrected, convolved (spatially filtered)
Convolution Kernel	(0018,1210)	3	Label for convolution kernel used in acquisition device visual processing
Recommended Absent Pixel CIELab Value	(0048,0015)	3	A color value with which it is recommended to display the pixels of the Total Pixel Matrix that are not encoded. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

C.8.12.4.1 Whole Slide Microscopy Image Attribute Descriptions

C.8.12.4.1.1 Image Type

Image Type (0008,0008) is specified to be Type 1 with the following constraints:

Value 1 shall have a value of ORIGINAL or DERIVED

Value 2 shall have a value of PRIMARY

Value 3 (Image Flavor) shall have the Defined Terms in Table C.8.12.4-2.

Table C.8.12.4-2. Whole Slide Microscopy Image Flavors

LOCALIZER	Collected for the purpose of planning or navigating other images; provides frame-level navigational features.
VOLUME	Set of frames that define a regularly sampled volume
LABEL	Purpose of image is to capture the slide label only; non-label area shall not be present; the label is shown in Figure C.8-16.

OVERVIEW	Purpose of image is to provide an overview of the entire glass slide; shall include the label, the specimen and the empty space that are shown in Figure C.8-16. Note One purpose of the OVERVIEW image is to allow visual quality control to assure that tissue fragments have not been omitted when selecting areas (manually or automatically) to digitize at high resolution. The OVERVIEW image is distinct from the lowest resolution VOLUME image(s) of WSI pyramids.

Value 4 (Derived Pixel) shall have the Defined Terms specified in Table C.8.12.4-3.

Table C.8.12.4-3. Whole Slide Microscopy Image Derived Pixels

NONE	No derivation of pixels (original)
RESAMPLED	Pixels were derived by down sampling a higher resolution image

No additional values shall be present.

C.8.12.4.1.2 Imaged Volume Width, Height, Depth

The full physical extent of the whole slide image target volume is described in the Attributes Imaged Volume Width (0048,0001), Imaged Volume Height (0048,0002), and Imaged Volume Depth (0048,0003). These values reflect the maximum extent in these dimensions. There is no requirement that this entire extent is actually encoded in frames of the Image SOP Instance, unless Dimension Organization Type (0020,9311) is present with a value of TILED_FULL.

The value of Imaged Volume Depth (0048,0003) shall not be 0. If only a single focal plane is imaged, the Imaged Volume Depth may be the optical depth of field as encoded in Slice Thickness (0018,0050) of the Pixel Measures Functional Group (see Section C.7.6.16.2.1).

C.8.12.4.1.3 Total Pixel Matrix Columns, Rows, Focal Planes

Total Pixel Matrix Columns (0048,0006), Total Pixel Matrix Rows (0048,0007) and Total Pixel Matrix Focal Planes (0048,0303) describe the size of the entire imaged volume as a single extent across all frames (tiles).

The extent would be as described in these Attributes if the whole volume would be imaged and encoded as a non-sparse pixel matrix with the pixel spacing as specified in Pixel Spacing (0028,0030) of the Pixel Measures Functional Group (see Section C.7.6.16.2.1), such as when Dimension Organization Type (0020,9311) is present with a value of TILED_FULL.

C.8.12.4.1.4 Total Pixel Matrix Origin Sequence and Image Orientation (Slide)

Total Pixel Matrix Origin Sequence (0048,0008) specifies the location of the top leftmost pixel of the pixel matrix, and Image Orientation (Slide) (0048,0102) specifies the direction cosines of the first row and the first column of the pixel matrix, both with respect to the Slide Coordinate System Frame of Reference (see Section C.8.12.2). Although the image acquisition may vary the true row and column orientation at the pixel scale to account for local variation in the physical specimen, this Attribute describes the orientation as if the Pixel Matrix were flat.

Note

Typically, Image Orientation (Slide) will describe only a planar rotation, as the image plane is usually nominally parallel to the slide surface.

C.8.12.4.1.5 Photometric Interpretation and Samples Per Pixel

See Section C.7.6.3.1.2.

Enumerated Values for Photometric Interpretation (0028,0004):

MONOCHROME2
RGB
YBR_FULL_422
YBR_ICT

YBR_RCT

The value shall be appropriate to the compression Transfer Syntax used, if any, and shall be MONOCHROME2 or RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT or RGB for irreversible JPEG 2000 Transfer Syntaxes, YBR_RCT or RGB for reversible JPEG 2000 Transfer Syntaxes, and YBR_FULL_422 or RGB for JPEG lossy compressed Transfer Syntaxes.

Note

1. Future lossless and lossy Transfer Syntaxes may lead to the need for new definitions and choices for Photometric Interpretation. The Enumerated Values may therefore be extended with additional Photometric Interpretation values directly associated with new Transfer Syntaxes that are negotiated, and hence do not render existing implementations non-conformant.

2. Motion compression Transfer Syntaxes are not expected to be used for Whole Slide Imaging, so the use of YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264 and HEVC/H.265 Transfer Syntaxes is not permitted.

3. The use of RGB with JPEG and JPEG 2000 is only intended to allow for conversion to DICOM of images from proprietary formats for which no color transformation from RGB to YBR was performed and the encoded components really are RGB. The value of Photometric Interpretation (0028,0004) describes what is actually encoded, so a value of RGB is not used when the compressed components are actually YBR.

Multi-spectral images may be encoded as a single wavelength band (color) in each frame using MONOCHROME2, or with up to three bands in each frame using one of the color Photometric Interpretations.

Enumerated Values for Samples per Pixel (0028,0002) when Photometric Interpretation (0028,0004) is MONOCHROME2:

1

Enumerated Values for Samples per Pixel (0028,0002) when Photometric Interpretation (0028,0004) is not MONOCHROME2:

3

C.8.12.5 Optical Path Module

Table C.8.12.5-1 specifies the Attributes of the optical paths used in the VL imaging. Each optical path is a combination of illumination, filters, lenses, and sensors, and each combination is identified for possible reference by Attributes in other Modules. Additional optical path parameters may be specified in the Acquisition Context Module.

Table C.8.12.5-1. Optical Path Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Optical Paths	(0048,0302)	1C	Number of Items in the Optical Path Sequence (0048,0105). Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Optical Path Sequence	(0048,0105)	1	Describes the optical paths used during the acquisition of this image. One or more Items shall be included in this Sequence. See Section C.8.12.5.1.1
>Optical Path Identifier	(0048,0106)	1	Identifier for the optical path specified in the Sequence Item. The identifier shall be unique for each Item within the Optical Path Sequence.
>Optical Path Description	(0048,0107)	3	Description of the optical path specified in the Sequence Item.
>Illuminator Type Code Sequence	(0048,0100)	3	Type of illuminator. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*CID may be defined in the IOD constraints.*

Attribute Name	Tag	Type	Attribute Description
>Illumination Wave Length	(0022,0055)	1C	Nominal wavelength of the illuminator in nm. Required if Illumination Color Code Sequence (0048,ee08) is not present. May be present otherwise.
>Illumination Color Code Sequence	(0048,0108)	1C	Color of the illuminator. Only a single Item shall be included in this Sequence. Required if Illumination Wave Length (0022,0055) is not present. May be present otherwise.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Illumination Type Code Sequence	(0022,0016)	1	Coded value for illumination method. See Section C.8.12.5.1.2. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Light Path Filter Type Stack Code Sequence	(0022,0017)	3	Filters used in the light source (excitation) path. One or more Items are permitted in this Sequence. See Section C.8.12.5.1.3.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Light Path Filter Pass-Through Wavelength	(0022,0001)	3	Nominal pass-through wavelength of light path filter(s) in nm
>Light Path Filter Pass Band	(0022,0002)	3	Pass band of light path filter(s) in nm. This Attribute has two Values. The first is the shorter and the second the longer wavelength relative to the peak. The values are for the - 3dB nominal (1/2 of peak) pass through intensity. One of the two Values may be zero length, in which case it is a cutoff filter.
>Image Path Filter Type Stack Code Sequence	(0022,0018)	3	Describes stack of filters used in image (emission) path between the imaging target and the optical sensor. One or more Items are permitted in this Sequence. See Section C.8.12.5.1.3.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Image Path Filter Pass-Through Wavelength	(0022,0003)	3	Nominal pass-through wavelength of image path filter(s) in nm
>Image Path Filter Pass Band	(0022,0004)	3	Pass band of image path filter(s) in nm. This Attribute has two Values. The first is the shorter and the second the longer wavelength relative to the peak. The values are for the - 3dB nominal (1/2 of peak) pass through intensity. One of the two Values may be zero length, in which case it is a cutoff filter
>Lenses Code Sequence	(0022,0019)	3	Lenses that were used in this optical path. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Condenser Lens Power	(0048,0111)	3	Nominal power of the condenser lens
>Objective Lens Power	(0048,0112)	3	Nominal power of the objective lens. If a single lens is used as both condenser and objective, its power is specified in this Attribute.

Attribute Name	Tag	Type	Attribute Description
>Objective Lens Numerical Aperture	(0048,0113)	3	Nominal numerical aperture of the objective lens.
>Channel Description Code Sequence	(0022,001A)	1C	Describes the light color sensed for each channel to generate the image. Required if this differs from the natural interpretation. Note 1. For MONOCHROME2, the natural interpretation is the full visible light spectrum. A full spectrum sensor may be presented with light of only a single color based on illumination and filters. 2. Equipment may use a color Photometric Interpretation (RGB, YBR) as a container representing up to 3 channels of any detected wavelength. Shall have the same number of Items as the value of Samples per Pixel Used (0028,0003) if present, or otherwise the value of Samples per Pixel (0028,0002). The channels shall be described in the order in which the channels are encoded.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID may be defined in the IOD constraints.*
>Palette Color Lookup Table Sequence	(0048,0120)	3	For MONOCHROME2 images, provides a transform of the pixel values with this optical path into an RGB color representation. The LUT provides a mapping to an appropriate color or pseudo-color for display purposes. Only a single Item is permitted in this Sequence.
>>Include Table C.7-22a "Palette Color Lookup Table Macro Attributes"			
>ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent stored pixel values into PCS-Values. See Section C.8.12.5.1.4 Required if Photometric Interpretation (0028,0004) is not MONOCHROME2, or if Palette Color Lookup Table Sequence (0048,0120) is present.
>Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.8.12.5.1 Optical Path Attribute Descriptions

C.8.12.5.1.1 Optical Path Sequence and Optical Path Identifier

The Optical Path Sequence (0048,0105) shall include an Item for every optical path used in the acquisition of the current image.

For single-frame images that do not include the Multi-frame Functional Groups Module, this Sequence shall include only one Item.

For images that use the Multi-frame Functional Groups Module, the optical path associated with each frame is identified by reference to the Optical Path Identifier (0048,0106) of this Sequence (see Optical Path Identification Sequence (0048,0207) in Section C.8.12.6.2). The Optical Path Sequence may include Items for defined optical paths that are not referenced by any frame.

For Whole Slide Microscopy Image LOCALIZER images (see Section C.8.12.4.1.1 and Section C.8.12.7), all the optical paths associated with referenced images shall be described in Items of this Optical Path Sequence. The optical path associated with each referenced frame is identified in the Referenced Image Navigation Sequence (0048,0200) by reference to an Optical Path Identifier (0048,0106) of this Sequence. The Optical Path Identifiers used in the LOCALIZER image do not have to be identical to those used in the referenced images.

Note

1. For example, each of four referenced images may use a different optical path (color), and within each of those image SOP Instances the single Optical Path Sequence (0048,0105) Item is identified as "1", although the meaning of optical path "1" is different for each image. The LOCALIZER, however, must include all four optical paths with distinct identifiers "1", "2", "3", and "4".

2. The Optical Path Identifier is not necessarily numeric; it is a string of up to 16 characters (VR SH).

C.8.12.5.1.2 Illumination Type Code Sequence

Illumination Type Code Sequence (0022,0016) specifies the type of illumination of the imaging target. This Attribute may include multiple Items, as some techniques may involve multiple methods, or some method identifiers may not be completely descriptive.

Note

For example, this Sequence might include two Items, (111741, DCM, "Transmission illumination") and (111748, DCM, "Differential interference contrast") to indicate "Transmission DIC".

The type of illumination often prescribes the set of optical path components such as filters and prisms, and their arrangement in the optical path.

Note

For instance, phase contrast illumination will utilize a condenser annulus and a phase contrast plate; this may be indicated by an Item (111747, DCM, "Phase contrast illumination") in this Attribute, but with no further specification in the filters and lenses identification Attributes.

C.8.12.5.1.3 Light Path and Image Path Filter Type Stack Code Sequences

In some optical imaging methods, e.g., epifluorescence, there may be a single light path with its associated imaging components that is used in both illumination/excitation of the imaging target and in the transmitted/emitted path to the imaging sensor. In this case, the optical components are to be specified in the Image Path Filter Type Stack Code Sequence (0022,0018).

C.8.12.5.1.4 ICC Profile

ICC Profile (0028,2000) provides the transform for mapping stored color pixel values into ICC standard color Profile Connection Space (PCS). For MONOCHROME2 pixels that have a preferred color rendering through the Palette Color Lookup Table Sequence (0048,0120), this Attribute provides a mapping of that preferred RGB color rendering into PCS. The ICC Profile shall follow the requirements specified in Section C.11.15.1.1.

C.8.12.6 Whole Slide Microscopy Image Functional Group Macros

The following sections contain Functional Group Macros specific to the VL Whole Slide Microscopy Image IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean "for all frames".

C.8.12.6.1 Plane Position (Slide) Macro

Table C.8.12.6.1-1 specifies the Attributes of the Plane Position (Slide) Functional Group Macro.

Table C.8.12.6.1-1. Plane Position (Slide) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Position (Slide) Sequence	(0048,021A)	1	Describes position of frame in the Total Pixel Matrix and in the Slide Coordinate System Frame of Reference. Only a single Item shall be included in this Sequence.
>Column Position In Total Image Pixel Matrix	(0048,021E)	1	The column position of the top left hand pixel of the frame in the Total Pixel Matrix (see Section C.8.12.4.1.1). The column position of the top left pixel of the Total Pixel Matrix is 1.
>Row Position In Total Image Pixel Matrix	(0048,021F)	1	The row position of the top left hand pixel of the frame in the Total Pixel Matrix (see Section C.8.12.4.1.1). The row position of the top left pixel of the Total Pixel Matrix is 1.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in mm from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in mm from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Z Offset in Slide Coordinate System	(0040,074A)	1	The Z offset in µm from the Origin of the Slide Coordinate System, nominally the surface of the glass slide substrate. See Figure C.8-17 Note Required even if only a single focal plane was acquired.

C.8.12.6.2 Optical Path Identification Macro

Table C.8.12.6.2-1 specifies the Attributes of the Optical Path Identification Functional Group Macro.

Table C.8.12.6.2-1. Optical Path Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Optical Path Identification Sequence	(0048,0207)	1	Identifies the optical path characteristics of this frame. Only a single Item shall be included in this Sequence.
>Optical Path Identifier	(0048,0106)	1	Uniquely identifies the path described in the Optical Path Sequence (0048,0105) by reference to an Item with the same Optical Path Identifier (0048,0106) value. See Section C.8.12.5.

C.8.12.6.3 Specimen Reference Macro

Table C.8.12.6.3-1 specifies the Attributes of the Specimen Reference Functional Group Macro. This allows association of the frame with specific specimens imaged on the same slide (e.g., tissue micro-arrays).

Table C.8.12.6.3-1. Specimen Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Specimen Reference Sequence	(0048,0110)	2	Identifies specimens that may be visible in this frame, and are fully identified in the Specimen Description Sequence (0040,0560). Zero or more Items shall be included in this Sequence.
>Specimen UID	(0040,0554)	1	Unique Identifier for Specimen. See Section C.7.6.22.1.2.

C.8.12.7 Multi-Resolution Navigation Module

Table C.8.12.7-1 specifies the Attributes that describe the Multi-Resolution Navigation Module, used in Whole Slide Microscopy LOCALIZER images.

Table C.8.12.7-1. Multi-Resolution Navigation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Image Navigation Sequence	(0048,0200)	1	Identification of correspondence between areas of Pixel Data (07FE,0010) and frames of higher resolution images. One or more Items shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			*Referenced Image Instance*
>Referenced Frame Number	(0008,1160)	1	Referenced Frame Number within Referenced Image. Only a single value shall be present.
>Top Left Hand Corner of Localizer Area	(0048,0201)	1	Top Left Hand Corner of Localizer image pixel area corresponding to referenced frame, specified as column\row. Column is the horizontal offset and row is the vertical offset.
>Bottom Right Hand Corner of Localizer Area	(0048,0202)	1	Bottom Right Hand Corner of Localizer image pixel area corresponding to referenced frame, specified as column\row. Column is the horizontal offset and row is the vertical offset.
>Pixel Spacing	(0028,0030)	1	Pixel Spacing in Referenced Image, specified as a numeric pair - adjacent row spacing \ adjacent column spacing, in mm.
>Z Offset in Slide Coordinate System	(0040,074A)	1	The Z offset of the referenced frame from the Slide Coordinates System reference plane, in microns
>Samples per Pixel	(0028,0002)	1	The number of samples (color planes) containing information in the referenced image.
>Optical Path Identifier	(0048,0106)	1	Identifies the optical path used in acquiring the referenced Frame by reference to an Item in the Optical Path Sequence (0048,0105) of the current SOP Instance. See Section C.8.12.5.

C.8.12.8 Slide Label Module

Table C.8.12.8-1 specifies the Attributes that describe the interpretation of a scanned Slide Label.

Table C.8.12.8-1. Slide Label Module Attributes

Attribute Name	Tag	Type	Attribute Description
Barcode Value	(2200,0005)	2	Barcode interpreted from the scanned slide label. Note This may be the same as Container Identifier (0040,0512).
Label Text	(2200,0002)	2	Label text interpreted from the scanned slide label, e.g., by optical character recognition.

C.8.12.9 Whole Slide Microscopy Image Frame Type Macro

Table C.8.12.9-1 specifies the Attributes of the Whole Slide Microscopy Image Frame Type Functional Group Macro.

Table C.8.12.9-1. Whole Slide Microscopy Image Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Whole Slide Microscopy Image Frame Type Sequence	(0040,0710)	1	Identifies the characteristics of this Whole Slide Microscopy Image frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008). See Section C.8.12.4.1.

C.8.12.10 VL Photographic Equipment Module

Table C.8.12.10-1 specifies the Attributes that identify and describe a photographic device such as a camera.

Table C.8.12.10-1. VL Photographic Equipment Module Attributes

Attribute Name	Tag	Type	Attribute Description
Camera Owner Name	(0016,004D)	3	The owner of the photographic equipment.
Lens Specification	(0016,004E)	3	The minimum focal length, maximum focal length, minimum F number in the minimum focal length, and minimum F number in the maximum focal length for the lens that was used.
Lens Make	(0016,004F)	3	The lens manufacturer.
Lens Model	(0016,0050)	3	The lens's model name and model number.
Lens Serial Number	(0016,0051)	3	The serial number of the lens that was used.

C.8.12.11 VL Photographic Acquisition Module

Table C.8.12.11-1 specifies the Attributes that describe the process of acquisition of a photographic image.

Table C.8.12.11-1. VL Photographic Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
White Point	(0016,0001)	3	The chromaticity of the white point of the image. This is the chromaticity when each of the primaries has its reference white value. The value is described using the 1931 CIE xy chromaticity diagram.
Primary Chromaticities	(0016,0002)	3	The chromaticity of the three primary colors of the image. This is the chromaticity for each of the primaries when it has its reference white value and the other primaries have their reference black values. These values are described using the 1931 CIE xy chromaticity diagram.
Battery Level	(0016,0003)	3	A description of the camera’s battery level at the time of image capture, encoded as a decimal, ratio, or text string.
Exposure Time in Seconds	(0016,0004)	3	Exposure time in seconds.

Attribute Name	Tag	Type	Attribute Description
F-Number	(0016,0005)	3	The f-number. Note 1. The nomenclature for representing the f-number varies in the literature. The capitalized hyphenated form is used here to be consistent with the pattern used for other DICOM Attribute names. 2. The f-number is defined as the ratio of the focal length to the diameter of the entrance pupil.
OECF Rows	(0016,0006)	3	The number of rows in the Opto-Electronic Conversion Function (OECF), as specified in [ISO 14524].
OECF Columns	(0016,0007)	3	The number of columns in the Opto-Electronic Conversion Function (OECF), as specified in [ISO 14524].
OECF Column Names	(0016,0008)	3	The names of the columns in the Opto-Electronic Conversion Function (OECF), as specified in [ISO 14524].
OECF Values	(0016,0009)	3	The values of the Opto-Electronic Conversion Function (OECF), as specified in [ISO 14524], encoded as successive column values of the first row, then as successive column values of each successive row.
Spatial Frequency Response Rows	(0016,000A)	3	The number of rows in the Spatial Frequency Response (SRF) table as specified in [ISO 12233].
Spatial Frequency Response Columns	(0016,000B)	3	The number of columns in the Spatial Frequency Response (SRF) table as specified in [ISO 12233].
Spatial Frequency Response Column Names	(0016,000C)	3	The names of the columns in the Spatial Frequency Response (SRF) table as specified in [ISO 12233].
Spatial Frequency Response Values	(0016,000D)	3	The values of the Spatial Frequency Response (SRF) table as specified in [ISO 12233], encoded as successive column values of the first row, then as successive column values of each successive row.
Color Filter Array Pattern Rows	(0016,000E)	3	The number of rows in the color filter array (CFA) geometric pattern.
Color Filter Array Pattern Columns	(0016,000F)	3	The number of columns in the ~~the~~ color filter array (CFA) geometric pattern.
Color Filter Array Pattern Values	(0016,0010)	3	The values of the color filter array (CFA) geometric pattern of the image sensor when a one-chip color area sensor is used, encoded as successive column values of the first row, then as successive column values of each successive row.
Exposure Program	(0016,0016)	3	The class of the program used by the camera to set exposure. Defined Terms: **0** Not defined **1** Manual **2** Normal program **3** Aperture priority **4** Shutter priority **5** Creative program (biased toward depth of field) **6** Action program (biased toward fast shutter speed) **7** Portrait mode (for closeup photos with the background out of focus) **8** Landscape mode (for landscape photos with the background in focus)

Attribute Name	Tag	Type	Attribute Description
Spectral Sensitivity	(0016,0017)	3	The spectral sensitivity of each channel of the camera used. The value is an ASCII string compatible with the standard developed by the ASTM Technical Committee.
Photographic Sensitivity	(0016,0018)	3	The sensitivity of the camera or input device, as specified by the [ISO 12232] parameter selected by Sensitivity Type (0016,001A).
Sensitivity Type	(0016,001A)	3	Which of the parameters of [ISO 12232] is used in Photographic Sensitivity (0016,0018). Defined Terms: **0** Unknown **1** Standard output sensitivity (SOS) **2** Recommended exposure index (REI) **3** ISO speed **4** Standard output sensitivity (SOS) and recommended exposure index (REI) **5** Standard output sensitivity (SOS) and ISO speed **6** Recommended exposure index (REI) and ISO speed **7** Standard output sensitivity (SOS) and recommended exposure index (REI) and ISO speed
Standard Output Sensitivity	(0016,001B)	3	The standard output sensitivity value of a camera or input device defined in [ISO 12232].
Recommended Exposure Index	(0016,001C)	3	The recommended exposure index value of a camera or input device defined in [ISO 12232].
ISO Speed	(0016,001D)	3	The ISO speed value of a camera or input device that is defined in [ISO 12232].
ISO Speed Latitude yyy	(0016,001E)	3	The ISO speed latitude yyy value of a camera or input device that is defined in [ISO 12232].
ISO Speed Latitude zzz	(0016,001F)	3	The ISO speed latitude zzz value of a camera or input device that is defined in [ISO 12232].
EXIF Version	(0016,0020)	3	The version of the EXIF standard.
Shutter Speed Value	(0016,0021)	3	The shutter speed. The unit is the APEX value.
Aperture Value	(0016,0022)	3	The lens aperture. The unit is the APEX value.
Brightness Value	(0016,0023)	3	The value of brightness. The unit is the APEX value.
Exposure Bias Value	(0016,0024)	3	The exposure bias. The unit is the APEX value.
Max Aperture Value	(0016,0025)	3	The smallest F number of the lens. The unit is the APEX value.
Subject Distance	(0016,0026)	3	The distance to the subject in meters.
Metering Mode	(0016,0027)	3	The metering mode. Defined Terms: **0** unknown **1** Average **2** CenterWeightedAverage **3** Spot **4** MultiSpot **5** Pattern **6** Partial **255** other

Attribute Name	Tag	Type	Attribute Description
Light Source	(0016,0028)	3	The kind of light source. Defined Terms: **0** unknown **1** Daylight **2** Fluorescent **3** Tungsten (incandescent light) **4** Flash **9** Fine weather **10** Cloudy weather **11** Shade **12** Daylight fluorescent (D 5700 - 7100K) **13** Day white fluorescent (N 4600 - 5500K) **14** Cool white fluorescent (W 3800 - 4500K) **15** White fluorescent (WW 3250 - 3800K) **16** Warm white fluorescent (L 2600 - 3250K) **17** Standard light A **18** Standard light B **19** Standard light C **20** D55 **21** D65 **22** D75 **23** D50 **24** ISO studio tungsten **255** other light source
Flash Firing Status	(0016,0011)	3	The status of firing of the flash (strobe light). Defined Terms: **0** Flash did not fire **1** Flash fired
Flash Return Status	(0016,0012)	3	The detection of returned light from firing of the flash (strobe light). Defined Terms: **0** No strobe return detection function **1** Reserved **2** Strobe return light not detected **3** Strobe return light detected
Flash Mode	(0016,0013)	3	The camera's flash (strobe light) mode. Defined Terms: **0** Unknown **1** Compulsory flash firing **2** Compulsory flash suppression **3** Auto mode

Attribute Name	Tag	Type	Attribute Description
Flash Function Present	(0016,0014)	3	Whether or not the camera has a flash function flash (strobe light). Defined Terms: **0** Flash function present **1** No flash function
Flash Red Eye Mode	(0016,0015)	3	Whether or not the camera supports red-eye reduction. Defined Terms: **0** No red-eye reduction mode or unknown **1** Red-eye reduction supported
Focal Length	(0016,0029)	3	The actual focal length of the lens, in mm.
Subject Area	(0016,002A)	3	The location and area of the main subject in the overall scene. If two values are present, they are the X and Y image-relative coordinates of a location. If three values are present, they are the X and Y image-relative center coordinates and the diameter in pixels of a circle. If four values are present, they are the ~~the~~ center X image-relative coordinate, the center Y image-relative coordinate, the width in pixels, and the height in pixels of a rectangle. The coordinate values, width, and height are expressed in relation to the upper left as origin.
Maker Note	(0016,002B)	3	Any desired information. The contents are up to the manufacturer.
Temperature	(0016,0030)	3	The ambient temperature at the time of acquisition, in °C.
Humidity	(0016,0031)	3	The ambient humidity at the time of acquisition, in %.
Pressure	(0016,0032)	3	The ambient pressure at the time of acquisition, in hPa.
Water Depth	(0016,0033)	3	The water depth at the time of acquisition, in m. When the value is negative, the absolute value of it indicates the height (elevation) above the water level.
Acceleration	(0016,0034)	3	The acceleration as a scalar, regardless of direction, at the time of acquisition, in mGal (10-5 m/s2).
Camera Elevation Angle	(0016,0035)	3	The elevation/depression (angle of the orientation of the camera, imaging optical axis) in degrees from -180 to less than 180, at the time of acquisition.
Flash Energy	(0016,0036)	3	The amount of flash (strobe) energy at the time the image is captured, in Beam Candle Power Seconds (BCPS). A single value if the exact flash energy is known, otherwise two values, the minimum value and the maximum value.
Subject Location	(0016,0037)	3	The location of the main subject in the scene. The value of this tag represents the pixel at the center of the main subject relative to the upper left corner. The first value indicates the X column number and second indicates the Y row number.
Photographic Exposure Index	(0016,0038)	3	The exposure index selected on the camera or input device at the time the image is captured.

Attribute Name	Tag	Type	Attribute Description
Sensing Method	(0016,0039)	3	The image sensor type on the camera or input device. Defined Terms: **1** Not defined **2** One-chip color area sensor **3** Two-chip color area sensor **4** Three-chip color area sensor **5** Color sequential area sensor **7** Trilinear sensor **8** Color sequential linear sensor
File Source	(0016,003A)	3	The image source. Defined Terms: **0** others **1** scanner of transparent type **2** scanner of reflex type **3** digital still camera (DSC)
Scene Type	(0016,003B)	3	The type of scene. Defined Terms: **1** A directly photographed image
Custom Rendered	(0016,0041)	3	Special processing that was used on image data. Defined Terms: **0** Normal process **1** Custom process
Exposure Mode	(0016,0042)	3	The exposure mode set when the image was shot. Defined Terms: **0** Auto exposure **1** Manual exposure **2** Auto bracket
White Balance	(0016,0043)	3	The white balance mode set when the image was shot. Defined Terms: **0** Auto white balance **1** Manual white balance
Digital Zoom Ratio	(0016,0044)	3	The digital zoom ratio when the image was shot.
Focal Length In 35mm Film	(0016,0045)	3	The equivalent focal length assuming a 35mm film camera, in mm.
Scene Capture Type	(0016,0046)	3	The type of scene that was shot. Defined Terms: **0** Standard **1** Landscape **2** Portrait **3** Night scene

Attribute Name	Tag	Type	Attribute Description
Gain Control	(0016,0047)	3	The degree of overall image gain adjustment. Defined Terms: **0** None **1** Low gain up **2** High gain up **3** Low gain down **4** High gain down
Contrast	(0016,0048)	3	The direction of contrast processing applied by the camera. Defined Terms: **0** Normal **1** Soft **2** Hard
Saturation	(0016,0049)	3	The direction of saturation processing applied by the camera. Defined Terms: **0** Normal **1** Low saturation **2** High saturation
Sharpness	(0016,004A)	3	The direction of sharpness processing applied by the camera. Defined Terms: **0** Normal **1** Soft **2** Hard
Device Setting Description	(0016,004B)	3	Information on the picture-taking conditions of a particular camera model, encoded as defined in [EXIF 2.31].
Subject Distance Range	(0016,004C)	3	The distance to the subject. Defined Terms: **0** unknown **1** Macro **2** Close view **3** Distant view
Self Timer Mode	(0016,0019)	3	The number of seconds the image capture was delayed from when the capture was initiated by the camera operator. If the value is zero, the self-timer is off.
Interoperability Index	(0016,0061)	3	Identification of the interoperability rule to which the image conforms. Defined Terms: **R98** Indicates a file conforming to R98 file specification of Recommended Exif Interoperability Rules (Exif R 98) or to DCF basic file stipulated by Design Rule for Camera File System. **THM** Indicates a file conforming to DCF thumbnail file stipulated by Design rule for Camera File System. **R03** Indicates a file conforming to DCF Option File stipulated by Design rule for Camera File System.

Attribute Name	Tag	Type	Attribute Description
Interoperability Version	(0016,0062)	3	The version interoperability rule to which the image conforms.

C.8.12.12 VL Photographic Geolocation Module

Table C.8.12.12-1 specifies the Attributes that describe the geographic location during acquisition of a photographic image.

Table C.8.12.12-1. VL Photographic Geolocation Module Attributes

Attribute Name	Tag	Type	Attribute Description
GPS Version ID	(0016,0070)	3	The version of GPS information.
GPS Latitude Ref	(0016,0071)	3	Whether the latitude is north or south latitude. Enumerated Values: **N** north latitude **S** south latitude
GPS Latitude	(0016,0072)	3	The latitude, expressed as three non-negative values giving the degrees, minutes, and seconds, respectively.
GPS Longitude Ref	(0016,0073)	3	Whether the longitude is east or west longitude. Enumerated Values: **E** east longitude **W** west longitude
GPS Longitude	(0016,0074)	3	The longitude, expressed as three non-negative values giving the degrees, minutes, and seconds, respectively.
GPS Altitude Ref	(0016,0075)	3	The altitude used as the reference altitude in meters. If the reference is sea level and the altitude is above sea level, 0 is given. If the altitude is below sea level, a value of 1 is given and the altitude is indicated as an absolute value in GPS Altitude (0016,0076).
GPS Altitude	(0016,0076)	3	The altitude based on the reference in GPS Altitude Ref (0016,0075), in meters.
GPS Time Stamp	(0016,0077)	3	The time as UTC (Coordinated Universal Time).
GPS Satellites	(0016,0078)	3	The GPS satellites used for measurements. This tag can be used to describe the number of satellites, their ID number, angle of elevation, azimuth, SNR and other information. The format is not specified.
GPS Status	(0016,0079)	3	The status of the GPS receiver when the image is recorded. Enumerated Values: **A** measurement is in progress **V** measurement interrupted
GPS Measure Mode	(0016,007A)	3	The GPS measurement mode. Enumerated Values: **2** two-dimensional **3** three-dimensional

Attribute Name	Tag	Type	Attribute Description
GPS DOP	(0016,007B)	3	The GPS data degree (dilution) of precision. A horizontal dilution of precision (HDOP) value is written during two-dimensional measurement, and position (3D) dilution of precision (PDOP) during three-dimensional measurement.
GPS Speed Ref	(0016,007C)	3	The unit used to express the GPS Speed (0016,007D). Enumerated Values: **K** kilometers per hour **M** miles per hour **N** knots
GPS Speed	(0016,007D)	3	The speed of GPS receiver movement in GPS Speed Ref (0016,007C) units.
GPS Track Ref	(0016,007E)	3	The reference for giving the direction of GPS receiver movement. Enumerated Values: **T** true direction **M** magnetic direction
GPS Track	(0016,007F)	3	The direction of GPS receiver movement in degrees. The range of values is from 0.00 to 359.99.
GPS Img Direction Ref	(0016,0080)	3	The reference for giving the direction of the image when it is captured. Enumerated Values: **T** true direction **M** magnetic direction
GPS Img Direction	(0016,0081)	3	The direction of the image when it was captured. The range of values is from 0.00 to 359.99.
GPS Map Datum	(0016,0082)	3	The geodetic survey data used by the GPS receiver.
GPS Dest Latitude Ref	(0016,0083)	3	Whether the latitude of the destination point is north or south latitude. Enumerated Values: **N** north latitude **S** south latitude
GPS Dest Latitude	(0016,0084)	3	The latitude of the destination point. The latitude is expressed as three values giving the degrees, minutes, and seconds, respectively.
GPS Dest Longitude Ref	(0016,0085)	3	Whether the longitude of the destination point is east or west longitude. Enumerated Values: **E** east longitude **W** west longitude

Attribute Name	Tag	Type	Attribute Description
GPS Dest Longitude	(0016,0086)	3	The longitude of the destination point. The longitude is expressed as three values giving the degrees, minutes, and seconds, respectively.
GPS Dest Bearing Ref	(0016,0087)	3	Indicates the reference used for giving the bearing to the destination point. Enumerated Values: **T** true direction **M** magnetic direction
GPS Dest Bearing	(0016,0088)	3	The bearing to the destination point in degrees. The range of values is from 0.00 to 359.99.
GPS Dest Distance Ref	(0016,0089)	3	The unit used to express the distance to the destination point. Enumerated Values: **K** kilometers **M** miles **N** nautical miles
GPS Dest Distance	(0016,008A)	3	The distance to the destination point in GPS Dest Distance Ref (0016,0089) units.
GPS Processing Method	(0016,008B)	3	The name of the method used for location finding.
GPS Area Information	(0016,008C)	3	The name of the GPS area.
GPS Date Stamp	(0016,008D)	3	The date and time information relative to UTC (Coordinated Universal Time).
GPS Differential	(0016,008E)	3	Whether differential correction is applied to the GPS receiver.

C.8.13 Enhanced MR Image

This section describes the specific Modules for the Enhanced MR Image IOD.

C.8.13.1 Enhanced MR Image Module

This section describes the Enhanced MR Image Module.

Table C.8-79 specifies the Attributes of the Enhanced MR Image Module.

Table C.8-79. Enhanced MR Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-83 “MR Image and Spectroscopy Instance Macro Attributes”			
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.16.1 and Section C.8.13.1.1.1.
Include Table C.8-131 “Common CT/MR Image Description Macro Attributes”			
Include Table C.8-84 “MR Image Description Macro Attributes”			
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. For Enumerated Values See Section C.8.13.1.1.2.

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values are specified in the IOD that invokes this Module. See Section C.7.6.3.1.2 for definition of this term.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. For Enumerated Values See Section C.8.13.1.1.2.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. For Enumerated Values See Section C.8.13.1.1.2.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. For Enumerated Values See Section C.8.13.1.1.2
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.7.6.3.1.3 and Section C.8.13.1.1.2 for further explanation.
Burned In Annotation	(0028,0301)	1C	Indicates whether or not the image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO** This means that images that contain this Module shall not contain such burned in annotations. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted), may be present otherwise.
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values. Required if Photometric Interpretation (0028,0004) is MONOCHROME2.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6.*
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			

C.8.13.1.1 Enhanced MR Image Module Attribute Description

C.8.13.1.1.1 Image Type and Frame Type

Image Type (0008,0008) and Frame Type (0008,9007) are not included in this Macro but one or the other is always included in the Module or Macro that invokes this Macro, and they are therefore described here.

In addition to the requirements specified in Section C.8.16.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

C.8.13.1.1.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.13.1.1.1.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.13.1.1.1.3 Image Flavor

Table C.8-80 specifies the Defined Terms for MR additional to those defined in Section C.8.16.1.3 for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-80. MR-Specific Image Type and Frame Type Value 3

Defined Term Name	Defined Term Description
ANGIO_TIME	Angio time acquisition (peripheral vascular/carotid)

Defined Term Name	Defined Term Description
ASL	Arterial Spin Labeling
CINE	Cardiac CINE
DIFFUSION	Collected to show diffusion effects.
DIXON	Dixon Water Fat Imaging Techniques.
FLOW_ENCODED	Flow Encoded
FLUID_ATTENUATED	Fluid Attenuated T2 weighted
FMRI	Collected for functional imaging calculations.
MAX_IP	Maximum Intensity Projection
MIN_IP	Minimum Intensity Projection
M_MODE	Image line over time
METABOLITE_MAP	Metabolite Maps from spectroscopy data
MULTIECHO	Multiple echoes with different contrast weighting (e.g., proton density and T2 weighted)
PROTON_DENSITY	Proton density weighted
REALTIME	Real-time collection of single slices
STIR	Short Tau Inversion Recovery
TAGGING	Images with superposition of thin saturation bands
TEMPERATURE	Images record temperature
T1	T1 weighted
T2	T2 weighted
T2_STAR	T2* weighted
TOF	Time Of Flight weighted
VELOCITY	Velocity encoded

C.8.13.1.1.1.4 Derived Pixel Contrast

Table C.8-81 specifies the Defined Terms for MR additional to those defined in Section C.8.16.1.4 for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-81. MR-Specific Image Type and Frame Type Value 4

Defined Term Name	Defined Term Description

Note

This table formerly contained defined terms such as ADC, etc. These have been replaced with the use of QUANTITY and the appropriate coded entry used in Quantity Definition Sequence (0040,9220) of the Real World Value Mapping Functional Group Macro. For former defined terms, see PS3.3 2018c.

C.8.13.1.1.2 Photometric Interpretation, Pixel Representation, Samples Per Pixel, Planar Configuration, Bits Allocated and Bits Stored

Table C.8-82 specifies the Enumerated Values and allowed combinations of Samples per Pixel (0028,0002), Planar Configuration (0028,0006), Pixel Representation (0028,0103), Bits Allocated (0028,0100) and Bits Stored (0028,0101) for each allowable Photometric Interpretation allowed by the IOD that invokes this Module.

Table C.8-82. Allowed Combinations of Attribute Values for Photometric Interpretation, Samples Per Pixel, Planar Configuration, Pixel Representation, Bits Allocated and Bits Stored

Photometric Interpretation	Samples per Pixel	Planar Configuration	Pixel Representation	Bits Allocated	Bits Stored
MONOCHROME2	1	-	0 or 1	8	8
MONOCHROME2	1	-	0 or 1	16	12, 16
RGB	3	0	0	8	8
YBR_ICT	3	0	0	8	8
YBR_RCT	3	0	0	8	8
YBR_PARTIAL_420	3	0	0	8	8
YBR_FULL_422	3	0	0	8	8
YBR_FULL	3	0	0	8	8

C.8.13.1.1.3 Pixel Presentation

See Section C.8.16.2.1.1. No additional requirements or Defined Terms.

C.8.13.1.1.3.1 Supplemental Palette Color LUTs

See Section C.8.16.2.1.1.1.

C.8.13.1.1.4 Volumetric Properties

See Section C.8.16.2.1.2. No additional requirements or Defined Terms.

C.8.13.1.1.5 Volume Based Calculation Technique

See Section C.8.16.2.1.3. No additional requirements or Defined Terms.

C.8.13.2 MR Image and Spectroscopy Instance Macro

Table C.8-83 specifies the common Attributes Enhanced MR Image Module and MR Spectroscopy Module.

Table C.8-83. MR Image and Spectroscopy Instance Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image. Note This number is not required to be unique across SOP Instances in a Series. See also the description of the Referenced Raw Data Sequence (0008,9121).
Acquisition DateTime	(0008,002A)	1C	The date and time that the acquisition of data started. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800). Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Acquisition Duration	(0018,9073)	1C	The time in seconds needed to run the prescribed pulse sequence. See Section C.7.6.16.2.2.1 for further explanation. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Referenced Raw Data Sequence	(0008,9121)	3	The Raw data that was used to derive this Image. One or more Items are permitted in this Sequence. Note The Items of in this Sequence may identify raw data that has not been stored or encoded as a DICOM object. This allows recognition that images and spectra in different Instances have been reconstructed from the same raw data.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Referenced Waveform Sequence	(0008,113A)	3	References to waveforms acquired in conjunction with this image. These Waveforms may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referred to inside the Referenced Image Sequences of this Enhanced MR Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Source Image Evidence Sequence	(0008,9154)	1C	Full set of Composite SOP Instances referred to inside the Source Image Sequences of this Enhanced MR Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Source Image Sequence (0008,2112) is present.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Referenced Presentation State Sequence	(0008,9237)	1C	References to Presentation State ~~Instances acquired in conjunction with this Instance.~~instances created together with this instance Note ~~May only be used to reference Presentation States belonging to the acquired data and not to~~This Sequence does not reference Presentation States generated ~~subsequently~~after image creation, such as during interpretation. One or more Items shall be included in this Sequence. Required if Presentation State is ~~generated during acquisition, shall not be present otherwise~~created together with the images.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Content Qualification	(0018,9004)	1C	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted), may be present otherwise.
Resonant Nucleus	(0018,9100)	1C	Nucleus that is resonant at the transmitter frequency. Defined Terms: **1H** **3HE** **7LI** **13C** **19F** **23NA** **31P** **129XE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
k-space Filtering	(0018,9064)	1C	Describes k-space filtering applied. Shall be NONE if no k-space filter. Defined Terms: **COSINE** **COSINE_SQUARED** **FERMI** **GAUSSIAN** **HAMMING** **HANNING** **LORENTZIAN** **LRNTZ_GSS_TRNSFM** **RIESZ** **TUKEY** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Magnetic Field Strength	(0018,0087)	1C	Nominal field strength of the MR Magnet, in Tesla. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Applicable Safety Standard Agency	(0018,9174)	1C	Agency that established MR safety standard applicable to the acquisition of this Instance. Defined Terms: **IEC** **FDA** **MHW** Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Applicable Safety Standard Description	(0018,9175)	3	Name and Version of the applicable standard.
Image Comments	(0020,4000)	3	User-defined comments about the image.
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
B1rms	(0018,1320)	3	B1+ rms value in units of micro_tesla (uT) for the acquisition producing the image. See [IEC 60601-2-33].

C.8.13.2.1 MR Image and Spectroscopy Instance Macro Attribute Description

C.8.13.2.1.1 Content Qualification

Content Qualification (0018,9004) shall have the value PRODUCT if the content (image or Spectroscopy data) was produced with approved hardware and software. It shall have the value RESEARCH or SERVICE if there is any doubt as to whether the content was produced with approved hardware and software.

If data with Content Qualification (0018,9004) of RESEARCH or SERVICE is used to derive other content then it is expected that this derived content will also have Content Qualification (0018,9004) set to RESEARCH or SERVICE.

The intent of this element is to allow annotation of an advisory message that indicates that this content may not be suitable for clinical interpretation.

C.8.13.2.1.2 Evidence Sequence Attributes

The intent of the Referenced Image Evidence Sequence (0008,9092) and Source Image Evidence Sequence (0008,9154) is to provide a list of all unique SOP Instances listed in the Referenced Image Sequence (0008,1140) and Source Image Sequence (0008,2112) Attributes respectively.

C.8.13.3 MR Image Description Macro

This section describes the MR Image Description Macro.

Table C.8-84 specifies the Attributes of the MR Image Description Macro.

Table C.8-84. MR Image Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Complex Image Component	(0008,9208)	1C	Representation of complex data of frames in the SOP Instance. See Section C.8.13.3.1.1 for a description and Defined Terms. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Acquisition Contrast	(0008,9209)	1C	Indication of acquisition contrast used with frames in the SOP Instance. See Section C.8.13.3.1.2 for a description and Defined Terms. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). May be present otherwise.
Functional Settling Phase Frames Present	(0018,9622)	3	Specifies if the acquisition used and stored settling phases. Enumerated Values: **YES** **NO**

C.8.13.3.1 MR Image Description Attribute Description

C.8.13.3.1.1 Complex Image Component

The value of Complex Image Component (0008,9208) Attribute shall be used to indicate which component of the complex representation of the signal is represented in the pixel data.

Table C.8-85 specifies the Defined Terms for Complex Image Component (0008,9208).

Table C.8-85. Complex Image Component Attribute Values

Defined Term Name	Defined Term Description
MAGNITUDE	The magnitude component of the complex image data.
PHASE	The phase component of the complex image data.
REAL	The real component of the complex image data.
IMAGINARY	The imaginary component of the complex image data.
MIXED	Used only as a value in Complex Image Component (0008,9208) in the Enhanced MR Image Module if frames within the image SOP Instance contain different values for the Complex Image Component Attribute in the MR Frame Type Functional Group.

C.8.13.3.1.2 Acquisition Contrast

Table C.8-86 specifies the Defined Terms for Acquisition Contrast (0008,9209).

Table C.8-86. Acquisition Contrast Values

Defined Term Name	Defined Term Description
DIFFUSION	Diffusion weighted contrast
FLOW_ENCODED	Flow Encoded contrast
FLUID_ATTENUATED	Fluid Attenuated T2 weighted contrast
PERFUSION	Perfusion weighted contrast
PROTON_DENSITY	Proton Density weighted contrast
STIR	Short Tau Inversion Recovery
TAGGING	Superposition of thin saturation bands onto image
T1	T1 weighted contrast
T2	T2 weighted contrast
T2_STAR	T2* weighted contrast
TOF	Time Of Flight weighted contrast
UNKNOWN	Value should be UNKNOWN if acquisition contrasts were combined resulting in an unknown contrast. Also this value should be used when the contrast is not known.
MIXED	Used only as a value in Acquisition Contrast (0008,9209) Attribute in the Enhanced MR Image Module Attribute Description if frames within the image SOP Instance contain different values for the Acquisition Contrast Attribute in the MR Frame Type Functional Group.

C.8.13.4 MR Pulse Sequence Module

The primary purpose of this Module is to identify the pulse sequence and variations on that, which was used in creation of the image. Terminology is intended to be neutral, and allow equivalent sequences provided by different vendors to be classified the same.

Table C.8-87 specifies the Attributes of the MR Pulse Sequence Module.

Table C.8-87. MR Pulse Sequence Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pulse Sequence Name	(0018,9005)	1C	Name of the pulse sequence for annotation purposes. Potentially vendor-specific name. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
MR Acquisition Type	(0018,0023)	1C	Identification of spatial data encoding scheme. Defined Terms: **1D** **2D** **3D** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Echo Pulse Sequence	(0018,9008)	1C	Echo category of pulse sequences. Enumerated Values: **SPIN** **GRADIENT** **BOTH** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Multiple Spin Echo	(0018,9011)	1C	Multiple Spin Echo category of pulse sequence used to collect different lines in k-space for a single frame. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Echo Pulse Sequence (0018,9008) equals SPIN or BOTH. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Echo Pulse Sequence (0018,9008) equals SPIN or BOTH.
Multi-planar Excitation	(0018,9012)	1C	Technique that simultaneously excites several volumes. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Phase Contrast	(0018,9014)	1C	Phase contrast pulse sequence is a pulse sequence in which the flowing spins are velocity encoded in phase. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Velocity Encoding Acquisition Sequence	(0018,9092)	1C	Velocity encoding directions used for acquisition. Required if Phase Contrast (0018,9014) equals YES. One or more Items shall be included in this Sequence.
>Velocity Encoding Direction	(0018,9090)	1	The direction cosines of the velocity encoding vector with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
Time of Flight Contrast	(0018,9015)	1C	Time of Flight contrast is created by the inflow of blood in the saturated plane. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Arterial Spin Labeling Contrast	(0018,9250)	1C	Arterial Spin Labeling contrast technique. Enumerated Values: **CONTINUOUS** a single long low powered RF pulse **PSEUDOCONTINUOUS** multiple short low powered RF pulses **PULSED** a single short high powered RF pulse Required if Image Type (0008,0008) Value 3 is ASL. May be present otherwise.
Steady State Pulse Sequence	(0018,9017)	1C	Steady State Sequence. Defined Terms: **FREE_PRECESSION** **TRANSVERSE** **TIME_REVERSED** **LONGITUDINAL** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Echo Planar Pulse Sequence	(0018,9018)	1C	Echo Planar category of Pulse Sequences. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Saturation Recovery	(0018,9024)	1C	Saturation recovery pulse sequence. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Spectrally Selected Suppression	(0018,9025)	1C	Spectrally Selected Suppression. Defined Terms: **FAT** **WATER** **FAT_AND_WATER** **SILICON_GEL** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Oversampling Phase	(0018,9029)	1C	Oversampling Phase. Enumerated Values: **2D** phase direction **3D** out of plane direction **2D_3D** both **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Geometry of k-Space Traversal	(0018,9032)	1C	Geometry category of k-Space traversal. Defined Terms: **RECTILINEAR** **RADIAL** **SPIRAL** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Rectilinear Phase Encode Reordering	(0018,9034)	1C	Rectilinear phase encode reordering. Defined Terms: **LINEAR** **CENTRIC** **SEGMENTED** **REVERSE_LINEAR** **REVERSE_CENTRIC** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR.
Segmented k-Space Traversal	(0018,9033)	1C	Segmented k-Space traversal. If Geometry of k-Space Traversal is rectilinear, multiple lines can be acquired at one time. If Geometry of k-Space Traversal is spiral or radial, paths can be interleaved and acquired at one time. Enumerated Values: **SINGLE** successive single echo coverage **PARTIAL** segmented coverage **FULL** single shot full coverage Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Coverage of k-Space	(0018,9094)	1C	Coverage of k-Space in the ky-kz plane. Defined Terms: **FULL** **CYLINDRICAL** **ELLIPSOIDAL** **WEIGHTED** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and MR Acquisition Type (0018,0023) equals 3D. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and MR Acquisition Type (0018,0023) equals 3D.
Number of k-Space Trajectories	(0018,9093)	1C	Number of interleaves or shots. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

C.8.13.5 Enhanced MR Image Functional Group Macros

The following sections contain Functional Group Macros specific to the Enhanced MR Image IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".".

C.8.13.5.1 MR Image Frame Type Macro

Table C.8-88 specifies the Attributes of the MR Image Frame Type Functional Group Macro.

Table C.8-88. MR Image Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Image Frame Type Sequence	(0018,9226)	1	Identifies the characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed unless the SOP Class UID is "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted). See Section C.8.16.1 and Section C.8.13.1.1.1.
>Include Table C.8-131 “Common CT/MR Image Description Macro Attributes”			
>Include Table C.8-84 “MR Image Description Macro Attributes”			

C.8.13.5.2 MR Timing and Related Parameters Macro

Table C.8-89 specifies the Attributes of the MR Timing and Related Parameters Functional Group Macro.

Table C.8-89. MR Timing and Related Parameters Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Timing and Related Parameters Sequence	(0018,9112)	1	Identifies the timing and safety information of this frame. Only a single Item shall be included in this Sequence.
>Repetition Time	(0018,0080)	1C	The time in ms between two successive excitations of the same volume. Shall be 0 (zero) if there is a single excitation per volume. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Flip Angle	(0018,1314)	1C	Steady state angle in degrees to which the magnetic vector is flipped from the magnetic vector of the primary field. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Echo Train Length	(0018,0091)	1C	Number of lines in k-space acquired per excitation of the same volume regardless of the type of echo or the number of frames derived from them. See Section C.8.13.5.2.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>RF Echo Train Length	(0018,9240)	1C	Number of RF echoes collected per RF shot (or excitation) per frame. A value of zero shall correspond to a pure gradient echo frame. Note that this value corresponds to the current frame. Several frames may be derived from the same shot. See Section C.8.13.5.2.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Gradient Echo Train Length	(0018,9241)	1C	Number of gradient echoes collected per RF echo per shot (or excitation) per frame. A value of zero shall correspond to a pure RF echo frame. If RF Echo Train Length (0018,9240) is non zero and Gradient Echo Train Length is as well then only the central echo will be an RF Spin Echo, all others will be gradient echoes. See Section C.8.13.5.2.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Specific Absorption Rate Sequence	(0018,9239)	1C	Sequence containing the methods of SAR calculation and the corresponding values. One or more Items shall be included in this Sequence. Required if the system is capable of calculating Specific Absorption Rate (0018,9181).
>>Specific Absorption Rate Definition	(0018,9179)	1	Specification of the method of SAR calculation as defined in Applicable Safety Standard Description (0018,9175). Defined Terms: **IEC_WHOLE_BODY** [IEC 60601-2-33] Clause 201.3.241 **IEC_PARTIAL_BODY** [IEC 60601-2-33] Clause 201.3.225 **IEC_HEAD** [IEC 60601-2-33] Clause 201.3.212 **IEC_LOCAL** [IEC 60601-2-33] Clause 201.3.216
>>Specific Absorption Rate Value	(0018,9181)	1	Specific Absorption Rate in W/kg.

Attribute Name	Tag	Type	Attribute Description
>Gradient Output Type	(0018,9180)	1C	Definition of gradient output unit, for which the value is stored in Gradient Output (0018,9182). Defined Terms: **DB_DT** in T/s **ELECTRIC_FIELD** in V/m **PER_NERVE_STIM** percentage of peripheral nerve stimulation Required if the system is capable of calculating Gradient Output (0018,9182).
>Gradient Output	(0018,9182)	1C	Unit is defined by Gradient Output Type (0018,9180). Required if the system is capable of calculating Gradient Output (0018,9182).
>Operating Mode Sequence	(0018,9176)	1C	Sequence of operating mode information relating to the Frame/SOP Instance as required to adhere to the Applicable Safety Standard Agency (0018,9174) regulations. One or more Items shall be included in this Sequence. Required if required by law or regulations. May be present otherwise.
>>Operating Mode Type	(0018,9177)	1	Defined Terms: **STATIC FIELD** **RF** **GRADIENT**
>>Operating Mode	(0018,9178)	1	Operating mode applicable for the defined by the applicable standard. Defined Terms: **IEC_NORMAL** [IEC 60601-2-33] Clause 201.3.224 **IEC_FIRST_LEVEL** [IEC 60601-2-33] Clause 201.3.208 **IEC_SECOND_LEVEL** [IEC 60601-2-33] Clause 201.3.231

C.8.13.5.2.1 RF Echo Train Length and Gradient Echo Train Length Attributes Usage

The three Echo Train Length Attributes all specify information related to the pulse sequence, one or more frames, and the echo type. The following examples illustrate their usage.

For a sequence with each excitation/shot producing 2 spin echoes that produce a line of k-Space for 2 different frames, the following values would be used for each frame:

Echo Train Length	2
Gradient Echo Train Length	0
RF Echo Train Length	1

For a sequence with each excitation/shot producing 2 gradient echoes that produce a line of k-Space for 2 different frames, the following values would be used:

Echo Train Length	2
Gradient Echo Train Length	1
RF Echo Train Length	0

For a sequence with each excitation/shot producing 8 spin echoes that produce 8 lines of k-Space for 1 frame, the following values would be used:

Echo Train Length	8

Gradient Echo Train Length	0
RF Echo Train Length	8

C.8.13.5.3 MR FOV/Geometry Macro

Table C.8-90 specifies the Attributes of the MR FOV/Geometry Functional Group Macro.

Table C.8-90. MR FOV/Geometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR FOV/Geometry Sequence	(0018,9125)	1	Identifies the geometry parameters of this frame. Only a single Item shall be included in this Sequence.
>In-plane Phase Encoding Direction	(0018,1312)	1C	The axes of the in-plane phase encoding with respect to the frame. Enumerated Values: **COLUMN** **ROW** **OTHER** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>MR Acquisition Frequency Encoding Steps	(0018,9058)	1C	Number of Frequency Encoding steps (kx) acquired Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>MR Acquisition Phase Encoding Steps in-plane	(0018,9231)	1C	Number of In-Plane Phase Encoding steps (ky) acquired Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>MR Acquisition Phase Encoding Steps out-of-plane	(0018,9232)	1C	Number of Out-of-Plane Phase Encoding steps (kz) acquired Required if MR Acquisition Type (0018,0023) equals 3D and Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Percent Sampling	(0018,0093)	1C	Fraction of acquisition matrix lines acquired, expressed as a percent. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Percent Phase Field of View	(0018,0094)	1C	Ratio of field of view dimension in phase direction to field of view dimension in frequency direction, expressed as a percent. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.13.5.4 MR Echo Macro

Table C.8-91 specifies the Attributes of the MR Echo Functional Group Macro.

Table C.8-91. MR Echo Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Echo Sequence	(0018,9114)	1	Identifies echo timing of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Effective Echo Time	(0018,9082)	1C	The time in ms between the middle of the excitation pulse and the peak of the echo produced for kx=0. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.13.5.5 MR Modifier Macro

Table C.8-92 specifies the Attributes of the MR Modifier Functional Group Macro.

Table C.8-92. MR Modifier Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Modifier Sequence	(0018,9115)	1	Identifies general acquisition parameters of this frame. Only a single Item shall be included in this Sequence.
>Inversion Recovery	(0018,9009)	1C	Inversion Recovery preparatory sequence. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Inversion Times	(0018,9079)	1C	Times in ms after the middle of inverting RF pulse to middle of excitation pulse to detect the amount of longitudinal magnetization. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Inversion Recovery (0018,9009) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Inversion Recovery (0018,9009) equals YES.
>Flow Compensation	(0018,9010)	1C	Flow Compensation. Defined Terms: **ACCELERATION** **VELOCITY** **OTHER** **NONE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Flow Compensation Direction	(0018,9183)	1C	Flow Compensation Direction. Enumerated Values: **PHASE** **FREQUENCY** **SLICE_SELECT** **SLICE_AND_FREQ** **SLICE_FREQ_PHASE** **PHASE_AND_FREQ** **SLICE_AND_PHASE** **OTHER** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Flow Compensation (0018,9010) equals other than NONE. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Flow Compensation (0018,9010) equals other than NONE.
>Spoiling	(0018,9016)	1C	Spoiling. Enumerated Values: **RF** RF spoiled **GRADIENT** gradient spoiled **RF_AND_GRADIENT** **NONE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Echo Pulse Sequence (0018,9008) equals GRADIENT or BOTH. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Echo Pulse Sequence (0018,9008) equals GRADIENT or BOTH.
>T2 Preparation	(0018,9021)	1C	T2 prepared Pulse Sequence. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Spectrally Selected Excitation	(0018,9026)	1C	Spectrally Selected Excitation. Enumerated Values: **WATER** water excitation **FAT** fat excitation **NONE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Spatial Pre-saturation	(0018,9027)	1C	Spatial Pre-saturation. Defined Terms: **SLAB** **NONE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Partial Fourier	(0018,9081)	1C	Partial Fourier. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Partial Fourier Direction	(0018,9036)	1C	Direction of Partial Fourier. Enumerated Values: **PHASE** **FREQUENCY** **SLICE_SELECT** **COMBINATION** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Partial Fourier (0018,9081) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Partial Fourier (0018,9081) equals YES.
>Parallel Acquisition	(0018,9077)	1C	Parallel acquisition has been used to reduce measurement time. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Parallel Acquisition Technique	(0018,9078)	1C	Parallel acquisition characteristics. Defined Terms: **PILS** **SENSE** **SMASH** **OTHER** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Parallel Acquisition (0018,9077) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Parallel Acquisition (0018,9077) equals YES.
>Parallel Reduction Factor In-plane	(0018,9069)	1C	Measurement time reduction factor expressed as ratio of original and reduced measurement time for the in-plane direction. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Parallel Acquisition (0018,9077) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Parallel Acquisition (0018,9077) equals YES.

Attribute Name	Tag	Type	Attribute Description
>Parallel Reduction Factor out-of-plane	(0018,9155)	1C	Measurement time reduction factor expressed as ratio of original and reduced measurement time for the out-of-plane direction Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Parallel Acquisition (0018,9077) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Parallel Acquisition (0018,9077) equals YES.
>Parallel Reduction Factor Second In-plane	(0018,9168)	1C	Measurement time reduction factor expressed as ratio of original and reduced measurement time for the second in-plane direction. Only required for MR Spectroscopy SOP Instances. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Parallel Acquisition (0018,9077) equals YES. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Parallel Acquisition (0018,9077) equals YES.

C.8.13.5.6 MR Imaging Modifier Macro

Table C.8-93 specifies the Attributes of the MR Imaging Modifier Functional Group Macro.

Table C.8-93. MR Imaging Modifier Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Imaging Modifier Sequence	(0018,9006)	1	A Sequence containing MR modifier Sequence Attributes. Only a single Item shall be included in this Sequence.
>Magnetization Transfer	(0018,9020)	1C	Magnetization Transfer pulse sequence. Enumerated Values: **ON_RESONANCE** **OFF_RESONANCE** **NONE** Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Blood Signal Nulling	(0018,9022)	1C	Blood Signal Nulling ("Black Blood") preparatory pulse sequence. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Tagging	(0018,9028)	1C	Tagging. Defined Terms: **GRID** **LINE** **NONE** Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Tag Spacing First Dimension	(0018,9030)	1C	Space between lines in mm. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Tagging (0018,9028) is GRID or LINE. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Tagging (0018,9028) is GRID or LINE.
>Tag Spacing Second Dimension	(0018,9218)	1C	Space between the lines in mm in the other direction. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Tagging (0018,9028) is GRID. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Tagging (0018,9028) is GRID.
>Tag Angle First Axis	(0018,9019)	1C	Angle of the tag lines relative to the rows axis (left to right) of the image, with a range of 0-180 degrees. The angle is increasing in clockwise direction. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Tagging (0018,9028) is GRID or LINE. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Tagging (0018,9028) is GRID or LINE.
>Tag Angle Second Axis	(0018,9219)	1C	Angle of the tag lines relative to the rows axis (left to right) of the image, with a range of 0-180 degrees. The angle is increasing in clockwise direction. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Tagging (0018,9028) is GRID. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Tagging (0018,9028) is GRID.
>Tag Thickness	(0018,9035)	1C	Thickness of the line in mm. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Tagging (0018,9028) is GRID or LINE. Otherwise may be present if Frame Type (0008,9007) Value 1 is DERIVED and Tagging (0018,9028) is GRID or LINE.
>Tagging Delay	(0018,9184)	3	Delay time in ms of the beginning of the application of the tagging pattern relative to the last R-peak.
>Transmitter Frequency	(0018,9098)	1C	Center transmitter frequency in MHz. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Pixel Bandwidth	(0018,0095)	1C	Reciprocal of the effective sampling period, in hertz per pixel. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.

C.8.13.5.7 MR Receive Coil Macro

Table C.8-94 specifies the Attributes of the MR Receive Coil Functional Group Macro.

Table C.8-94. MR Receive Coil Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Receive Coil Sequence	(0018,9042)	1	A Sequence that provides information about each receive coil used. One or more Items shall be included in this Sequence.
>Receive Coil Name	(0018,1250)	1C	Name of receive coil used. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Receive Coil Manufacturer Name	(0018,9041)	2C	Name of manufacturer of receive coil. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Receive Coil Type	(0018,9043)	1C	Type of receive coil used. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise. Defined Terms: **BODY** **VOLUME** head, extremity, etc. **SURFACE** **MULTICOIL**
>Quadrature Receive Coil	(0018,9044)	1C	Indicates whether the receive coil is quadrature. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise. Enumerated Values: **YES** quadrature or circularly polarized **NO** linear
>Multi-Coil Definition Sequence	(0018,9045)	1C	A Sequence that provides information regarding each element of a multi-coil. It should include Attributes for all elements, whether used in the current acquisition or not. One or more Items shall be included in this Sequence. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Receive Coil Type (0018,9043) equals MULTICOIL. May be present otherwise only if Receive Coil Type (0018,9043) equals MULTICOIL.
>>Multi-Coil Element Name	(0018,9047)	1	Name of element of multi-coil.
>>Multi-Coil Element Used	(0018,9048)	1	Indicates whether the multi-coil element was used in the current acquisition. Enumerated Values: **YES** **NO**
>Multi-Coil Configuration	(0018,9046)	3	A textual description of the configuration of multi-coil elements that was used in the current acquisition.

C.8.13.5.8 MR Transmit Coil Macro

Table C.8-95 specifies the Attributes of the MR Transmit Coil Functional Group Macro.

Table C.8-95. MR Transmit Coil Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Transmit Coil Sequence	(0018,9049)	1	A Sequence that provides information about the transmit coil used. Only a single Item shall be included in this Sequence.
>Transmit Coil Name	(0018,1251)	1C	Name of transmit coil used. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Transmit Coil Manufacturer Name	(0018,9050)	2C	Name of manufacturer of transmit coil. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Transmit Coil Type	(0018,9051)	1C	Type of transmit coil used. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise. Defined Terms: **BODY** **VOLUME** head, extremity, etc. **SURFACE**

C.8.13.5.9 MR Diffusion Macro

Table C.8-96 specifies the Attributes of the MR Diffusion Functional Group Macro.

Table C.8-96. MR Diffusion Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Diffusion Sequence	(0018,9117)	1	Identifies the diffusion parameters of this frame. Only a single Item shall be included in this Sequence.
>Diffusion b-value	(0018,9087)	1C	Diffusion sensitization factor in sec/mm^2. This is the actual b-value for original frames and those derived from frames with the same b-value, or the most representative b-value when derived from images with different b-values. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Diffusion Directionality	(0018,9075)	1C	Specifies whether diffusion conditions for the frame are directional, or isotropic with respect to direction. Defined Terms: **DIRECTIONAL** **BMATRIX** **ISOTROPIC** **NONE** To be used when Frame Type (0008,9007) value 4 equals DIFFUSION_ANISO or Diffusion b-value (0018,9087) is 0 (zero). Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Diffusion Gradient Direction Sequence	(0018,9076)	1C	Sequence containing orientations of all diffusion sensitization gradients that were applied during the acquisition of this frame. Only a single Item shall be included in this Sequence. Required if Diffusion Directionality (0018,9075) equals DIRECTIONAL May be present if Diffusion Directionality (0018,9075) equals BMATRIX.
>>Diffusion Gradient Orientation	(0018,9089)	1C	The direction cosines of the diffusion gradient vector with respect to the patient Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Diffusion b-matrix Sequence	(0018,9601)	1C	The directional diffusion sensitization expressed as a 3x3 matrix with diagonal symmetry (with six unique elements from which the other elements can be derived). The rows and columns of the matrix are the X (right to left), Y (anterior to posterior) and Z (foot to head) patient-relative orthogonal axes as defined in Section C.7.6.2.1.1. The values are in units of ms/mm^2. Only a single Item shall be included in this Sequence. Required if Diffusion Directionality (0018,9075) equals BMATRIX.
>>Diffusion b-value XX	(0018,9602)	1	The value of b[X,X].
>>Diffusion b-value XY	(0018,9603)	1	The value of b[X,Y].
>>Diffusion b-value XZ	(0018,9604)	1	The value of b[X,Z].
>>Diffusion b-value YY	(0018,9605)	1	The value of b[Y,Y].
>>Diffusion b-value YZ	(0018,9606)	1	The value of b[Y,Z].
>>Diffusion b-value ZZ	(0018,9607)	1	The value of b[Z,Z].
>Diffusion Anisotropy Type	(0018,9147)	1C	Class of diffusion anisotropy calculation. Defined Terms: **FRACTIONAL** **RELATIVE** **VOLUME_RATIO** Required if Frame Type (0008,9007) value 4 equals DIFFUSION_ANISO.

C.8.13.5.10 MR Averages Macro

Table C.8-97 specifies the Attributes of the MR Averages Functional Group Macro.

Table C.8-97. MR Averages Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Averages Sequence	(0018,9119)	1	Identifies the averaging parameters of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Number of Averages	(0018,0083)	1C	Maximum number of times any point in k-space is acquired. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.13.5.11 MR Spatial Saturation Macro

Table C.8-98 specifies the Attributes of the MR Spatial Saturation Functional Group Macro.

Table C.8-98. MR Spatial Saturation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Spatial Saturation Sequence	(0018,9107)	2	A Sequence that provides the position of spatial saturation bands deposited as part of the pulse sequence. Zero or more Items shall be included in this Sequence.
>Slab Thickness	(0018,9104)	1	Thickness of slab in mm.
>Slab Orientation	(0018,9105)	1	The direction cosines of a normal vector perpendicular to the saturation plane with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>Mid Slab Position	(0018,9106)	1	The x, y, and z coordinates of the midpoint of the slab plane in mm with respect to the patient. See Section C.7.6.2.1.1 for further explanation.

C.8.13.5.12 MR Metabolite Map Macro

Table C.8-99 specifies the Attributes of the MR Metabolite Map Functional Group Macro.

Table C.8-99. MR Metabolite Map Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Metabolite Map Sequence	(0018,9152)	1	Describes the chemical shift parameters used to measure the resonant peaks from which the MR metabolite map represented by this frame was derived. Only a single Item shall be included in this Sequence.
>Metabolite Map Description	(0018,9080)	1C	Text describing the Metabolite Map. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Metabolite Map Code Sequence	(0018,9083)	3	When the measured peaks or their ratios can be related to metabolite substances, this Sequence may be used to describe the metabolite substance whose resonant peaks are mapped in the Metabolite Map, or the ratio of substance resonant peaks that is mapped. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4032 “MR Spectroscopy Metabolites”.*
>Chemical Shift Sequence	(0018,9084)	3	The list of frequencies that were used to create the Metabolite Map. One or more Items are permitted in this Sequence.
>>Chemical Shift Minimum Integration Limit in ppm	(0018,9295)	1	Minimal value of Chemical Shift Frequency in ppm.

Attribute Name	Tag	Type	Attribute Description
>>Chemical Shift Maximum Integration Limit in ppm	(0018,9296)	1	Maximum value of Chemical Shift Frequency in ppm.

C.8.13.5.13 MR Velocity Encoding Macro

Table C.8-100 specifies the Attributes of the MR Velocity Encoding Functional Group Macro. This Functional Group contains the velocity encoding values as valid for the reconstructed Images, rather than for their acquisition. The velocity encoding directions for acquisition are described in the Velocity Encoding Acquisition Sequence (0018,9092) defined in the MR Pulse Sequence Module.

Table C.8-100. MR Velocity Encoding Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Velocity Encoding Sequence	(0018,9197)	1	Identifies the velocity encoding of this frame. One or more Items shall be included in this Sequence.
>Velocity Encoding Direction	(0018,9090)	1C	The direction cosines of the velocity encoding vector with respect to the patient. See Section C.7.6.2.1.1 and Section C.8.13.5.13.1 for further explanation. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Velocity Encoding Minimum Value	(0018,9091)	1C	Minimum velocity in cm/s. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Velocity Encoding Maximum Value	(0018,9217)	1C	Maximum velocity in cm/s. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.13.5.13.1 Velocity Encoding Direction

The direction of the flow in a flow image is defined by the direction of the relevant flow vector in the MR Velocity Encoding Sequence (0018,9197).

The actual flow value (as specified in the Real World Value Mapping Sequence (0040,9096)) has a positive sign when the flow direction coincides with the Velocity Encoding Direction (0018,9090) vector.

C.8.13.5.14 MR Arterial Spin Labeling Macro

Table C.8-100b specifies the Attributes of the MR Arterial Spin Labeling Functional Group Macro.

Table C.8-100b. MR Arterial Spin Labeling Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Arterial Spin Labeling Sequence	(0018,9251)	1	A Sequence that provides the position of Arterial Spin Labeling regions deposited as part of the pulse sequence. One or more Items shall be included in this Sequence.
>ASL Technique Description	(0018,9252)	2	Text describing the used labeling technique in more detail.

Attribute Name	Tag	Type	Attribute Description
>ASL Context	(0018,9257)	1C	The purpose of the Arterial Spin Labeling. Enumerated Values: **LABEL** **CONTROL** **M_ZERO_SCAN** Required if Frame Type (0008,9007) is ORIGINAL. May be present otherwise. See Section C.8.13.5.14.1 for further explanation.
>ASL Slab Sequence	(0018,9260)	1C	Sequence describing the ASL Slab geometry and anatomical region. One or more Items shall be included in this Sequence. Required if ASL Context (0018,9257) is CONTROL or LABEL. May be present otherwise.
>>ASL Slab Number	(0018,9253)	1	Consecutive number identifying the different slabs used for labeling, starting with 1.
>>Include Table 10-7 “General Anatomy Optional Macro Attributes”			*The anatomical region where the slab is positioned.* *Anatomic Region Sequence (0008,2218) DCID 4030 “CT, MR and PET Anatomy Imaged”.* *Anatomic Region Modifier Sequence (0008,2220) and Primary Anatomic Structure Modifier Sequence (0008,2230) DCID 2 “Anatomic Modifier”.*
>>ASL Slab Thickness	(0018,9254)	1	Thickness of slab in mm.
>>ASL Slab Orientation	(0018,9255)	1	The direction cosines of a normal vector perpendicular to the ASL slab with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>>ASL Mid Slab Position	(0018,9256)	1	The x, y, and z coordinates of the midpoint of the slab in mm with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>>ASL Pulse Train Duration	(0018,9258)	1	Duration (in milliseconds) of the Label or Control pulse. See Section C.8.13.5.14.3 for further explanation.
>ASL Crusher Flag	(0018,9259)	1	Indicates if an ASL Crusher Method has been used. Enumerated Values: **YES** **NO** See Section C.8.13.5.14.2 for further explanation.
>ASL Crusher Flow Limit	(0018,925A)	1C	Maximum Flow Limit (in cm/s). Required if ASL Crusher Flag (0018,9259) is YES.
>ASL Crusher Description	(0018,925B)	1C	Description of the ASL Crusher Method. Required if ASL Crusher Flag (0018,9259) is YES.

Attribute Name	Tag	Type	Attribute Description
>ASL Bolus Cut-off Flag	(0018,925C)	1	Indicates if a Bolus Cut-off technique is used. Enumerated Values: **YES** **NO**
>ASL Bolus Cut-off Timing Sequence	(0018,925D)	1C	Sequence that specifies the timing of the Bolus Cut-off technique and possibly its (scientific) description. Only a single Item shall be included in this Sequence. Required if ASL Bolus Cut-off Flag (0018,925C) is YES.
>>ASL Bolus Cut-off Delay Time	(0018,925F)	1	Bolus Cut-off pulse delay time (in ms). See Section C.8.13.5.14.3 for further explanation.
>>ASL Bolus Cut-off Technique	(0018,925E)	2	Text describing the cut-off technique.

C.8.13.5.14.1 ASL Context

The Attribute ASL Context (0018,9257) categorize the Original ASL images according to three contexts. This categorization allows post processing applications to select the correct type of image.

LABEL: Images are acquired with magnetically labeled arterial blood supply.

CONTROL: Images are acquired with a 'control' pulse in the proximal vessels.

M_ZERO_SCAN: Images are acquired with no label or control pulse in the proximal vessels.

C.8.13.5.14.2 ASL Crusher Flag

In order to quantify the perfusion accurately, it may be necessary to suppress signals within the macroscopic blood vessels (crushing). This can be used to separate the arterial input function from the brain parenchymal signal. The ASL Crusher Flag (0018,9259) indicates the application of an ASL crushing technique.

Note

Frames with and without crushing may be present in one SOP Instance.

C.8.13.5.14.3 Relationship of ASL Timing Attributes

The general description of the ASL Acquisition technique requires a number of time related Attributes that are depicted in Figure C.8.13.5.14-1.

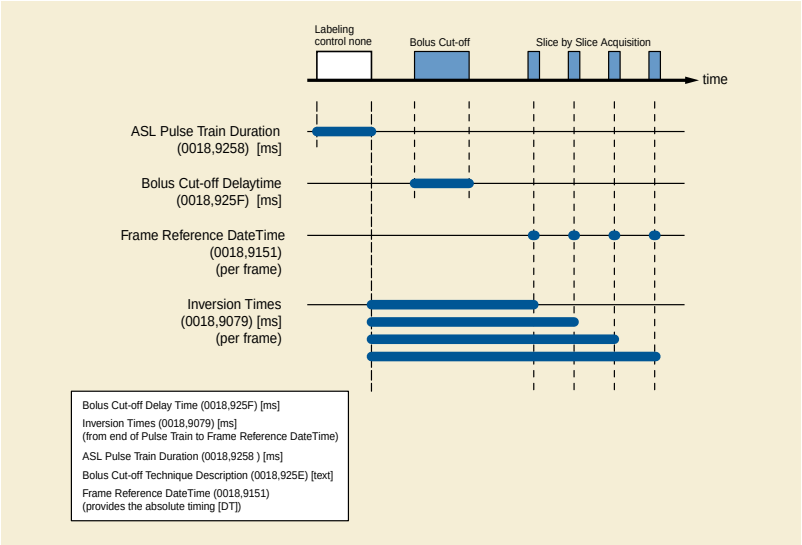


Figure C.8.13.5.14-1. Attributes for Quantitative ASL

C.8.13.5.15 Functional MR Macro

Table C.8-100c specifies the Attributes of the Functional MR Group Macro.

Table C.8-100c. Functional MR Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Functional MR Sequence	(0018,9621)	1	Identifies the Functional parameters of this frame. Only a single Item shall be included in this Sequence.
>Settling Phase Frame	(0018,9624)	1C	Identifies if the frame is part of a Functional MR settling phase. All frames with the same combination of Stack ID (0020,9056) and Temporal Position Index (0020,9128) shall have the same value. Enumerated Values: **YES** **NO** Required if Functional Settling Phase Frames Present (0018,9622) is YES.
>Functional Sync Pulse	(0018,9623)	1	The date and time of the Functional Sync Pulse for this frame. See Section C.8.13.5.15.1

C.8.13.5.15.1 Functional Sync Pulse

Functional Studies require synchronization between the Acquisition Modality and external devices to coordinate paradigm presentation by an external system with image acquisition. It is required that the Acquisition Time Synchronized (0018,1800) shall be "Y".

The Functional Sync Pulse (0018,9623) is the date-time stamp of the pulse at the start of the acquired volume(s) in the SOP Instance. All frames with the same combination of Stack ID (0020,9056) and Temporal Position Index (0020,9128) share the same time stamp.

C.8.13.6 MR Series Module

The MR IODs use the General Series Module, specialized by the MR Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of MR device.

Table C.8-101 specifies the Attributes that identify and describe general information about the MR Series.

Table C.8-101. MR Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **MR** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.14 MR Spectroscopy Modules

This section describes the MR Spectroscopy Modules.

Note

Many Attributes have names and descriptions that include the terms "pixel" and "image". Although MR spectroscopy is not pixel based, some of these "pixel" and "image" Attributes encode concepts that are still relevant for this technique. Where such Attributes appear in the MR Spectroscopy IOD, it may be helpful to consider the term "pixel" to be equivalent to a spectroscopy "voxel", and the term "image" to be equivalent to "MR Spectroscopy SOP Instance".

C.8.14.1 MR Spectroscopy Module

Table C.8-102 specifies the Attributes of the MR Spectroscopy Module.

Table C.8-102. MR Spectroscopy Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-83 “MR Image and Spectroscopy Instance Macro Attributes”			
Image Type	(0008,0008)	1	Spectroscopy data characteristics. See Section C.8.14.5.1.1.
Include Table C.8-107 “MR Spectroscopy Description Macro Attributes”			
Transmitter Frequency	(0018,9098)	1C	Precession frequency in MHz of the nucleus being addressed for each spectral axis. See Section C.8.14.1.1 for further explanation of the ordering. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Spectral Width	(0018,9052)	1C	Spectral width in Hz. See Section C.8.14.1.1 for further explanation of the ordering. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Chemical Shift Reference	(0018,9053)	1C	The chemical shift at the transmitter frequency in ppm. See Section C.8.14.1.1 for further explanation of the ordering. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Volume Localization Technique	(0018,9054)	1C	Name of volume localization technique used. Shall be "NONE" if no spatial localization was performed. Defined Terms: **ILOPS** **ISIS** **PRIME** **PRESS** **SLIM** **SLOOP** **STEAM** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Volume Localization Sequence	(0018,9126)	1C	A Sequence of Items that provide the position of RF excitations used to select a volume of tissue. The selected volume is described by the intersection of the Sequence Items. One or more Items shall be included in this Sequence. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Volume Localization Technique (0018,9054) is other than NONE. May be present if Volume Localization Technique (0018,9054) is other than NONE.
>Slab Thickness	(0018,9104)	1	Thickness of slab in mm.
>Slab Orientation	(0018,9105)	1	The direction cosines of a normal vector perpendicular to the selection plane with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>Mid Slab Position	(0018,9106)	1	The x, y, and z coordinates of the mid-point of the slab in mm. See Section C.7.6.2.1.1 for further explanation.
De-coupling	(0018,9059)	1C	Indicates whether de-coupling was active. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
De-coupled Nucleus	(0018,9060)	1C	Nucleus being de-coupled. Defined Terms: **1H** **3HE** **7LI** **13C** **19F** **23NA** **31P** **129XE** See Section C.8.14.1.1 for further explanation of the ordering. Required if De-coupling (0018,9059) equals YES.
De-coupling Frequency	(0018,9061)	1C	The center frequency (Hz) for the de-coupling. See Section C.8.14.1.1 for further explanation of the ordering. Required if De-coupling (0018,9059) equals YES.
De-coupling Method	(0018,9062)	1C	The de-coupling modulation scheme used. Defined Terms: **MLEV** **WALTZ** **NARROWBAND** Required if De-coupling (0018,9059) equals YES.
De-coupling Chemical Shift Reference	(0018,9063)	1C	The chemical shift in ppm at the de-coupling frequency. See Section C.8.14.1.1 for further explanation of the ordering. Required if De-coupling (0018,9059) equals YES.
Time Domain Filtering	(0018,9065)	1C	Describes time domain filtering or apodization applied. Shall be NONE if no filtering operations were applied to the time domain data. Defined Terms: **COSINE** **COSINE_SQUARED** **EXPONENTIAL** **GAUSSIAN** **HAMMING** **HANNING** **LORENTZIAN** **LRNTZ_GSS_TRNSFM** **NONE** See Section C.8.14.1.1 for further explanation of the ordering. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Number of Zero Fills	(0018,9066)	1C	Number of zero fills added to the time domain data before FT. Shall be 0 (zero) if no zero filling performed. See Section C.8.14.1.1 for further explanation of the ordering. See Section C.8.14.1.2 for further explanation on Zero Fills. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Baseline Correction	(0018,9067)	1C	Describes baseline correction techniques. Shall be NONE if no baseline correction was performed. Defined Terms: **LINEAR_TILT** **LOCAL_LINEAR_FIT** **POLYNOMIAL_FIT** **SINC_DECONVOLUTN** **TIME_DOMAIN_FIT** **SPLINE** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Frequency Correction	(0018,9101)	1C	Specifies whether operations were performed to correct resonant frequency of metabolite peaks due to B0 field inhomogeneities. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
First Order Phase Correction	(0018,9198)	1C	Describes whether a first order (frequency dependent) phase correction was applied to the spectral data. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Water Referenced Phase Correction	(0018,9199)	1C	Indicates if the images or spectra were created using Water Reference time domain data for phase correction. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise. See Section C.8.14.1.3 for relation between Water Reference data and other Spectroscopic objects.

Attribute Name	Tag	Type	Attribute Description
Water Reference Acquisition	(0018,9297)	3	Describes the relation to Water Reference data for this Instance. Enumerated Values: **WATER_REFERENCE** **USED_DISCARDED** **REFERENCED** **NONE** See Section C.8.14.1.4 for description of enumerated values.
Referenced Instance Sequence	(0008,114A)	1C	References to SOP Instances significantly related to the current SOP Instance, including water reference data. Required if Water Reference Acquisition (0018,9297) equals REFERENCED. May be present otherwise. One or more Items shall be present in this Sequence.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 7215 "Spectroscopy Purpose of Reference".*

C.8.14.1.1 MR Spectroscopy Attribute Multiplicity Ordering

The following Attributes may have a Value Multiplicity of one or two depending whether one or two frequency axes are used as specified by the value of Data Point Rows (0028,9001):

Transmitter Frequency (0018,9098)

Resonant Nucleus (0018,9100)

Spectral Width (0018,9052)

Chemical Shift Reference (0018,9053)

De-coupled Nucleus (0018,9060)

De-coupling Frequency (0018,9061)

De-coupling Chemical Shift Reference (0018,9063)

Time Domain Filtering (0018,9065)

Number of Zero Fills (0018,9066)

Value 1 shall contain the value corresponding to the sampling time axis (the axis along a data point row).

Value 2, if present, shall contain the value corresponding to the evolution time axis (the axis along a data point column).

C.8.14.1.2 MR Spectroscopy Zero Fill Explanation

Zero filling is a data processing technique where zero points are appended to the time domain data before Fourier transformation. The effect of zero filling is to increase the digital resolution in the spectrum. Since the zeros contain no new information, there is no new information added to the spectrum. It is artificially increasing the acquisition time after the data collection without adding any new information or true resolution to the spectrum. See Figure C.8.14.1-1, Figure C.8.14.1-2 and Figure C.8.14.1-3.

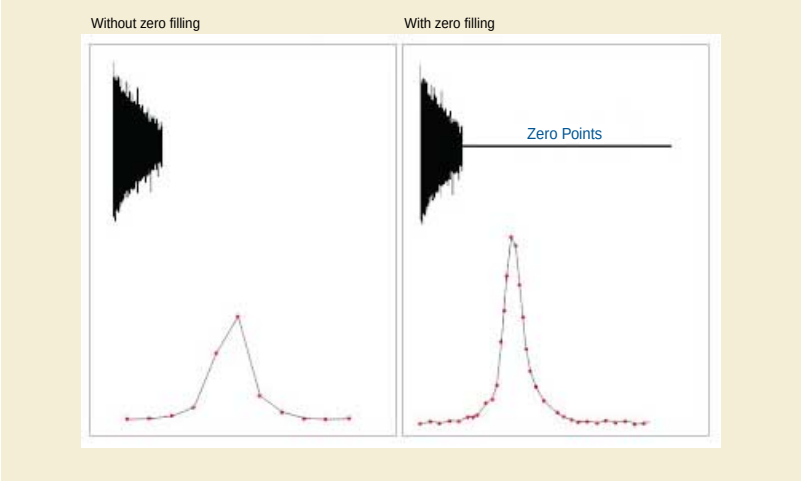


Figure C.8.14.1-1. Example Result without and with Zero Filling

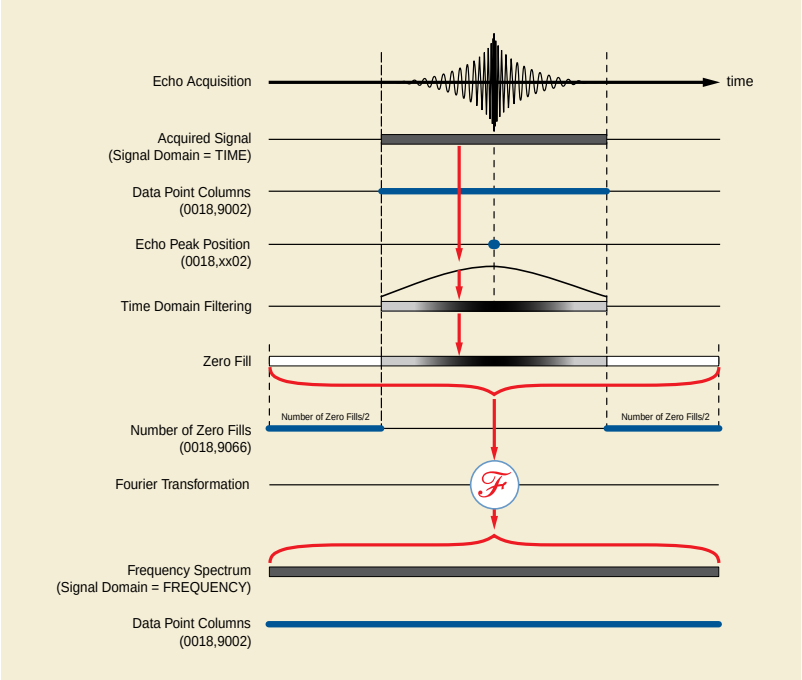


Figure C.8.14.1-2. Echo Acquisition with Applying Zero Fill

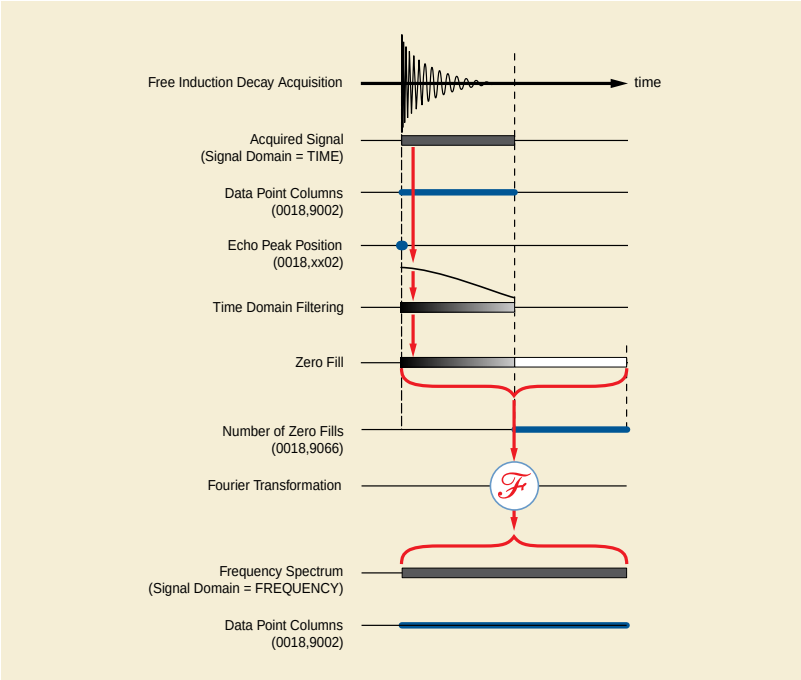


Figure C.8.14.1-3. Free Induction Decay Acquisition with Applying Zero Fill

C.8.14.1.3 MR Spectroscopy Water Reference Data Clarification

MR Spectroscopy is using diagnostic data and water reference data. The water reference data is acquired and used to correct the phase of the diagnostic time domain data before the Fourier transformation to the frequency domain. The relation between the different spectroscopy objects is given in Figure C.8.14.1-4.

When Water Reference Acquisition (0018,9297) equals REFERENCED, it means that Instances are available that were or can be used for Water Phase Correction. All other values mean that there are no Instances available although data might have been used for water phase correction, see Water Referenced Phase Correction (0018,9199).

The water reference data can also be used for quantification of the signal strength of the diagnostic data.

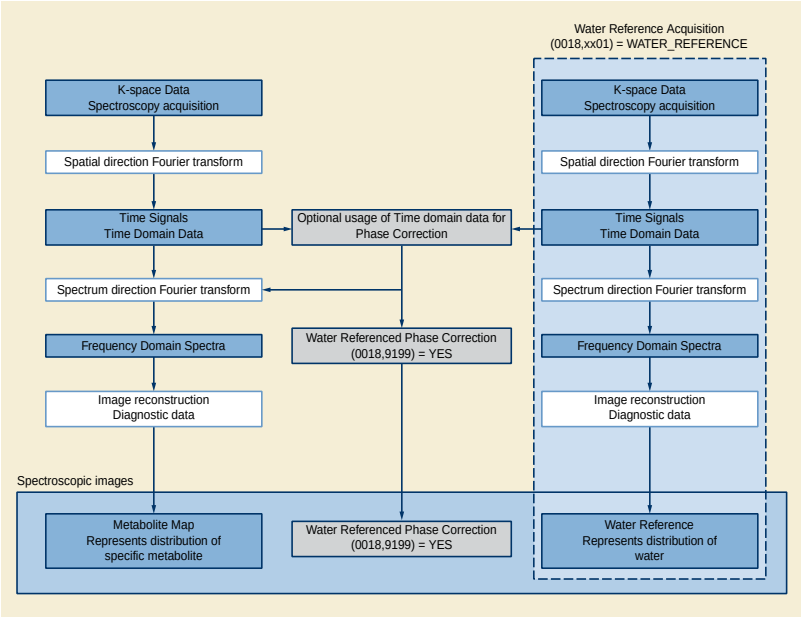


Figure C.8.14.1-4. Relation Between Spectroscopy Instances

C.8.14.1.4 Water Reference Acquisition

The value of Water Reference Acquisition (0018,9297) specifies the intent of the spectroscopy data acquired.

Enumerated Values:

WATER_REFERENCE This Instance is acquired to be used as water reference and can be used by other spectroscopy data in the Study for water phase correction.

USED_DISCARDED The phase of this spectroscopic Instance is corrected with water reference data. The water reference data used is discarded after correction and no longer available.

REFERENCED This spectroscopic Instance has water reference data available for phase correction or the phase is already corrected with water reference data. The water reference data shall be specified in the Referenced Instance Sequence (0008,114A).

NONE This spectroscopic Instance has not been corrected for the water phase signal and water reference data has not been acquired.

C.8.14.2 MR Spectroscopy Pulse Sequence Module

The primary purpose of this Module is to identify the pulse sequence and variations that were used in creation of the spectroscopic data. Terminology is intended to be neutral, and allow equivalent pulse sequences provided by different vendors to be classified together.

Table C.8-103 specifies the Attributes of the MR Spectroscopy Pulse Sequence Module.

Table C.8-103. MR Spectroscopy Pulse Sequence Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pulse Sequence Name	(0018,9005)	1C	Name of the pulse sequence for annotation purposes. Potentially vendor-specific name. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
MR Spectroscopy Acquisition Type	(0018,9200)	1C	Identification of data encoding scheme. Defined Terms: **SINGLE_VOXEL** **ROW** **PLANE** **VOLUME** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Echo Pulse Sequence	(0018,9008)	1C	Echo category of pulse sequences. Enumerated Values: **SPIN** **GRADIENT** **BOTH** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Multiple Spin Echo	(0018,9011)	1C	Multiple Spin Echo category of pulse sequence used to collect different lines in k-space for a single frame. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Echo Pulse Sequence (0018,9008) equals SPIN or BOTH. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Echo Pulse Sequence (0018,9008) equals SPIN or BOTH.
Multi-planar Excitation	(0018,9012)	1C	Technique that simultaneously excites several volumes. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Steady State Pulse Sequence	(0018,9017)	1C	Steady State Sequence. Defined Terms: **FREE_PRECESSION** **TRANSVERSE** **TIME_REVERSED** **LONGITUDINAL** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Echo Planar Pulse Sequence	(0018,9018)	1C	Echo Planar category of pulse sequences. Enumerated Values: **YES** **NO** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Spectrally Selected Suppression	(0018,9025)	1C	Spectrally Selected Suppression. Defined Terms: **WATER** **FAT** **FAT_AND_WATER** **SILICON_GEL** **NONE** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Geometry of k-Space Traversal	(0018,9032)	1C	Geometry category of k-Space traversal. Defined Terms: **RECTILINEAR** **RADIAL** **SPIRAL** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Rectilinear Phase Encode Reordering	(0018,9034)	1C	Rectilinear phase encode reordering. Defined Terms: **LINEAR** **CENTRIC** **SEGMENTED** **REVERSE_LINEAR** **REVERSE_CENTRIC** Required if Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and Geometry of k-Space Traversal (0018,9032) equals RECTILINEAR.
Segmented k-Space Traversal	(0018,9033)	1C	Segmented k-Space traversal. If Geometry of k-Space Traversal is rectilinear, multiple lines can be acquired at one time. If Geometry of k-Space Traversal is spiral or radial, paths can be interleaved and acquired at one time. Enumerated Values: **SINGLE** successive single echo coverage **PARTIAL** segmented coverage **FULL** single shot full coverage Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Coverage of k-Space	(0018,9094)	1C	Coverage of k-Space. Defined Terms: **FULL** **CYLINDRICAL** **ELLIPSOIDAL** **WEIGHTED** Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED and MR Spectroscopy Acquisition Type (0018,9200) equals VOLUME. Otherwise may be present if Image Type (0008,0008) Value 1 is DERIVED and MR Spectroscopy Acquisition Type (0018,9200) equals VOLUME.
Number of k-Space Trajectories	(0018,9093)	1C	Number of interleaves or shots. Required if Image Type (0008,0008) Value 1 is ORIGINAL or MIXED. May be present otherwise.
Echo Peak Position	(0018,9298)	3	Number specifying the sample that coincides with the echo peak used during acquisition of the data. First sample will be numbered 1.

C.8.14.3 MR Spectroscopy Functional Group Macros

The following sections contain Functional Group Macro's specific to the MR Spectroscopy IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".".

C.8.14.3.1 MR Spectroscopy Frame Type Macro

Table C.8-104 specifies the Attributes of the MR Spectroscopy Frame Type Functional Group Macro.

Table C.8-104. MR Spectroscopy Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Spectroscopy Frame Type Sequence	(0018,9227)	1	A Sequence containing Frame Type Attributes. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Spectroscopy data characteristics. See Section C.8.14.5.1.1.
>Include Table C.8-107 “MR Spectroscopy Description Macro Attributes”			

C.8.14.3.2 MR Spectroscopy FOV/Geometry Macro

Table C.8-105 specifies the Attributes of the MR Spectroscopy FOV/Geometry Functional Group Macro.

Table C.8-105. MR Spectroscopy FOV/Geometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MR Spectroscopy FOV/Geometry Sequence	(0018,9103)	1	Identifies the geometry parameters of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Spectroscopy Acquisition Data Columns	(0018,9127)	1C	Number of data points in the columns direction. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Spectroscopy Acquisition Phase Rows	(0018,9095)	1C	Number of Phase Encoding Rows. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Spectroscopy Acquisition Phase Columns	(0018,9234)	1C	Number of Phase Encoding Columns. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Spectroscopy Acquisition Out-of-plane Phase Steps	(0018,9159)	1C	Number of out-of-plane Phase Encoding steps. Required if MR Spectroscopy Acquisition Type (0018,9200) equals PLANE and Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Percent Sampling	(0018,0093)	1C	Fraction of acquisition matrix lines acquired, expressed as a percent. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Percent Phase Field of View	(0018,0094)	1C	Ratio of field of view dimension in phase direction to field of view dimension in frequency direction, expressed as a percent. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.14.4 MR Spectroscopy Data Module

Table C.8-106 specifies the Attributes that describe the Spectroscopy Data.

Table C.8-106. MR Spectroscopy Data Module Attributes

Attribute Name	Tag	Type	Attribute Description
Rows	(0028,0010)	1	Number of voxels in the vertical direction in the frame.
Columns	(0028,0011)	1	Number of voxels in the horizontal direction in the frame.
Data Point Rows	(0028,9001)	1	Number of rows of data points in spectroscopic data.
Data Point Columns	(0028,9002)	1	Number of columns of data points in spectroscopic data.
Data Representation	(0028,9108)	1	Data representation of the data points. Each data point shall have the same representation. Enumerated Values: **COMPLEX** Data is complex pair **REAL** Data contains only real component **IMAGINARY** Data contains only imaginary component **MAGNITUDE** Magnitude data
Signal Domain Columns	(0028,9003)	1	Domain of represented signal in column direction. Enumerated Values: **FREQUENCY** **TIME**

Attribute Name	Tag	Type	Attribute Description
Signal Domain Rows	(0028,9235)	1C	Domain of represented signal in row direction. Enumerated Values: **FREQUENCY** **TIME** Required if Data Point Rows (0028,9001) has a value of more than 1.
First Order Phase Correction Angle	(5600,0010)	1C	First Order Phase Correction Angle. Number of values is determined by Row*Column*Number of Frames. Required if First Order Phase Correction (0018,9198) equals YES
Spectroscopy Data	(5600,0020)	1	A data stream of the signal intensities that comprise the spectroscopic data. See Section C.8.14.4.1 for further explanation.

C.8.14.4.1 Spectroscopy Data

The Spectroscopy Data (5600,0020) Attribute contains the Signal intensities for the spectra. The order of voxels encoded for each spectral plane is left to right, top to bottom, i.e., the upper left voxel (labeled 1,1) is encoded first followed by the remainder of row 1, followed by the first voxel of row 2 (labeled 2,1) then the remainder of row 2 and so on. Each "voxel" represents an entire spectrum. The complete spectral data from each voxel is encoded, followed by the spectral data from the next voxel position.

The number of voxels on each frame are described by Rows (0028,0010) and Columns (0028,0011). The number of frames is described by Number of Frames (0028,0008). The frames may represent different locations in a 3D acquisition, or the same position at a different point of time, or a difference of some other combination of Attributes.

Note

Either Rows or Columns or both may have a value of 1 (e.g., for single voxel spectroscopy). A value of zero for the corresponding value of Pixel Spacing in the Pixel Measures Macro is permitted under these circumstances. See Section 10.7.1.3.

The spectral data points are ordered from high frequencies to low frequencies for a fixed static magnetic field strength, in the case that the Signal Domain Columns (0028,9003) or Signal Domain Rows (0028,9235) Attributes contain the value FREQUENCY.

The spectral data points are ordered in sequence of increasing time in the case that the Signal Domain Columns (0028,9003) or Signal Domain Rows (0028,9235) Attributes contain the value TIME.

The apparent rotation of magnetization in a quadrature representation shall be counterclockwise (from the (positive) real part to the (positive) imaginary part) for positive relative frequencies.

Note

When Complex time data points are transformed by a straightforward Fourier transformation to complex spectral data points, these are ordered from low frequency to high frequency.

For two-dimensional spectral acquisitions, the ordering is such that all data points from a row (corresponding to all data points acquired in an individual sampling period), are followed by all data points from the successive sampling period. Following all data of the rows from a given voxel position, the data from the subsequent voxel position are encoded. The axis parallel to the row direction corresponds to the sampling time axis. The axis parallel to the column direction corresponds to the evolution time axis.

The dimensions of each spectrum that make up a voxel are described by Data Point Rows (0028,9001) and Data Point Columns (0028,9002). In the case of 1D spectra, the number of Data Point Rows shall be 1.

For a Data Representation (0028,9108) value of COMPLEX, the order of data points is real channel followed by imaginary channel for each spectral data point. For the other Data Representation values (REAL, IMAGINARY and MAGNITUDE), each spectral data point contains only a single value.

The Figure C.8-18 depicts 6 frames each made up of 4 rows and 4 columns of voxels. Specific values for Data Point Rows (0028,9001) and Data Point Columns (0028,9002) of these voxels are not depicted.

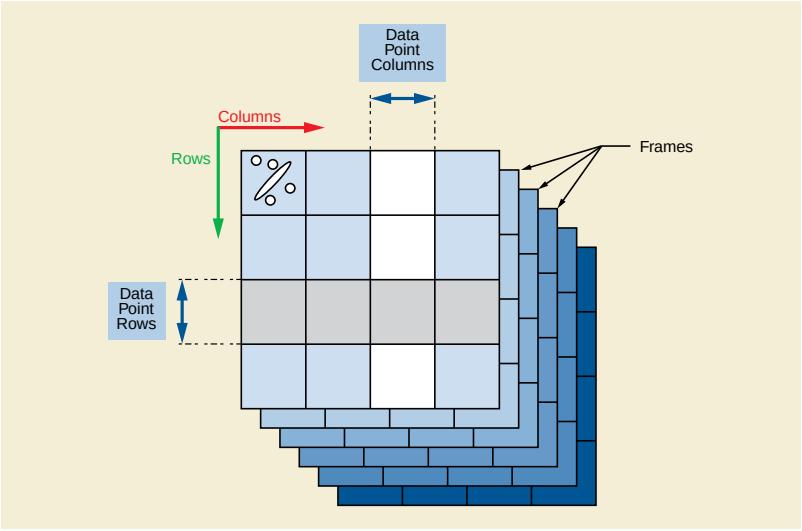


Figure C.8-18. Dimensions of Spectroscopy Data

C.8.14.5 MR Spectroscopy Description Macro

Table C.8-107 specifies the Attributes that describe the Spectroscopy.

Table C.8-107. MR Spectroscopy Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See Section C.8.14.5.1.2 for a description and Enumerated Values.
Volume Based Calculation Technique	(0008,9207)	1	Method used for volume calculations with frames in the SOP Instance. See Section C.8.14.5.1.3 for a description and Defined Terms.
Complex Image Component	(0008,9208)	1	Representation of complex data of frames in the SOP Instance. See Section C.8.14.5.1.4 for a description and Defined Terms.
Acquisition Contrast	(0008,9209)	1	Indication of acquisition contrast used with frames in the SOP Instance. See Section C.8.14.5.1.5 for a description and Defined Terms.

C.8.14.5.1 MR Spectroscopy Description Attribute Description

C.8.14.5.1.1 Image Type and Frame Type

Image Type (0008,0008) and Frame Type (0008,9007) are not included in this Macro but one or the other is always included in the Module or Macro that invokes this Macro, and they are therefore described here.

In addition to the requirements specified in Section C.8.16.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

C.8.14.5.1.1.1 Pixel Data Characteristics

See Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.14.5.1.1.2 Patient Examination Characteristics

See Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.14.5.1.1.3 Image Flavor

See Section C.8.16.1.3 for requirements, but not Defined Terms.

Table C.8-108 specifies the Defined Terms for MR Spectroscopy for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-108. MR Spectroscopy Image Type and Frame Type Value 3

Defined Term Name	Defined Term Description
SPECTROSCOPY	Spectroscopy

C.8.14.5.1.1.4 Derived Pixel Contrast

See Section C.8.16.1.4 for requirements, but not Defined Terms.

Table C.8-109 specifies the Defined Terms for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-109. MR Spectroscopy Image Type and Frame Type Value 4

Defined Term Name	Defined Term Description
ADDITION	Created through point by point addition operation
DIVISION	Created through point by point division operation
MAXIMUM	Created through point by point maximum operation
MEAN	Created through point by point mean operation
MINIMUM	Created through point by point minimum operation
MULTIPLICATION	Created through point by point multiplication operation
STD_DEVIATION	Standard Deviation
SUBTRACTION	Created through point by point subtraction operation
NONE	Not calculated
MIXED	Used only as value in Image Type (0008,0008) if frames within the spectroscopy SOP Instance contain different values for value 4 in their Frame Type (0008,9007) Attribute.

C.8.14.5.1.2 Volumetric Properties

See Section C.8.16.2.1.2. No additional requirements or Defined Terms.

C.8.14.5.1.3 Volume Based Calculation Technique Attribute

See Section C.8.16.2.1.3 for requirements, but not Defined Terms.

Table C.8-110 specifies the Defined Terms for the Volume Based Calculation Technique (0008,9207) Attribute.

Table C.8-110. Volume Based Calculation Technique Attribute Values

Defined Term Name	Defined Term Description
MAX_IP	Maximum Intensity Projection
MIN_IP	Minimum Intensity Projection
NONE	Pixels not derived geometrically
MIXED	Used only as a value in Volume Based Calculation Technique (0008,9207) Attribute in the MR Spectroscopy Module if frames within the image SOP Instance contain different terms for the Volume Based Calculation Technique Attribute in MR Spectroscopy Frame Type Functional Group.

C.8.14.5.1.4 Complex Image Component

The value of Complex Image Component (0008,9208) Attribute shall be used to indicate which component of the complex representation of the signal is represented in the spectroscopy data.

Table C.8-111 specifies the Defined Terms for Complex Image Component (0008,9208).

Table C.8-111. Complex Image Component Attribute Values

Defined Term Name	Defined Term Description
MAGNITUDE	The magnitude component of the complex spectroscopy data.
PHASE	The phase component of the complex spectroscopy data.
REAL	The real component of the complex spectroscopy data.
IMAGINARY	The imaginary component of the complex spectroscopy data.
COMPLEX	The real and imaginary components of the complex spectroscopy data
MIXED	Used only as a value in Complex Image Component (0008,9208) in the MR Spectroscopy Module if frames within the image SOP Instance contain different values for the Complex Image Component Attribute in the MR Spectroscopy Frame Type Functional Group.

C.8.14.5.1.5 Acquisition Contrast

Table C.8-112 specifies the Defined Terms for Acquisition Contrast (0008,9209).

Table C.8-112. Acquisition Contrast Values

Defined Term Name	Defined Term Description
PROTON_DENSITY	Proton Density weighted contrast
T1	T1 weighted contrast
T2	T2 weighted contrast
UNKNOWN	Value should be UNKNOWN if acquisition contrasts were combined resulting in an unknown contrast. Also this value should be used when the contrast is not known.
MIXED	Used only as a value in Acquisition Contrast (0008,9209) Attribute in the MR Spectroscopy Module if frames within the SOP Instance contain different values for the Acquisition Contrast Attribute in the MR Spectroscopy Frame Type Functional Group.

C.8.15 Enhanced CT Image

This section describes the specific Modules for the Enhanced CT Image IOD.

C.8.15.1 CT Series Module

The CT IODs use the General Series Module, specialized by the CT Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of CT device.

Table C.8-113 specifies the Attributes that identify and describe general information about the CT Series.

Table C.8-113. CT Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **CT** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.15.2 Enhanced CT Image Module

This section describes the Enhanced CT Image Module. Table C.8-114 specifies the Attributes of the Enhanced CT Image Module.

Table C.8-114. Enhanced CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.16.1 and Section C.8.15.2.1.1.
Multi-energy CT Acquisition	(0018,9361)	3	Indicates whether the image is created by means of Multi-energy technique. Enumerated Values: **YES** **NO**
Include Table C.8-131 "Common CT/MR Image Description Macro Attributes"			
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image. Note This number is not required to be unique across SOP Instances in a Series. See also the description of the Referenced Raw Data Sequence (0008,9121).

Attribute Name	Tag	Type	Attribute Description
Acquisition DateTime	(0008,002A)	1C	The date and time that the acquisition of data started. Note 1. The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800). 2. See Section C.7.6.16.2.2.1 for an overview of all acquisition related timing Attributes. Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted), may be present otherwise.
Acquisition Duration	(0018,9073)	1C	The time in seconds needed to complete the acquisition of data. See Section C.7.6.16.2.2.1 for further explanation. Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL or MIXED and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted), may be present otherwise.
Referenced Raw Data Sequence	(0008,9121)	3	The Raw data that was used to derive this Image. One or more Items are permitted in this Sequence. Note The Items of in this Sequence may identify raw data that has not been stored or encoded as a DICOM object. This allows recognition that images in different Instances have been reconstructed from the same raw data.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Referenced Waveform Sequence	(0008,113A)	3	References to waveforms acquired in conjunction with this image. These Waveforms may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referring to image SOP Instances inside the frames of this Enhanced CT Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Source Image Evidence Sequence	(0008,9154)	1C	Full set of Composite SOP Instances used as source image SOP Instances inside the frames of this Enhanced CT Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Source Image Sequence (0008,2112) is present.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Referenced Presentation State Sequence	(0008,9237)	1C	References to Presentation State ~~Instances acquired in conjunction with this Instance.~~instances created together with this instance Note ~~May only be used to reference Presentation States belonging to the acquired data and not to~~This Sequence does not reference Presentation States generated ~~subsequently~~after image creation, such as during interpretation. One or more Items shall be included in this Sequence. Required if Presentation State is ~~generated during acquisition, shall not be present otherwise~~created together with the images.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. This value shall be 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2** See Section C.7.6.3.1.2 for definition of this term.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. This value shall be 16.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. This value shall be 12 or16.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Content Qualification	(0018,9004)	1C	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted), may be present otherwise.
Image Comments	(0020,4000)	3	User-defined comments about the image

Attribute Name	Tag	Type	Attribute Description
Burned In Annotation	(0028,0301)	1C	Indicates whether or not the image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO** This means that images that contain this Module shall not contain such burned in annotations. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted), may be present otherwise.
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted). May be present otherwise.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6.*
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
Include Table 10-27 "RT Equipment Correlation Macro Attributes Description"			

C.8.15.2.1 CT Image Description Attribute Description

C.8.15.2.1.1 Image Type and Frame Type

In addition to the requirements specified in Section C.8.16.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified.

These requirements and Defined Terms are also applicable to Frame Type (0008,9007).

C.8.15.2.1.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.15.2.1.1.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.15.2.1.1.3 Image Flavor

Table C.8-115 specifies the Defined Terms for CT additional to those defined in Section C.8.16.1.3 for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-115. Image Type and Frame Type Value 3 for CT

Defined Term Name	Defined Term Description
ATTENUATION	Collected for the purpose of performing attenuation corrections (e.g., PET attenuation correction)
CARDIAC_CTA	Images of the heart collected for the purpose of CT Coronary Angiography (CTA)
CARDIAC_CASCORE	Images of the heart collected for the purpose of CT Coronary Calcium Scoring
REFERENCE	Collected for anatomical reference for PET or SPECT

C.8.15.2.1.1.4 Derived Pixel Contrast

Table C.8-116 specifies the Defined Terms for CT additional to those defined in Section C.8.16.1.4 for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8-116. Image Type and Frame Type Value 4 for CT

Defined Term Name	Defined Term Description
FILTERED	An image filter has been applied
MEDIAN	Pixel by pixel median

Defined Term Name	Defined Term Description
ENERGY_PROP_WT	Image pixels created through proportional weighting of multiple acquisitions at distinct X-Ray energies.

C.8.15.3 Enhanced CT Image Functional Group Macros

The following sections contain Functional Group Macros specific to the Enhanced CT Image IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".

C.8.15.3.1 CT Image Frame Type Macro

Table C.8-117 specifies the Attributes of the CT Image Frame Type Functional Group Macro.

Table C.8-117. CT Image Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Image Frame Type Sequence	(0018,9329)	1	Identifies the characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed unless the SOP Class UID is "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted). See Section C.8.16.1 and Section C.8.15.2.1.1.1.
>Include Table C.8-131 “Common CT/MR Image Description Macro Attributes”			

C.8.15.3.2 CT Acquisition Type Macro

Table C.8-118 specifies the Attributes of the CT Acquisition Type Functional Group Macro.

Table C.8-118. CT Acquisition Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Acquisition Type Sequence	(0018,9301)	1	Contains the Attributes defining the CT acquisition mode. Only a single Item shall be included in this Sequence.
>Acquisition Type	(0018,9302)	1C	Description of the method used during acquisition of this frame. See Section C.8.15.3.2.1 for Defined Terms. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Tube Angle	(0018,9303)	1C	The constant angle at which the X-Ray source is located during acquisition. 0 degrees means that the source is located at the highest point of the gantry orbit. Degrees increase from 0 to positive 360 in a clockwise direction as viewed when facing the gantry where the table enters the gantry. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is CONSTANT_ANGLE. May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is CONSTANT_ANGLE.
>Constant Volume Flag	(0018,9333)	1C	Identifies that the acquisition was performed by repetitively acquiring the same volume set over a period of time. Note Acquisition Type (0018,9302) may be SEQUENCED, SPIRAL or STATIONARY depending on whether table movement is necessary to cover the volume. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Fluoroscopy Flag	(0018,9334)	1C	Identifies that near real-time display of a block of continuously acquired data was performed, which may result in a lower than usual image quality. Enumerated Values: **YES** **NO** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.15.3.2.1 Acquisition Type

Defined Terms:

SEQUENCED identifies that the acquisition was performed by acquiring single or multi detector data while rotating the source about the gantry while the table is not moving; additional slices may be acquired by incrementing the table position and again rotating the source about the gantry while the table is not moving

SPIRAL identifies that the acquisition was performed by acquiring data while rotating the source about the gantry while continuously moving the table

CONSTANT_ANGLE identifies that the acquisition was performed by holding the source at a constant angle and moving the table to obtain a projection image (e.g., a localizer image)

STATIONARY identifies that the acquisition was performed by holding the table at a constant position and performing one or more acquisitions over time at the same location

FREE identifies that the acquisition was performed while rotating the source about the gantry while the table movement is under direct control of a human operator or under the control of an analysis application (e.g., fluoroscopic image)

C.8.15.3.3 CT Acquisition Details Macro

Table C.8-119 specifies the Attributes of the CT Acquisition Details Functional Group Macro.

Table C.8-119. CT Acquisition Details Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Acquisition Details Sequence	(0018,9304)	1	Contains the Attributes defining the details of the acquisition. If Multi-energy CT Acquisition (0018,9361) is NO or is absent, only a single Item shall be included in this Sequence. If Multi-energy CT Acquisition (0018,9361) is YES, one or more Items shall be included in this Sequence.
>Referenced Path Index	(0018,9378)	1C	References the X-Ray Path Index (0018,937A) in the Multi-energy CT Path Sequence (0018,9379) for this exposure. Note This attribute may contain multiple values if this item describes multiple paths. Required if Multi-energy CT Acquisition (0018,9361) is YES.
>Rotation Direction	(0018,1140)	1C	Direction of rotation of the source about the gantry, as viewed while facing the gantry where the table enters the gantry. Enumerated Values: **CW** clockwise **CC** counter clockwise Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL, and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE. Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED or Image Type (0008,0008) Value 1 is DERIVED, and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.
>Revolution Time	(0018,9305)	1C	The time in seconds of a complete revolution of the source around the gantry orbit. This value is independent of the Reconstruction Angle (0018,9319) of the frame. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL, and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE. Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED or Image Type (0008,0008) Value 1 is DERIVED, and Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.
>Single Collimation Width	(0018,9306)	1C	The width of a single row of acquired data (in mm). Note Adjacent physical detector rows may have been combined to form a single effective acquisition row. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Total Collimation Width	(0018,9307)	1C	The width of the total collimation (in mm) over the area of active X-Ray detection. Note This will be equal to the number of effective detector rows multiplied by single collimation width. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Table Height	(0018,1130)	1C	The distance in mm from the top of the patient table to the center of rotation of the source (i.e., the data collection center or isocenter). The distance is positive when the table is below the data collection center. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Gantry/Detector Tilt	(0018,1120)	1C	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations. Zero degrees means the gantry is not tilted, negative degrees are when the top of the gantry is tilted away from where the table enters the gantry. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Data Collection Diameter	(0018,0090)	1C	The diameter in mm of the region over which data were collected. See Section C.8.15.3.6.1. Note In the case of an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the diameter is that in a plane normal to the central ray of the diverging X-Ray beam as it passes through the data collection center. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.

C.8.15.3.4 CT Table Dynamics Macro

Table C.8-120 specifies the Attributes of the CT Table Dynamics Functional Group Macro.

Table C.8-120. CT Table Dynamics Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Table Dynamics Sequence	(0018,9308)	1	Contains the Attributes defining the movement of the CT table. Only a single Item shall be included in this Sequence.
>Table Speed	(0018,9309)	1C	The distance in mm that the table moves in one second during the gathering of data that resulted in this frame. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL or CONSTANT_ANGLE. May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL or CONSTANT_ANGLE.

Attribute Name	Tag	Type	Attribute Description
>Table Feed per Rotation	(0018,9310)	1C	Motion of the table (in mm) during a complete revolution of the source around the gantry orbit. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL. May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL.
>Spiral Pitch Factor	(0018,9311)	1C	Ratio of the Table Feed per Rotation (0018,9310) to the Total Collimation Width (0018,9307). See Section C.8.15.3.4.1 for further explanation and some examples. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Acquisition Type (0018,9302) is SPIRAL. May be present otherwise if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Acquisition Type (0018,9302) is SPIRAL.

C.8.15.3.4.1 Spiral Pitch Factor

The formula for Spiral Pitch Factor (0018,9311) in terms of Table Feed per Rotation (0018,9310) and Total Collimation Width (0018,9307) is:

Spiral Pitch Factor = (Table Feed per Rotation (mm))/(Total Collimation Width (mm))

An example calculation of Spiral Pitch Factor (0018,9311) for a single slice spiral acquisition of an image with a Total Collimation Width of 2.5mm and a Table Feed per Rotation of 10mm is:

Spiral Pitch Factor = (10 mm) / (2.5 mm) = 4.0

An example calculation of Spiral Pitch Factor (0018,9311) for a multiple slice spiral acquisition having a Total Collimation Width of 20mm and a Table Feed per Rotation of 10mm is:

Spiral Pitch Factor = (10 mm) / (20 mm) = 0.5

C.8.15.3.5 CT Position Macro

Table C.8-121 specifies the Attributes of the CT Position Functional Group Macro.

Table C.8-121. CT Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Position Sequence	(0018,9326)	1	Contains the Attributes defining the CT geometry. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Table Position	(0018,9327)	1C	Relative longitudinal position of acquisition location of this frame in mm from an implementation specific reference point. Shall be relative to the same reference point for all frames in this SOP Instance, but may be different from the reference point in other SOP Instances. Positions as the table moves into the gantry viewed from the front are more negative. Note 1. For contiguous slices reconstructed from multiple detectors one would expect different values for adjacent slices. 2. Lateral positioning or tilting or swiveling are not described. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Data Collection Center (Patient)	(0018,9313)	1C	The x, y, and z coordinates (in the Patient-Based Coordinate System) in mm of the center of the region in which data were collected. See Section C.8.15.3.6.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Reconstruction Target Center (Patient)	(0018,9318)	1C	The x, y, and z coordinates (in the Patient-Based Coordinate System) of the reconstruction center target point as used for reconstruction in mm. See Section C.8.15.3.6.1. Note If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (0018,9313) Attribute. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.

C.8.15.3.6 CT Geometry Macro

Table C.8-122 specifies the Attributes of the CT Geometry Functional Group Macro.

Table C.8-122. CT Geometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Geometry Sequence	(0018,9312)	1	Contains the Attributes defining the CT geometry. If Multi-energy CT Acquisition (0018,9361) is NO or is absent, only a single Item shall be included in this Sequence. If Multi-energy CT Acquisition (0018,9361) is YES, one or more Items shall be included in this Sequence.
>Referenced Path Index	(0018,9378)	1C	References the X-Ray Path Index (0018,937A) in the Multi-energy CT Path Sequence (0018,9379) for this exposure. Note This attribute may contain multiple values if this item describes multiple paths. Required if Multi-energy CT Acquisition (0018,9361) is YES.

Attribute Name	Tag	Type	Attribute Description
>Distance Source to Detector	(0018,1110)	1C	Distance in mm from source to detector center. See Section C.8.15.3.6.1. Note This value is traditionally referred to as Source Image Receptor Distance (SID). Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Distance Source to Data Collection Center	(0018,9335)	1C	Distance in mm from source to data collection center. See Section C.8.15.3.6.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.

C.8.15.3.6.1 Relationships Between CT Geometric Attributes (Informative)

In Figure C.8-19 the relationship of the Geometric Attributes within the CT Geometry and CT Reconstruction Functional Groups is shown. In this example, the Pixel Data is shown encoding the entire reconstructed region with no outside padding or clipping, and the reconstructed region is illustrated as being square, i.e., the value of Reconstruction Diameter would be the same as both values of Reconstruction Field of View, whichever Attribute is present. Figure C.8-19, viewed from the front of the gantry (where the table enters the gantry), is informative only and is not meant to represent a standardization of an equipment-based Frame of Reference.

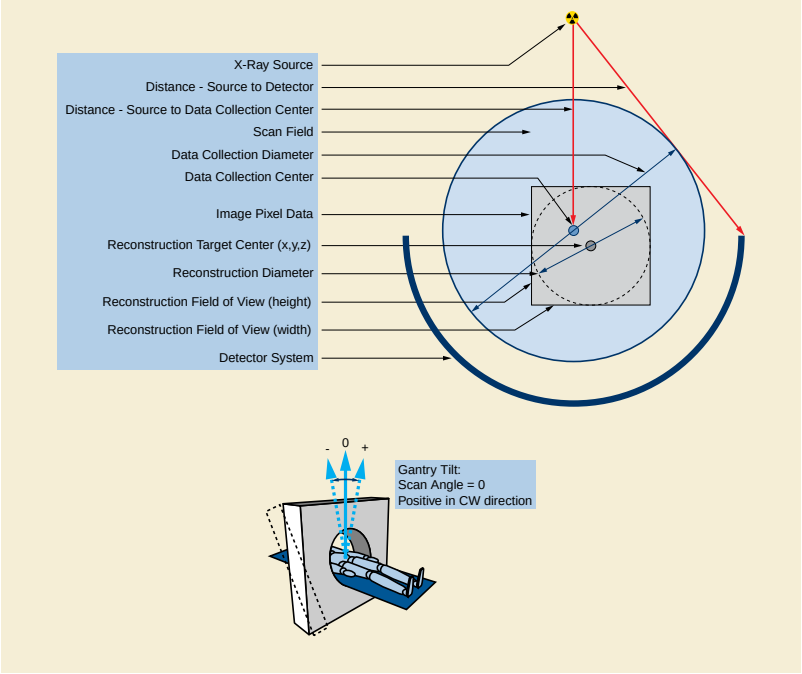


Figure C.8-19. Geometry of CT Acquisition System

C.8.15.3.7 CT Reconstruction Macro

Table C.8-123 specifies the Attributes of the CT Reconstruction Functional Group Macro.

Table C.8-123. CT Reconstruction Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Reconstruction Sequence	(0018,9314)	1	Contains the Attributes holding information about the reconstruction techniques used. Only a single Item shall be included in this Sequence.
>Reconstruction Algorithm	(0018,9315)	1C	Description of the algorithm used when reconstructing the image from the data acquired during the acquisition process. Defined Terms: **FILTER_BACK_PROJ** **ITERATIVE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Convolution Kernel	(0018,1210)	1C	A label describing the convolution kernel or algorithm used to reconstruct the data. A single value shall be present. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Convolution Kernel Group	(0018,9316)	1C	A label describing the group to which Convolution Kernel (0018,1210). Defined Terms: **BRAIN** **SOFT_TISSUE** **LUNG** **BONE** **CONSTANT_ANGLE** Required if Convolution Kernel (0018,1210) is present. May be present otherwise.
>Reconstruction Diameter	(0018,1100)	1C	The diameter in mm of the region from which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. See Section C.8.15.3.6.1. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011). Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Reconstruction Field of View (0018,9317) is not present. Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Reconstruction Field of View (0018,9317) is not present.

Attribute Name	Tag	Type	Attribute Description
>Reconstruction Field of View	(0018,9317)	1C	The field of view width followed by height as used for reconstruction in mm. Note If not cropped or padded, for both Pixel Spacing (0028,0030) and Reconstruction Pixel Spacing (0018,9322): • The first value (adjacent row spacing) will be equal to the second value of Reconstruction Field of View (0018,9317) / Rows (0028,0010). • The second value (adjacent column spacing) will be equal to the first value of Reconstruction Field of View (0018,9317) / Columns (0028,0011). Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Reconstruction Diameter (0018,1100) is not present. Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED and Reconstruction Diameter (0018,1100) is not present.
>Reconstruction Pixel Spacing	(0018,9322)	1C	Physical distance in the patient between the center of each reconstructed pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Note The values of Reconstruction Pixel Spacing (0018,9322) will equal the corresponding values of Pixel Spacing (0028,0030) unless the pixel data has been post-processed to change the pixel size after reconstruction and before storage. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Reconstruction Angle	(0018,9319)	1C	Angle (in degrees) over which the data from which the frame was reconstructed was collected, where 360 degrees signifies a complete revolution of the source around the gantry orbit. It is possible, in the case of over-scanning that the Reconstruction Angle is greater than 360 degrees. Shall be 0 if Acquisition Type (0018,9302) is CONSTANT_ANGLE. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Image Filter	(0018,9320)	1C	A label describing the filter applied to the reconstructed image after the original reconstruction has been completed. Note When Frame Type (0008,9007) Value 1 of this frame is DERIVED and Frame Type (0008,9007) Value 4 is FILTERED the type of filtration is described in Derivation Image Macro. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL.

C.8.15.3.8 CT Exposure Macro

Table C.8-124 specifies the Attributes of the CT Exposure Functional Group Macro.

Table C.8-124. CT Exposure Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Exposure Sequence	(0018,9321)	1	Contains the Attributes defining exposure information. If Multi-energy CT Acquisition (0018,9361) is NO or is absent, only a single Item shall be included in this Sequence. If Multi-energy CT Acquisition (0018,9361) is YES, one or more Items shall be included in this Sequence.
>Referenced X-Ray Source Index	(0018,9377)	1C	References the X-Ray Source Index (0018,9366) in the Multi-energy CT Source Sequence (0018,9365) for which exposure details are specified here. Note This Attribute may contain multiple values if this Item summarizes the total exposure from multiple sources e.g., from multiple switching phases from a switching source. Required if Multi-energy CT Acquisition (0018,9361) is YES.
>Exposure Time in ms	(0018,9328)	1C	Duration of exposure for this frame in milliseconds. If Acquisition Type (0018,9302) equals SPIRAL the duration of the exposure time for this frame shall be Revolution Time (0018,9305) divided by the Spiral Pitch Factor (0018,9311). See Section C.8.15.3.8.1. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL, or if Image Type (0008,0008) Value 1 is ORIGINAL and Multi-energy CT Acquisition (0018,9361) is YES. May be present otherwise.
>X-Ray Tube Current in mA	(0018,9330)	1C	Nominal X-Ray tube current in milliamperes. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Exposure in mAs	(0018,9332)	1C	The exposure expressed in milliampere seconds, for example calculated from exposure time and X-Ray tube current. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Exposure Modulation Type	(0018,9323)	1C	A label describing the type of exposure modulation used for the purpose of limiting the dose. Defined Terms: **NONE** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Estimated Dose Saving	(0018,9324)	2C	A percent value of dose saving due to the use of Exposure Modulation Type (0018,9323). A negative percent value of dose savings reflects an increase of exposure. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Exposure Modulation Type (0018,9323) is not equal to NONE. Otherwise may be present if Frame Type (0008,9007) Value 1 of this frame is DERIVED or Image Type (0008,0008) Value 1 is DERIVED, and Exposure Modulation Type (0018,9323) is not equal to NONE.

Attribute Name	Tag	Type	Attribute Description
>CTDIvol	(0018,9345)	2C	Computed Tomography Dose Index ($CTDI_{vol}$), in mGy according to [IEC 60601-2-44] ~~(Clause 29.1.103.4), The Volume~~. The $CTDI_{vol}$~~. It~~ describes the average dose for this frame for the selected CT conditions of operation. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>CTDI Phantom Type Code Sequence	(0018,9346)	3	The type of phantom used for CTDI measurement according to [IEC 60601-2-44]. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4052 "Phantom Devices".*
>Water Equivalent Diameter	(0018,1271)	3	The diameter, in mm, of a cylinder of water having the same X-Ray attenuation as the patient for this reconstructed slice (e.g., as described in [AAPM Report 220]).
>Water Equivalent Diameter Calculation Method Code Sequence	(0018,1272)	1C	The method of calculation of Water Equivalent Diameter (0018,1271). Required if Water Equivalent Diameter (0018,1271) is present. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 10024 "Water Equivalent Diameter Method".*
>Image and Fluoroscopy Area Dose Product	(0018,115E)	3	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of the entire Irradiation Event from which this image and frame was reconstructed. Note 1. All of the images and frames reconstructed from the same Irradiation Event will have the same value for this Attribute, which is the total for the Irradiation Event, which is repeated in each image or frame, regardless of whether or not the Irradiation Event UID (0008,3010) is present with a value in the Irradiation Event Identification Macro. I.e., the values for each image or frame should not be summed. The sum of the area dose products for each Irradiation Event may not result in the total area dose product to which the patient was exposed. 2. This may be an estimated value based on assumptions about the patient's body size and habitus. 3. This value is required by [IEC 60601-2-63].

Note

The dose that a patient receives in a given procedure may be reported in one or more Instances of the Radiation Dose Report SOP Class using TID 10011 "CT Radiation Dose".

C.8.15.3.8.1 Exposure Time in ms Attribute (Informative)

An example of how the value of Exposure Time in ms (0018,9328) can be calculated:

The Exposure Time $T_{exposuretime}$ of a volume shall be the time of the X-Ray radiation in position with this volume. It depends on the travel speed and the total collimation width.

$T_{exposuretime}$ of the volume represented by a distinguished frame of a Spiral Scan can be calculated as follows:

$T_{exposuretime} = N \times S / V_{travelspeed}$

$CT_{pitchfactor} = DD / N \times S$

$V_{travelspeed} = DD / T_{revolutiontime}$

From this the exposure time can be derived:

$T_{exposuretime} = N \times S \times T_{revolutiontime} / DD = T_{revolutiontime} / CT_{pitchfactor}$

Legend:

DD = Table Feed per Rotation (0018,9310) in mm distance moved by the patient support in the z direction per 360° revolution in Spiral scanning

S = collimation of a single slice in mm

N = number slices

N x S = Total Collimation Width (0018,9307) in mm

$V_{travelspeed}$ = Table Speed (0018,9309) in mm/second, travel speed of the patient table

$T_{revolutiontime}$ = Revolution time (0018,9305) in seconds

$CT_{pitchfactor}$ = Spiral Pitch Factor (0018,9311)

C.8.15.3.9 CT X-Ray Details Macro

Table C.8-125 specifies the Attributes of the CT X-Ray Details Functional Group Macro.

Table C.8-125. CT X-Ray Details Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT X-Ray Details Sequence	(0018,9325)	1	Contains the Attributes defining the X-Ray information. If Multi-energy CT Acquisition (0018,9361) is NO or is absent, only a single Item shall be included in this Sequence. If Multi-energy CT Acquisition (0018,9361) is YES, one or more Items shall be included in this Sequence.
>Referenced Path Index	(0018,9378)	1C	References the X-Ray Path Index (0018,937A) in the Multi-energy CT Path Sequence (0018,9379) for this exposure. Note This attribute may contain multiple values if this item describes multiple paths. Required if Multi-energy CT Acquisition (0018,9361) is YES.

Attribute Name	Tag	Type	Attribute Description
>KVP	(0018,0060)	1C	Nominal peak kilo voltage output of the X-Ray generator used. If Multi-energy Source Technique (0018,9368) in Multi-energy CT X-Ray Source Sequence (0018,9365) (of the referenced Multi-energy CT Path Index (0018,937A)) is “SWITCHING_SOURCE”, this value is the nominal peak value for a switching phase. The switching phase is identified by the value of X-Ray Source Index (0018,9366) in the Multi-energy CT Path Sequence (0018,9379) corresponding to the value of Referenced Path Index (0018,9378) in this Sequence. Due to limitations of the generating hardware the actual voltage may not reach the nominal peak value. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Focal Spot(s)	(0018,1190)	1C	Used nominal size of the focal spot in mm. The Attribute may only have one or two values, for devices with variable focal spot, small dimension followed by large dimension Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Filter Type	(0018,1160)	1C	Type of filter(s) inserted into the X-Ray beam. Defined Terms: **WEDGE** **BUTTERFLY** **MULTIPLE** **FLAT** **SHAPED** **NONE** Note Multiple type of filters can be expressed by a combination, e.g., BUTTERFLY+WEDGE. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Filter Material	(0018,7050)	1C	The X-Ray absorbing material used in the filter. May be multi-valued. Defined Terms: **MOLYBDENUM** **ALUMINUM** **COPPER** **RHODIUM** **NIOBIUM** **EUROPIUM** **LEAD** **MIXED** Note MIXED may be used to indicate a filter type of complex composition for which listing the individual materials would be excessive or undesirable; it is not intended to mean "unknown". Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL or Image Type (0008,0008) Value 1 is ORIGINAL, and the value of Filter Type (0018,1160) is other than NONE. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Calcium Scoring Mass Factor Patient	(0018,9351)	3	The calibration factor for the calcium mass score. These factors incorporate the effects of • KV value of the CT image • the patient size. • machine specific corrections See Section C.8.2.1.1.7.
>Calcium Scoring Mass Factor Device	(0018,9352)	3	The calibration factors for the calcium mass score of the device. These factors incorporate the effects of • KV value of the CT image • machine specific corrections This a multi-value Attribute, the first value specifies the mass factor for a small patient size, the second value for a medium patient size and the third value for a large patient size. See Section C.8.2.1.1.7.
>Energy Weighting Factor	(0018,9353)	1C	The weighting factor of the data from this Sequence Item. Required if Required if Frame Type (0008,9007) Value 4 of this frame is ENERGY_PROP_WT or Image Type (0008,0008) Value 4 is ENERGY_PROP_WT. May be present otherwise.

C.8.15.3.10 CT Pixel Value Transformation Macro

Table C.8-126 specifies the Attributes of the CT Pixel Value Transformation Functional Group Macro.

Note

1. This Macro is equivalent to the Modality LUT transformation in non Multi-frame IODs.
2. This in effect specializes the Section C.7.6.16.2.9 Pixel Value Transformation Macro.

Table C.8-126. CT Pixel Value Transformation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Value Transformation Sequence	(0028,9145)	1	Contains the Attributes involved in the transformation of stored pixel values. Only a single Item shall be included in this Sequence.
>Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b.
>Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052).
>Rescale Type	(0028,1054)	1	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. If Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Frame Type (0008,9007) Value 3 is not LOCALIZER, the value shall be HU (Hounsfield Units).

C.8.15.3.11 CT Additional X-Ray Source Macro

Table C.8-126b specifies the Attributes of the CT Additional X-Ray Source Macro. This Sequence may be multi-valued, depending on the number of additional active X-Ray sources. It defines the X-Ray source parameters beyond the basic system.

Table C.8-126b. CT Additional X-Ray Source Macro Attributes

Attribute Name	Tag	Type	Attribute Description
CT Additional X-Ray Source Sequence	(0018,9360)	1	Contains the Attributes defining the data acquisition in a multiple X-Ray source system beyond the primary source. The primary X-Ray source is specified in the CT X-Ray Details Sequence. One or more Items shall be included in this Sequence.
>KVP	(0018,0060)	1	Peak kilo voltage output of the X-Ray generator used.
>X-Ray Tube Current in mA	(0018,9330)	1	Nominal X-Ray tube current in milliamperes.
>Data Collection Diameter	(0018,0090)	1	The diameter in mm of the region over which data were collected.
>Focal Spot(s)	(0018,1190)	1	Used nominal size of the focal spot in mm.
>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam. See Section C.8.15.3.9.
>Filter Material	(0018,7050)	1	The X-Ray absorbing material used in the filter.
>Exposure in mAs	(0018,9332)	1	The exposure expressed in milliampere seconds, for example calculated from exposure time and X-Ray tube current.
>Energy Weighting Factor	(0018,9353)	1C	The weighting factor of the data from this additional source in a multiple energy composition image. This factor incorporates the effects of • the specific X-Ray source and kV value • examination specific characteristics. Required if Required if Frame Type (0008,9007) Value 4 of this frame is ENERGY_PROP_WT. May be present otherwise.

C.8.15.3.12 Multi-energy CT Characteristics Macro

This Macro specifies the Attributes for CT Image Characteristics.

Table C.8.15.3.12-1. Multi-energy CT Characteristics Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT Characteristics Sequence	(0018,9364)	1C	Multi-energy characteristics of the generated image. Required if Image Type (0008,0008) Value 4 is VMI. May be present otherwise. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Monoenergetic Energy Equivalent	(0018,937C)	1C	Single energy equivalent in keV. Required if Image Type (0008,0008) Value 4 is EQUAL to VMI. May be present otherwise. Note If the Image Type Value 4 is (MAT_REMOVED, MAT_MODIFIED) and a VMI image was used as the source then this value reflects the keV value of the VMI image.
>Derivation Algorithm Sequence	(0022,1612)	3	Software algorithm that performed the derivation. One or more Items are permitted in this Sequence.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			
>Performed Processing Parameters Sequence	(0074,1212)	3	Parameters used to perform the derivation algorithm. Note Implementers are encouraged to put the Algorithm Parameters here instead of in Algorithm Parameters (0066,0032) in the Algorithm Identification Macro One or more items are permitted in this Sequence.
>>Include Table 10.2.1-1 "Content Item with Modifiers Macro Attributes"			

C.8.15.3.13 Multi-energy CT Processing Macro

This Macro defines the Attributes for Multi-energy CT processing.

Table C.8.15.3.13-1. Multi-energy CT Processing Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-energy CT Processing Sequence	(0018,9363)	3	How the acquired Multi-energy data was processed to generate this image. Only a single Item is permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Decomposition Method	(0018,937E)	1	Method used to decompose the acquired Multi-energy CT data into basis data. Defined Terms: **PROJECTION_BASED** The acquired projection data was fully decomposed into basis projection data (i.e. sinograms). **IMAGE_BASED** The acquired projection data was fully reconstructed into images before being decomposed into basis image data. **HYBRID** The acquired projection data was reconstructed using knowledge in both projection and image space to produce basis image data. Decomposition and image reconstruction may be performed in a one-step approach. Note 1. Basis images and basis projection data are not necessarily instantiated as DICOM Instances. 2. There may be additional processing steps (e.g. linear combination of basis data) creating the result image.
>Decomposition Description	(0018,937F)	3	Description of decomposition method
>Decomposition Algorithm Identification Sequence	(0018,9380)	3	Algorithm used for decomposition of the acquired data. One or more Items are permitted in this Sequence.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			
>Decomposition Material Sequence	(0018,9381)	3	Basis materials used in the decomposition process. Two or more Items are permitted in this Sequence.
>>Material Code Sequence	(0018,937D)	1	Nominal material for Multi-energy CT processing. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 300 "Multi-energy Relevant Materials".*
>>Material Attenuation Sequence	(0018,9382)	3	Attenuation curve of the material, defined as a set of points. Two or more Items are ~~permittedin~~permitted in this Sequence. Note Attenuation curves for non-standard materials can be generated by NIST http://physics.nist.gov/PhysRefData/Xcom/html/xcom1.html.
>>>Photon Energy	(0018,9383)	1	Photon energy in keV.
>>>X-Ray Mass Attenuation Coefficient	(0018,9384)	1	Attenuation of this material at the specific Photon Energy (0018,9383), normalized to material density.

C.8.15.4 Enhanced Multi-energy CT Acquisition Module

Table C.8.15.4-1 specifies the Attributes that describe the Multi-energy CT Acquisition technique in the Enhanced CT Image.

Table C.8.15.4-1. Enhanced Multi-energy CT Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8.2.2-2 "Multi-energy CT X-Ray Source Macro Attributes"			*See Section C.8.2.2.1.*
Include Table C.8.2.2-3 "Multi-energy CT X-Ray Detector Macro Attributes"			*See Section C.8.2.2.2.*
Include Table C.8.2.2-4 "Multi-energy CT Path Macro Attributes"			*See Section C.8.2.2.3.*

C.8.16 Common CT, MR and US Descriptions

This section contains descriptions of Macros and Attributes used in Modules and Functional Group Macros that are common to the Enhanced CT Image, Enhanced MR Images, MR Spectroscopy and Enhanced US Volume IODs.

C.8.16.1 Image Type and Frame Type

Image Type (0008,0008) and associated Image Type related Attributes provide a high level description of a multi-frame SOP Instance. These Attributes describe properties that provide key summary information to users of the SOP Instance. Image Type (0008,0008) contains the highest level summary of what is in the SOP Instance.

Frame Type (0008,9007) mirrors the corresponding Image Type Attribute and applies to the frame level rather than to the image level.

If more than one value is used by the set of frames for a given Frame Type (0008,9007) Attribute value or associated Attribute value then the corresponding value of Image Type (0008,0008) or associated Attribute shall contain a value of MIXED. This indicates that a mixed set of values exists within the multi-frame SOP Instance.

The value MIXED shall only be used in Image Type (0008,0008) when the corresponding values for the individual frames are not equal. When a value of an Attribute is equal for all frames, the same value shall be used for the corresponding value of Image Type (0008,0008). Values 2 and 3 of Image Type (0008,0008) are an exception to the rule for MIXED: Values 2 and 3 may never have the value of MIXED as described in Section C.8.16.1.2 and Section C.8.16.1.3.

Image Type (0008,0008) and Frame Type (0008,9007) shall consist of four values.

C.8.16.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) shall use one of the following Enumerated Values from Table C.8-127.

Value 1 of Image Type (0008,0008) and Value 1 of Frame Type (0008,9007) shall not be zero length.

Table C.8-127. Image Type and Frame Type Value 1

Enumerated Value Name	Enumerated Value Description
ORIGINAL	An image or frame is original if its pixel data was directly reconstructed from the original data that is obtained from the sensors of the imaging equipment, Image Type (0008,0008) Value 4 is NONE, and Volume Based Calculation Technique (0008,9207) is NONE. Note 1. For MR, original data is data directly reconstructed from k-space data. 2. For CT, original frames are those directly reconstructed from projection data.
DERIVED	An image or frame is derived if its pixel data was calculated from original or other derived pixel data (i.e., it is not original).
MIXED	Used only as a value in Image Type (0008,0008) if frames within the SOP Instance contain different values for Value 1 in their Frame Type (0008,9007).

C.8.16.1.2 Patient Examination Characteristics

Value 2 for Image Type (0008,0008) and Frame Type (0008,9007) follows the standard definition and shall have the following Enumerated Value from Table C.8-128.

Value 2 of Image Type (0008,0008) and Value 2 of Frame Type (0008,9007) shall not be zero length.

Table C.8-128. Image Type and Frame Type Value 2

Enumerated Value Name	Enumerated Value Description
PRIMARY	See Section C.7.6.1.1.2

C.8.16.1.3 Image Flavor

Value 3 is an overall representation of the image type. This value may be a summary of several other Attributes or a duplication of one of the other Attributes to indicate the most important aspect of this image. Value 3 Image Flavor is to be used with Value 4 Derived Pixel Contrast to indicate the nature of the image set.

Note

For example Value 3 = DIFFUSION together with Value 4 = NONE indicates that the image set was originally collected for DIFFUSION.

If Value 3 = DIFFUSION together with Value 4 = DIFFUSION this indicates that the object contains DIFFUSION weighted post processed images.

Value 3 of Image Type (0008,0008) shall not be zero length.

Value 3 of Frame Type (0008,9007) may have the same value as found in Value 3 of Image Type (0008,0008), or may have a different value.

The Attribute value may not be MIXED as this value needs to be a summary of the primary purpose of the images, whether the frames have the same value or not.

Table C.8-129 specifies the Defined Terms for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007) that are common to CT and MR. Additional Defined Terms are defined in the modality-specific Module and Macro definitions.

Table C.8-129. Image Type and Frame Type Value 3 Common

Defined Term Name	Defined Term Description
ANGIO	Collected for the purpose of angiography
CARDIAC	Images of the heart
CARDIAC_GATED	Cardiac gated images, other than of the heart
CARDRESP_GATED	Cardiac and respiratory gated images
DYNAMIC	An image in which the same anatomical volume is imaged at multiple times in order to capture images of a non-cyclic, time varying event. For example, imaging of the uptake of a tracer or contrast in a specific organ over time. Note This is different from gating techniques, in which the same anatomical volume is imaged during some portion of a cyclic event, e.g., inspiration or R-R Interval.
FLUOROSCOPY	Real-time collection of single slices (e.g., CT or MR Fluoroscopy)
LOCALIZER	Collected for the purpose of planning other images.
MOTION	Collected for looking at body motion
PERFUSION	Collected for the purposes of perfusion calculations.

Defined Term Name	Defined Term Description
PRE_CONTRAST	Collected before contrast was administered
POST_CONTRAST	Collected during or after contrast was administered
RESP_GATED	Respiratory gated images
REST	Cardiac rest image set
STATIC	A group of frames at varying spatial locations acquired at the same time.
STRESS	Cardiac stress image set
VOLUME	Set of frames that define a regularly sampled volume
NON_PARALLEL	Set of frames that are not parallel
PARALLEL	Set of frames that are parallel but do not constitute a regularly sampled volume
WHOLE_BODY	A group of frames of the whole body; the frames may be acquired at various times (as distinct from STATIC).

C.8.16.1.4 Derived Pixel Contrast

Value 4 shall be used to indicate derived pixel contrast - generally, contrast created by combining or processing images with the same geometry. Value 4 shall have a value of NONE when Value 1 is ORIGINAL.

Value 4 may have the value QUANTITY if the derived pixel contrast is described in the Quantity Definition Sequence (0040,9220) of the Real World Value Mapping Functional Group Macro.

Note

If more than one of the following derived types is applicable, then it is up to the generating application to specify the value that best characterizes the derived image.

Value 4 of Image Type (0008,0008) and Value 4 of Frame Type (0008,9007) shall not be zero length unless the SOP Class UID is "1.2.840.10008.5.1.4.1.1.2.2" or "1.2.840.10008.5.1.4.1.1.4.4" or "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted).

Table C.8-130 specifies the Defined Terms for Value 4 for Image Type (0008,0008) and Frame Type (0008,9007) that are common to CT and MR. Additional Defined Terms are defined in the modality-specific Module and Macro definitions.

Table C.8-130. Image Type and Frame Type Value 4 Common

Defined Term Name	Defined Term Description
ADDITION	Created through Pixel by pixel addition operation
DIVISION	Created through Pixel by pixel division operation
MASKED	Created through Pixel by pixel masking operation
MAXIMUM	Created through Pixel by Pixel maximum operation
MEAN	Created through Pixel by pixel mean operation
MINIMUM	Created through Pixel by Pixel minimum operation
MULTIPLICATION	Created through Pixel by pixel multiplication operation
RESAMPLED	Pixels have been spatially re-sampled, e.g., MPR
STD_DEVIATION	Standard Deviation
SUBTRACTION	Created through Pixel by pixel subtraction operation
NONE	Not a calculated image
QUANTITY	Derived pixel values are a quantity described by Quantity Definition Sequence (0040,9220) of the Real World Value Mapping Functional Group Macro.
MIXED	Used only as value in Image Type (0008,0008) if frames within the image SOP Instance contain different values for value 4 in their Frame Type (0008,9007) Attribute.

C.8.16.2 Common CT/MR Image Description Macro

This section describes the Common CT/MR Image Description Macro.

Table C.8-131 specifies the Attributes of the Common CT/MR Image Description Macro.

Table C.8-131. Common CT/MR Image Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Presentation	(0008,9205)	1	Indication of the presence or absence of color information that may be used during rendering. See Section C.8.16.2.1.1 for a description and Enumerated Values.
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See Section C.8.16.2.1.2 for a description and Enumerated Values.
Volume Based Calculation Technique	(0008,9207)	1	Method used for volume calculations with frames in the SOP Instance. See Section C.8.16.2.1.3 for a description and Defined Terms.

C.8.16.2.1 Common CT/MR Image Description Attribute Description

C.8.16.2.1.1 Pixel Presentation

Table C.8-132. Pixel Presentation Attribute Values

Enumerated Value Name	Enumerated Value Description
COLOR	Image is best displayed in color using Supplemental Palette Color LUTs, but can be displayed in grayscale if current display does not support color. See Section C.8.16.2.1.1.1.
MONOCHROME	Image is intended to be displayed in grayscale only. No Supplemental Palette Color LUTs are supplied.
MIXED	Used only as a value in Pixel Presentation (0008,9205) in the Enhanced MR Image Module or Enhanced CT Image Module if frames within the image SOP Instance contain different values for the Pixel Presentation Attribute in the MR Image Frame Type Functional Group or CT Image Frame Type Functional Group.
TRUE_COLOR	Image can be displayed in color only

C.8.16.2.1.1.1 Supplemental Palette Color LUTs

Figure C.8-20 presents two separate image visualization pipelines that can be used for interpreting the stored pixel values.

If Pixel Presentation (0008,9205) equals COLOR, the stored values are split into two ranges. The stored values up to one less than the second value of the Red, Green and Blue Palette Color Lookup Table Descriptor (0028,1101-1103) are passed through the gray scale visualization pipeline. The values equal to or greater than the second value of the Red, Green and Blue Palette Color Lookup Table Descriptor (0028,1101-1103) are mapped by the Palette Color LUTs.

Note

1. Some images may be purely color, and there will be no grayscale range of stored pixel values "below" those that are passed through the color lookup tables.
2. Images containing Supplemental Palette Color LUTs cannot be irreversibly (lossy) compressed, since that would potentially change the index values and result in different colors being rendered.

The complete range of stored pixel values can also be displayed via the grayscale visualization pipeline only, but the information content may be less useful because the color information is not available.

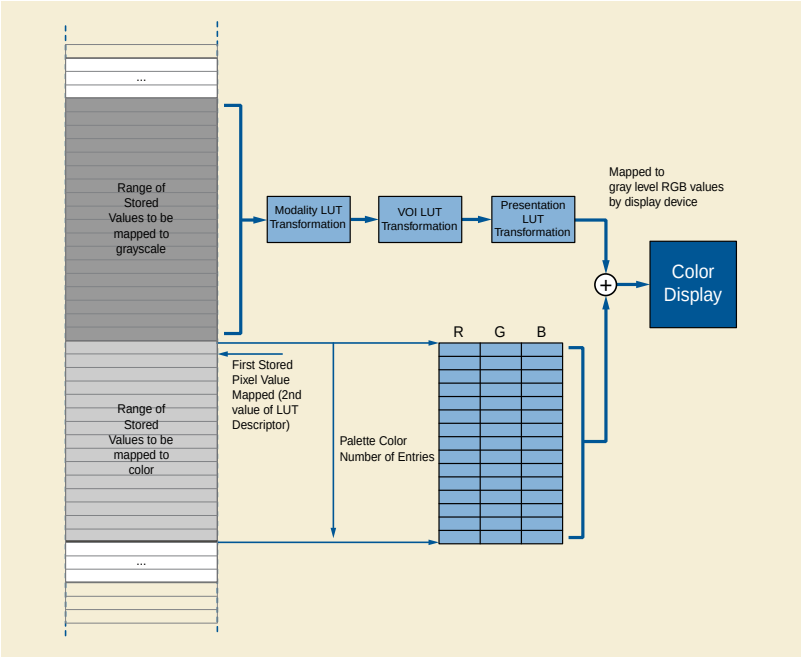


Figure C.8-20. MONOCHROME2 Photometric Interpretation with Supplemental Palette Color Mapping

C.8.16.2.1.2 Volumetric Properties

The value of Volumetric Properties (0008,9206) allows applications doing geometric manipulations (e.g., MAX_IP or MPR or planning) to determine if the image is an appropriate candidate for an operation without having to know all the details of the generating application.

Table C.8-133 specifies the Enumerated Values for Volumetric Properties (0008,9206).

Table C.8-133. Volumetric Properties Attribute Values

Enumerated Value Name	Enumerated Value Description
VOLUME	Image contains pixels that represent the volume specified for the image (Examples: Volume Based Calculation Technique (0008,9207) is NONE or MPR).
SAMPLED	The specified frame or each frame within the image will not contain a representation of the average information in the slice direction because the frame was calculated by the non-linear re-sampling of a volume where each pixels of the resulting frame does not contain an average representation of the voxel represented by the frame's pixel. For example a projection (MAX_IP) frame uses the maximum value along a ray for each pixel rather than the average value of the represented voxel.
DISTORTED	Image contains significantly distorted information from what is specified by the image volume Attributes. For example this image should not be used in planning or for 3D volume. An example of this image type is a curved reformatted image (CURVED_MPR).
MIXED	Used only as a value in Volumetric Properties (0008,9206) in the Enhanced MR Image Module Attribute Description or Enhanced CT Image Module if frames within the image SOP Instance contain different values for Volumetric Properties (0008,9206) in the MR Image Frame Type Functional Group or CT Frame Type Functional Group.

Note

A value of MIXED may be necessary if creating a Legacy Converted Enhanced image and insufficient information is present to specify a more specific value.

C.8.16.2.1.3 Volume Based Calculation Technique Attribute

The value of Volume Based Calculation Technique (0008,9207) shall be used to indicate the method used for calculating pixels based on geometry.

Shall have a value of NONE when Value 1 of Image Type (0008,0008) or Value 1 of Frame Type (0008,9007) is ORIGINAL.

Table C.8-134 specifies the Defined Terms for the Volume Based Calculation Technique (0008,9207) Attribute.

Table C.8-134. Volume Based Calculation Technique Attribute Values

Defined Term Name	Defined Term Description
MAX_IP	Maximum Intensity Projection
MIN_IP	Minimum Intensity Projection
VOLUME_RENDER	Volume Rendering Projection Volume Rendering Image represents 3D voluminar information constructed from measured voxel intensities covering a 3D volume.
SURFACE_RENDER	Surface Rendering Projection Surface Rendering Image represents 3D surface information constructed from measured voxel intensities covering a 3D volume.
MPR	Multi-Planar Reformat
CURVED_MPR	Curved Multi-Planar Reformat
NONE	Pixels not derived geometrically
MIXED	Used only as a value in Volume Based Calculation Technique (0008,9207) Attribute in the Enhanced MR Image Module or MR Spectroscopy Module if frames within the image SOP Instance contain different terms for the Volume Based Calculation Technique Attribute in MR Frame Type Functional Group or MR Spectroscopy Frame Type Functional Group.

Note

A value of MIXED may be necessary if creating a Legacy Converted Enhanced image and insufficient information is present to specify a more specific value.

C.8.17 Ophthalmic Photography and Tomography Modules

C.8.17.1 Ophthalmic Photography Series Module

Table C.8.17.1-1 specifies the Attributes that describe an Ophthalmic Photography Series.

Table C.8.17.1-1. Ophthalmic Photography Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Source equipment that produced the Ophthalmic Photography Series. Enumerated Values: **OP**

C.8.17.2 Ophthalmic Photography Image Module

Table C.8.17.2-1 specifies the Attributes that describe an Ophthalmic Photography Image produced by Ophthalmic Photography equipment (OP) imaging Modalities.

Table C.8.17.2-1. Ophthalmic Photography Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.17.2.1.4 for specialization.
Instance Number	(0020,0013)	1	A number that identifies this image.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **3** **1** See Section C.8.17.2.1.2 for further explanation.
Samples per Pixel Used	(0028,0003)	1C	The number of samples (planes) containing information. Enumerated Values: **2** Required if different from Samples per Pixel (0028,0002). See Section C.8.17.2.1.2
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.17.2.1.3
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Enumerated Values: **0**
Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. Enumerated Values: **0** color-by-pixel

Attribute Name	Tag	Type	Attribute Description
Pixel Spacing	(0028,0030)	1C	Nominal physical distance at the focal plane (in the retina) between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Note These values are specified as nominal because the physical distance may vary across the field of the images and the lens correction is likely to be imperfect. Shall not be present when Two Dimensional to Three Dimensional Map Sequence (0022,1518) or X Coordinates Center Pixel View Angle (0022,1528) and Y Coordinates Center Pixel View Angle (0022,1529) are present. Otherwise, required when Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (409898007, SCT, "Fundus Camera"). May be present otherwise.
Content Time	(0008,0033)	1	The time the image pixel data creation started.
Content Date	(0008,0023)	1	The date the image pixel data creation started.
Acquisition DateTime	(0008,002A)	1C	The date and time that the acquisition of data started. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time Synchronized (0018,1800). Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Source Image Sequence	(0008,2112)	2C	A Sequence that identifies the Images that were used to derive this Image. Required if Image Type Value 1 is DERIVED. Zero or more Items shall be included in this Sequence. See Section C.12.4.1.2 for further explanation.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made, that is what role the source image or frame(s) played in the derivation of this image. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*DCID 7202 “Source Image Purposes of Reference”.*
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values. Required if Photometric Interpretation (0028,0004) is MONOCHROME2
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: **YES** **NO**
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **YES** **NO**
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.

C.8.17.2.1 Ophthalmic Photography Image Module Attribute Descriptions

C.8.17.2.1.1 Referenced Image Sequence

The Referenced Image Sequence (0008,1140) in the General Image Module (Section C.7.6.1) shall not convey stereoscopic information, which instead shall be encoded using the Stereometric Relationship IOD.

C.8.17.2.1.2 Samples Per Pixel and Samples Per Pixel Used

Samples per Pixel (0028,0002) shall be 1 or 3.

Cameras producing 2-color images are required to use a value of 3 for Samples per Pixel (0028,0002) and a value of 2 for Samples per Pixel Used (0028,0003). For 2-color images with a RGB Photometric Interpretation, the R and G channel shall be used and the B channel shall have all values set to zero.

Note

In the case of Photometric Interpretations typically used for compression such as YBR_FULL_422, the encoding will be as if the RGB values were transformed to YCbCr.

C.8.17.2.1.3 Photometric Interpretation

Specifies the intended interpretation of the pixel data.

Enumerated Values:

MONOCHROME2
RGB
YBR_FULL_422
YBR_PARTIAL_420
YBR_ICT
YBR_RCT

When Samples per Pixel (0028,0002) is greater than 1, Photometric Interpretation (0028,0004) shall be RGB for uncompressed or lossless compressed Transfer Syntaxes that do not have defined color space transformations, YBR_ICT for irreversible JPEG 2000 Transfer Syntaxes, YBR_RCT for reversible JPEG 2000 Transfer Syntaxes, YBR_PARTIAL_420 for MPEG2, MPEG-4 AVC/H.264 and HEVC/H.265 Transfer Syntaxes and YBR_FULL_422 for JPEG lossy compressed Transfer Syntaxes.

C.8.17.2.1.4 Image Type

The Image Type (0008,0008) Attribute (General Image Module, Section C.7.6.1) identifies important image characteristics in a multiple valued Data Element. For the Ophthalmic Photography Image IOD, Image Type is specified as a Type 1 Attribute and further specialized as follows:

- Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values for Value 1:
  ORIGINAL
  DERIVED

- Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values for Value 2:
  PRIMARY

- Value 3 shall only be present if Value 1 is DERIVED.

  Defined Terms for Value 3:
  MONTAGE

- Value 4 (optionally present) shall identify the type of test performed for image acquisition.

  Defined Terms for Value 4:

COLOR	a picture take at "white" light; no filters applied
REDFREE	a picture take at "green" illumination light; or just the green channel of a color sensor
RED	a picture take at "red" illumination light; or just the red channel of a color sensor
BLUE	a picture take at "blue" illumination light; or just the blue channel of a color sensor
FA	fluorescein injected; a picture taken at fluorescein exciting illumination light; a filter passing just the emitted wavelength to sensor applied
ICG	Indocyanine green injected; a picture taken at Indocyanine green exciting illumination light; a filter passing just the emitted wavelength to sensor applied

Note

A Montage Image is constructed out of several individual images, which also can be exchanged separately. The images used to create the montage image will be included in the Source Image Sequence (0008,2112) if those images are also exchanged. A Montage Image is identified as Image Type DERIVED\PRIMARY\MONTAGE

C.8.17.3 Ophthalmic Photographic Parameters Module

This Module describes equipment used to create original images.

Table C.8.17.3-1. Ophthalmic Photographic Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Device Type Code Sequence	(0022,0015)	1	Describes the type of acquisition device Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4202 “Ophthalmic Photography Acquisition Device”.*
Illumination Type Code Sequence	(0022,0016)	2	Coded value for illumination Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4203 “Ophthalmic Photography Illumination”.*
Light Path Filter Type Stack Code Sequence	(0022,0017)	2	Filters used in the light source path Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4204 “Ophthalmic Filter”.*
Light Path Filter Pass-Through Wavelength	(0022,0001)	3	Nominal pass-through wavelength of light path filter in nm
Light Path Filter Pass Band	(0022,0002)	3	Pass band of light path filter in nm. This Attribute has two Values. The first is the shorter and the second the longer wavelength relative to the peak. The values are for the - 3dB nominal (1/2 of peak) pass through intensity One of the two Values may be zero length, in which case it is a cutoff filter.
Image Path Filter Type Stack Code Sequence	(0022,0018)	2	Describes stack of filters used in image path Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4204 “Ophthalmic Filter”.*
Image Path Filter Pass-Through Wavelength	(0022,0003)	3	Nominal pass-through wavelength of image path filter in nm
Image Path Filter Pass Band	(0022,0004)	3	Pass band of image path filter in nm. This Attribute has two Values. The first is the shorter and the second the longer wavelength relative to the peak. The values are for the - 3dB nominal (1/2 of peak) pass through intensity One of the two Values may be zero length, in which case it is a cutoff filter
Lenses Code Sequence	(0022,0019)	2	Lenses that were used during the image acquisition Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4205 “Ophthalmic Lens”.*

Attribute Name	Tag	Type	Attribute Description
Detector Type	(0018,7004)	2	Type of detector used for creating this image. Defined Terms: **CCD** Charge Coupled Devices **CMOS** Complementary Metal Oxide Semiconductor
Channel Description Code Sequence	(0022,001A)	1C	Describes the light color used for each channel to generate the image. Required if this differs from the natural interpretation. Note Interpretation and representation of RGB images rely on the assumption that the red channel really contains the red wavelength range of illumination light, the blue channel the blue wavelength range, etc. Some modalities use the RGB Photometric Interpretation as a container representing 3 channels of any illumination wavelength. Shall have the same number of Items as the Value of Samples per Pixel Used (0028,0003) if present, or otherwise the value of Samples per Pixel (0028,0002). The channels shall be described in the order in which the channels are encoded.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4206 "Ophthalmic Channel Description".*
Camera Angle of View	(0022,001E)	3	The aperture angle of the camera, in degrees

C.8.17.4 Ophthalmic Photography Acquisition Parameters Module

This Module describes patient clinical conditions related to the image acquisition.

Table C.8.17.4-1. Ophthalmic Photography Acquisition Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Eye Movement Commanded	(0022,0005)	2	Enumerated Values: **YES** **NO**
Patient Eye Movement Command Code Sequence	(0022,0006)	1C	Coded value for patient movement or orientation, which is the intent, and not necessarily the result, based on what the patient is capable of. Required if the value of Patient Eye Movement Commanded (0022,0005) is YES. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4201 "Patient Eye Movement Command".*
Horizontal Field of View	(0022,000C)	2	The horizontal field of view in degrees
Include Table C.8.17.8-2 "Ophthalmic Acquisition Parameters Macro Attributes"			

C.8.17.5 Ocular Region Imaged Module

Table C.8.17.5-1 contains IOD Attributes that describe the anatomy imaged in an Ophthalmic Photography or Ophthalmic Tomography Image Storage SOP Instance.

Table C.8.17.5-1. Ocular Region Imaged Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Laterality	(0020,0062)	1	Laterality of object imaged (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right eye **L** left eye **B** both left and right eye Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series. Since most Ophthalmic Photographic Image Series contain images of both eyes, the Series level Attribute will rarely be present.
Relative Image Position Code Sequence	(0022,001D)	2C	The position of this image on the retina (as defined by a specified nomenclature; the nomenclature is implicit in the code used). Only a single Item is permitted in this Sequence. Required if Ophthalmic Volumetric Properties Flag (0022,1622) is set to YES and Attributes Ophthalmic Anatomic Reference Point X-Coordinate (0022,1624) and Ophthalmic Anatomic Reference Point Y-Coordinate (0022,1626) do not contain a value. May be present otherwise. Note This Attribute is used to provide the user with a general reference point when viewing the image. If the implementation is able to identify a precise anatomic location, it will convey that information in Attributes Ophthalmic Anatomic Reference Point X-Coordinate (0022,1624) and Ophthalmic Anatomic Reference Point Y-Coordinate (0022,1626).
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4207 "Ophthalmic Image Position".*
Ophthalmic Anatomic Reference Point X-Coordinate	(0022,1624)	2C	The horizontal offset location (column) of the anatomic reference point identified by Attribute Primary Anatomic Region Sequence (0008,2228). See Section C.8.17.5.1 for further explanation. Image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The value must be within the range 0\0 to Columns. Required if Ophthalmic Volumetric Properties Flag (0022,1622) is set to YES. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Anatomic Reference Point Y-Coordinate	(0022,1626)	2C	The vertical offset location (row) of the anatomic reference point identified by Attribute Primary Anatomic Region Sequence (0008,2228). See Section C.8.17.5.1 for further explanation. Image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The value must be within the range 0\0 to Rows. Required if Ophthalmic Volumetric Properties Flag (0022,1622) is set to YES. May be present otherwise.
Include Table 10-5 "General Anatomy Mandatory Macro Attributes"			*DCID 4209 "Ophthalmic Anatomic Structure Imaged" for Anatomic Region Sequence.* *DCID 4266 "Ophthalmic Anatomic Structure Reference Point" for Primary Anatomic Structure Sequence.* *In this Module, Primary Anatomic Structure Sequence (0008,2228) is specialized to be Type 1C; required if Attributes Ophthalmic Anatomic Reference Point X-Coordinate (0022,0024) and Ophthalmic Anatomic Reference Point Y-Coordinate (0022,0026) contain a value; may be present otherwise.*

C.8.17.5.1 Ocular Region Imaged Module Attribute Descriptions

C.8.17.5.1.1 Ophthalmic Anatomic Reference Point Location

The Attributes Ophthalmic Anatomic Reference Point X-Coordinate (0022,1624) and Ophthalmic Anatomic Reference Point Y-Coordinate (0022,1626) are used when an Ophthalmic Tomography Image Storage SOP Instance contains Attributes to convey volumetric properties (such as when using the Ophthalmic Tomography image for angiography). These Attributes identify the location of the anatomic region conveyed in Attribute Primary Anatomic Region Sequence (0008,2228). The most common anatomic regions identified for an OCT angiography are the fovea centralis and optic nerve head.

Note

The Anatomic Region Sequence (0008,2218) is typically set to (81745001, SCT, "Eye").

Figure C.8.17.5-1 shows an Ophthalmic Tomography image displaying the fovea centralis. The image Row/Column is defined as 245 x 245 and the location of the fovea centralis is horizontal row = 194 and vertical row = 132. Therefore, Attribute Ophthalmic Anatomic Reference Point X-Coordinate (0022,0024) is equal to 194 and Attribute Ophthalmic Anatomic Reference Point Y-Coordinate (0022,0026) is equal to 132.

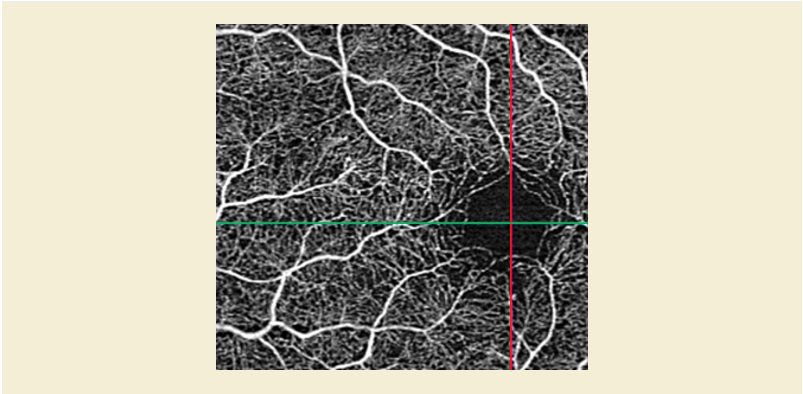


Figure C.8.17.5-1. En face Image - Ophthalmic Anatomic Reference Point Location Example

C.8.17.6 Ophthalmic Tomography Series Module

Table C.8.17.6-1 specifies the Attributes that identify and describe general information about the Ophthalmic Tomography Series.

Table C.8.17.6-1. Ophthalmic Tomography Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **OPT** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.17.7 Ophthalmic Tomography Image Module

Table C.8.17.7-1 specifies the Attributes that describe an Image produced by Ophthalmic Tomography imaging modalities.

Table C.8.17.7-1. Ophthalmic Tomography Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Volumetric Properties Flag	(0022,1622)	1C	Whether this SOP Instance is suitable for OCT volumetric processing. Required if this SOP Instance is suitable for OCT volumetric processing. May be present otherwise. Enumerated Values: **YES** **NO**
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.7.6.1.1.2 for Enumerated Values and Defined Terms and further explanation.
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation. Enumerated Values: **1**
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data started. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800).

Attribute Name	Tag	Type	Attribute Description
Acquisition Duration	(0018,9073)	1C	The scan time in seconds used to create all frames of an Ophthalmic Tomography image. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Acquisition Number	(0020,0012)	1	A number identifying the single continuous gathering of data over a period of time that resulted in this image.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. Enumerated Values: **8** **12** **16**
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. High Bit (0028,0102) shall be one less than Bits Stored
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Concatenation Frame Offset Number	(0020,9228)	1	Offset of the first frame in a multi-frame image of a concatenation. Enumerated Values: **0**
In-concatenation Number	(0020,9162)	1	Identifier for one SOP Instance belonging to a concatenation. Enumerated Values: **1**
In-concatenation Total Number	(0020,9163)	1	The number of SOP Instances sharing the same Concatenation UID (0020,9161). See Section C.8.17.16.3 for further explanation. Enumerated Values: **1**
Image Comments	(0020,4000)	3	User-defined comments about the image

The value constraints on Concatenation Frame Offset Number (0020,9228), In-concatenation Number (0020,9162), and In-concatenation Total Number (0020,9163) have the effect of preventing the use of concatenations.

The Attribute Ophthalmic Volumetric Properties Flag (0022,1622) is YES when the Ophthalmic Tomography Image Storage SOP Instance encodes volumetric spatial information (e.g. Frame of Reference, Pixel Measures, Plane Orientation, Plane Position, etc.). For example, ophthalmic tomography volumetric information is required when implementations encode Surface Segmentation SOP Instance(s) (e.g., surface segmentation is applied to the structural OCT volume to delineate the anatomical boundaries) and/or an Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage SOP Instance (e.g., angiographic (blood flow) volume information) based upon the volumetric Ophthalmic Tomography Image Storage SOP Instance.

C.8.17.8 Ophthalmic Tomography Acquisition Parameters Module

Table C.8.17.8-1 describes patient clinical conditions related to an Ophthalmic Tomography image acquisition.

Table C.8.17.8-1. Ophthalmic Tomography Acquisition Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Axial Length of the Eye	(0022,0030)	2	Axial length of the eye in mm.
Horizontal Field of View	(0022,000C)	2	The horizontal field of view in degrees
Include Table C.8.17.8-2 "Ophthalmic Acquisition Parameters Macro Attributes"			

Table C.8.17.8-2. Ophthalmic Acquisition Parameters Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Refractive State Sequence	(0022,001B)	2	The refractive state of the imaged eye at the time of acquisition. Zero or one Itemshall be included in this Sequence. Zero length means the refractive state was not measured.
>Spherical Lens Power	(0022,0007)	1	Sphere value in diopters
>Cylinder Lens Power	(0022,0008)	1	Cylinder value in diopters
>Cylinder Axis	(0022,0009)	1	Axis value in degrees
Emmetropic Magnification	(0022,000A)	2	Emmetropic magnification value (dimensionless). Zero length means the emmetropic magnification was not measured.
Intra Ocular Pressure	(0022,000B)	2	Value of intraocular pressure in mmHg. Zero length means the pressure was not measured
Pupil Dilated	(0022,000D)	2	Whether or not the patient's pupils were pharmacologically dilated for this acquisition. Enumerated Values: **YES** **NO** If this Attribute is empty, no information is available.
Mydriatic Agent Sequence	(0022,0058)	2C	Information about the agent administered. Zero or more Items shall be included in this Sequence. Note An empty Sequence indicates that an agent was used for dilation, but the name was not entered. Required if the value of Pupil Dilated (0022,000D) is YES.
>Mydriatic Agent Code Sequence	(0022,001C)	1	The actual agent administered to dilate the pupil. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4208 "Mydriatic Agent".*
>Mydriatic Agent Concentration	(0022,004E)	3	The concentration of the agent.

Attribute Name	Tag	Type	Attribute Description
>Mydriatic Agent Concentration Units Sequence	(0022,0042)	1C	Units of measure for the Mydriatic Agent Concentration. Only a single Item shall be included in this Sequence. Required if Mydriatic Agent Concentration (0022,004E) is present.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 82 “Units of Measurement”.*
Degree of Dilation	(0022,000E)	2C	The degree of the dilation in mm. Required if the value of Pupil Dilated (0022,000D) is YES.

C.8.17.9 Ophthalmic Tomography Parameters Module

Table C.8.17.9-1 describes the parameters and characteristics of the acquisition device related to an Ophthalmic Tomography image acquisition.

Table C.8.17.9-1. Ophthalmic Tomography Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Device Type Code Sequence	(0022,0015)	1	Describes the type of acquisition device. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4210 “Ophthalmic Tomography Acquisition Device”.*
Light Path Filter Type Stack Code Sequence	(0022,0017)	2	Filters used in the light source path. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4204 “Ophthalmic Filter”.*
>Light Path Filter Pass-Through Wavelength	(0022,0001)	3	Nominal pass-through wavelength of light path filter in nm
>Light Path Filter Pass Band	(0022,0002)	3	Pass band of light path filter in nm. This Attribute has two Values. The first is the shorter and the second the longer wavelength relative to the peak. The values are for the - 3dB nominal (1/2 of peak) pass through intensity. One of the two Values may be zero length, in which case it is a cutoff filter.
Detector Type	(0018,7004)	1	Type of detector used for creating this image. Defined Terms: **CCD** Charge Coupled Device **CMOS** Complementary Metal Oxide Semiconductor **PHOTO** Photodetector **INT** Interferometer
Scan Pattern Type Code Sequence	(0022,1618)	3	The scan pattern type used to generate this SOP Instance. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4272 “Opt Scan Pattern Types”*
Illumination Wave Length	(0022,0055)	1C	Wavelength of the illuminator in nm. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Illumination Power	(0022,0056)	1C	Power of the illuminator in microwatts at corneal plane. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Illumination Bandwidth	(0022,0057)	1C	Bandwidth of the illuminator in nm. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Depth Spatial Resolution	(0022,0035)	1C	The inherent limiting resolution in microns for depth of the acquisition equipment for high contrast objects for the data gathering and reconstruction technique chosen. If variable, the value at the center of the scanning volume. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Maximum Depth Distortion	(0022,0036)	1C	Maximum distortion in depth direction in % of Depth Spatial Resolution. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Along-scan Spatial Resolution	(0022,0037)	1C	The inherent limiting resolution in microns of the acquisition equipment in the direction of a row. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Maximum Along-scan Distortion	(0022,0038)	1C	Maximum distortion in along-scan direction in % of Along-scan Spatial Resolution. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Across-scan Spatial Resolution	(0022,0048)	1C	The inherent limiting resolution in microns of the acquisition equipment perpendicular to the slice. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Maximum Across-scan Distortion	(0022,0049)	1C	Maximum distortion in across-scan direction in % of cross-scan Spatial Resolution. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.

C.8.17.10 Ophthalmic Tomography Functional Group Macros

C.8.17.10.1 Ophthalmic Frame Location Macro

Table C.8.17.10-1 specifies the Attributes of the Ophthalmic Frame Location Functional Group Macro. This is used to provide a frame location relative to one or more referenced images. This Macro describes a frame perpendicular or parallel to the reference image; it describes column locations for frames that are scanned either uniformly along a line segment, or with a non-uniform spacing along any trajectory in the reference image.

Table C.8.17.10-1. Ophthalmic Frame Location Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Frame Location Sequence	(0022,0031)	1	Specifies the column locations for this frame in terms of locations on a referenced image. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Defined Code Concept for Purpose of Reference is (121311, DCM, "Localizer").*
>Reference Coordinates	(0022,0032)	1	Image coordinates for the points on the referenced image that correspond to the points on this frame. See Section C.8.17.10.1.1. Multiple pairs of values where the first value of each pair is the row and the second value of each pair is the column. Row is the vertical offset and column is the horizontal offset. Specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Rows\Columns (see Figure C.10.5-1, except that ~~that~~ row and column order is reversed). The values must be within the range 0\0 to Rows\Columns.
>Depth of Transverse Image	(0022,0041)	2C	Relative position in microns signifying the location of a Transverse image in the z-axis. Required if Ophthalmic Image Orientation (0022,0039) is TRANSVERSE.
>Ophthalmic Image Orientation	(0022,0039)	1	Enumerated Values: **LINEAR** **NONLINEAR** **TRANSVERSE**

C.8.17.10.1.1 Reference Coordinates

A frame can be described in terms of its "position" on another image. In the case of ophthalmic tomography (OPT) images with longitudinal orientation, the OPT image corresponds to a vertical slice along a trajectory on the referenced image. Each column of the OPT frame is nominally perpendicular to the image. Therefore, each column of the OPT frame can also correspond to a particular pixel on an associated image. It is normal in OPT analysis to indicate the location of the OPT slice by showing the corresponding pixel locations on the image. For Transverse frames, the position is indicated by two corners of a rectangle.

Note

The simple geometric relationship Modules are not practical to use for describing the relationship between OPT and retinal photography images. The retinal surface is highly curved, and the optical path is influenced by the lens and other eye structures. It is impractical to measure all of the geometric and optical properties of the eye to the degree needed to establish the relationship by geometric computation. It is easy to capture a retinal image and the slice path on that image as part of the OPT acquisition.

The OPT columns for a retinal slice are not strictly perpendicular to the retina and there are minor systematic distortions as a result. This DICOM Functional Group does not attempt to capture the data needed to measure or correct for these effects, except for the presence of the Maximum Along-scan Distortion Attribute (0022,0038).

The relationship between the columns in the image frame and the reference image are illustrated in Figure C.8.17.10-1.

Frames can be captured using a linear scan with uniform column spacing. This permits the column position to be described by giving the endpoints of the line segment that was scanned. Figure C.8.17.10-1 shows such a scan labeled as "OCT Frame 1". When describing this frame using the Linear Column Locations Functional Group Macro, the Sequence Attributes would contain:

a. The Attributes of the Image SOP Instance Reference Macro would point to a frame of the reference image.

b. Reference Coordinates (0022,0032) would contain values that give the row and column coordinates for the image pixel on the referenced image that corresponds to the first column of the OPT Frame 1 and the row and column coordinates that corresponds to the last column of the OPT Frame 1.

Frames can also be taken along curved paths, or with non-uniform spacing. These frames cannot be described by just the two endpoints. These frames are described by specifying the referenced image pixel coordinates for each column in the frame. The frame labeled "OCT Frame 2" illustrates this kind of relationship. The Non-linear Column Locations Functional Group Macro description for this frame would contain:

a. The Attributes of the Image SOP Instance Reference Macro would point to a frame of the reference image.

b. Reference Coordinates (0022,0032) would contain 2N integer values. Their contents would be:

1-2 (e,f)

… other values

2L-1, 2L (g,h)

… other values

2N-1, 2N (x,y)

A three dimensional OPT raster scan image would be described by a series of Linear Column Location Sequences, one for each frame.

Note

One expected use of column location is the automatic generation of annotation graphics display. The slice location can be indicated and dynamically controlled on the reference image while examining the observed slices. This replaces the relatively inflexible practice of creating a modified retinal image with burned in annotation to indicate the slice locations.

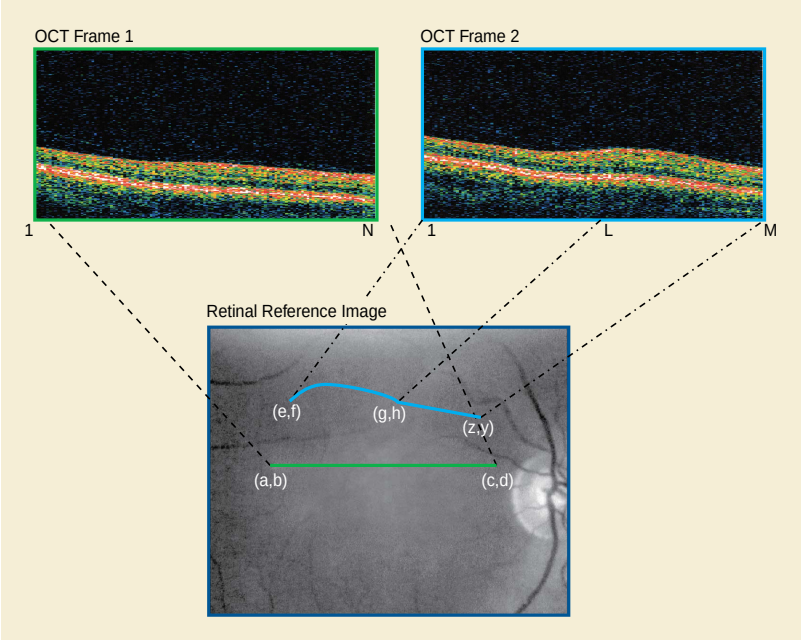


Figure C.8.17.10-1. Relationship of Longitudinal (Nominally Perpendicular) OCT Frames to Reference Frame

In the case of ophthalmic tomography (OPT) images with a transverse orientation, the OPT image corresponds to a sub-rectangle of the reference image. See Figure C.8.17.10-2. The OPT frame is nominally parallel to the reference image. Therefore, each corner of

the OPT frame can also correspond to a particular pixel on an associated image. It is assumed that the edges of OPT frame are exactly parallel to the edges of the reference image.

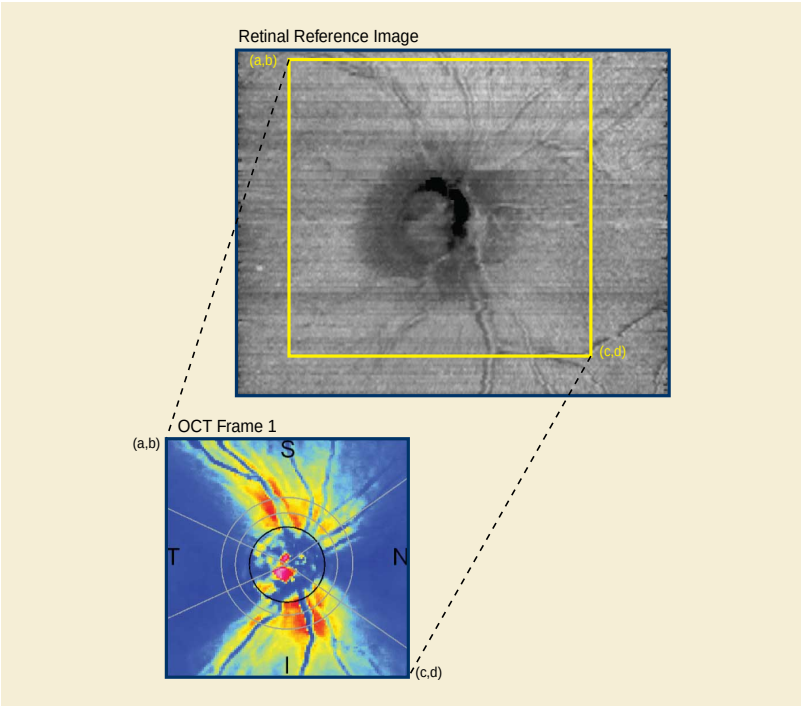


Figure C.8.17.10-2. Relationship of Transverse (Nominally Parallel) OCT Frame to Reference Frame

C.8.17.11 Wide Field Ophthalmic Photography Stereographic Projection Module

Table C.8.17.11-1 specifies the Attributes that describe the Wide Field Photography Stereographic Projection Module.

Table C.8.17.11-1. Wide Field Ophthalmic Photography Stereographic Projection Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-5 "General Anatomy Mandatory Macro Attributes"			*The concept code for Anatomic Region Sequence (0008,2218) shall be (81745001, SCT, "Eye"), and DCID 244 "Laterality" shall be used for Anatomic Region Modifier Sequence (0008,2220). Only a single Item shall be included in Anatomic Region Modifier Sequence (0008,2220).*
Transformation Algorithm Sequence	(0022,1513)	1	Software algorithm used for stereographic projection. Only a single Item shall be included in this Sequence.
>Include Table 10-19 "Algorithm Identification Macro Attributes"			
Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement used for the stereographic projection, in mm.

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length Method	(0022,1515)	1	The method used to obtain the Ophthalmic Axial Length. Enumerated values: **MEASURED** Measured axial length. **ESTIMATED** An estimated value based upon performing the examination (i.e., based upon surrogate markers of axial length). **POPULATION** A length that represents a population norm (i.e., not based upon a measured axial length or surrogate markers of axial length).
X Coordinates Center Pixel View Angle	(0022,1528)	1	The horizontal angle covered on the sphere by the center pixel of the projected image, as measured from the center of the sphere, in degrees. See Section C.8.17.11.1.1 for further explanation.
Y Coordinates Center Pixel View Angle	(0022,1529)	1	The vertical angle covered on the sphere by the center pixel of the projected image, as measured from the center of the sphere, in degrees. See Section C.8.17.11.1.1 for further explanation.
Ophthalmic FOV	(0022,1517)	3	The field of view used to capture the ophthalmic image, in degrees. The field of view is the maximum image size displayed on the image plane, expressed as the angle subtended at the exit pupil of the eye by the maximum dimension 2r (where r equals the radius).

C.8.17.11.1 Wide Field Ophthalmic Photography Stereographic Projection Attribute Descriptions

C.8.17.11.1.1 Center Pixel View Angle

The Center Pixel View Angle (0022,1528) comprises two real numbers XCENTERPIXELVIEWANGLE and YCENTERPIXELVIEWANGLE that represent in degrees the angle along the horizontal axis and the vertical axis respectively covered by the center pixel in the image, where this angle is measured from the center of the sphere. These are used to convert pixel locations in the image to their corresponding locations on a sphere. x and y are pixel locations (may be sub pixels) in the image, x running from 0 to XPIXELS from the left-hand side of the image to the right-hand side, and y running from 0 to YPIXELS from top to bottom, and if λ denotes the azimuth or longitude on the sphere and ϕ the elevation or latitude on the sphere, both in degrees, then,

$$\lambda = \tan2^{-1}\left(\frac{x'}{\rho}, \frac{1}{\tan(c)}\right)$$

$$\phi = \sin^{-1}\left(\frac{y'\sin(c)}{\rho}\right)$$

where

$\tan2^{-1}$ used to define λ represents the two-argument inverse tangent function:

$$\tan2^{-1}(y, x) = \begin{cases} \tan^{-1}\frac{y}{x} & x > 0 \\ \tan^{-1}\frac{y}{x} + 180 & y \geq 0,\ x < 0 \\ \tan^{-1}\frac{y}{x} - 180 & y < 0,\ x < 0 \\ +\frac{180}{2} & y > 0,\ x = 0 \\ -\frac{180}{2} & y < 0,\ x = 0 \\ \text{undefined} & y = 0,\ x = 0 \end{cases}$$

and

$$x' = \left(x - \frac{XPIXELS}{2}\right)XCENTERPIXELVIEWANGLE$$

$$y' = \left(-y + \frac{YPIXELS}{2} \right) YCENTERPIXELVIEWANGLE$$

and

$$\rho = \sqrt{x'^2 + y'^2}$$

$$c = 2\tan^{-1}\left(\frac{\rho}{2} \frac{\pi}{180} \right)$$

The above equations assume the use of degrees throughout. Radians can be used, if XCENTERPIXELVIEWANGLE and YCENTERPIXELVIEWANGLE are given in radians, if all trigonometric functions are switched to their radian-equivalent, and if the factor π/180 is removed from the definition of c.

C.8.17.12 Wide Field Ophthalmic Photography 3D Coordinates Module

Table C.8.17.12-1 specifies the Attributes that describe the Wide Field Ophthalmic Photography 3D Coordinates Module.

Table C.8.17.12-1. Wide Field Ophthalmic Photography 3D Coordinates Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-5 "General Anatomy Mandatory Macro Attributes"			*The concept code for Anatomic Region Sequence (0008,2218) shall be (81745001, SCT, "Eye"), and DCID 244 "Laterality" shall be used for Anatomic Region Modifier Sequence (0008,2220). Only a single Item shall be included in Anatomic Region Modifier Sequence (0008,2220).*
Transformation Method Code Sequence	(0022,1512)	1	Method used to map the 2D Pixel Image data in this SOP Instance to the 3D Cartesian coordinates in the Dimensional to Two Three Dimensional Map Sequence (0022,1518). Only a single Item shall be included in this Sequence. See Section C.8.17.12.1.1 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4245 "Wide Field Ophthalmic Photography Transformation Method"*
Transformation Algorithm Sequence	(0022,1513)	1	Software algorithm that performed the mapping. Only a single Item shall be included in this Sequence.
>Include Table 10-19 "Algorithm Identification Macro Attributes"			
Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement used when performing the 2D pixel ~~imagemapping~~image mapping into 3D Cartesian coordinates, in mm.
Ophthalmic Axial Length Method	(0022,1515)	1	The method used to obtain the Ophthalmic Axial Length. Enumerated values: **MEASURED** Measured axial length. **ESTIMATED** An estimated value based upon performing the examination (i.e., based upon surrogate markers of axial length). **POPULATION** A length that represents a population norm (i.e., not based upon a measured axial length or surrogate markers of axial length).

Attribute Name	Tag	Type	Attribute Description
Ophthalmic FOV	(0022,1517)	3	The field of view used to capture the ophthalmic image, in degrees. The field of view is the maximum image size displayed on the image plane, expressed as the angle subtended at the exit pupil of the eye by the maximum dimension 2r (where r equals the radius).
Two Dimensional to Three Dimensional Map Sequence	(0022,1518)	1	A sparsely sampled map of 2D image pixels (with sub pixel resolution) to 3D coordinates. Each frame shall be referenced once and only once in this Sequence in Referenced Frame Numbers (0040,A136). One or more Items shall be included in this Sequence.
>Referenced Frame Number	(0008,1160)	1	References one or more frames within this SOP Instance to which this Sequence Item applies. The first frame shall be denoted as frame number one.
>Number of Map Points	(0022,1530)	1	The number of points in the map. Shall include one or more points.
>Two Dimensional to Three Dimensional Map Data	(0022,1531)	1	See Section C.8.17.12.1.2 for further explanation.

C.8.17.12.1 Wide Field Ophthalmic Photography 3D Coordinates Attribute Descriptions

C.8.17.12.1.1 Transformation Method Code Sequence

If Transformation Method Code Sequence (0022,1512) is (111791, DCM, "Spherical projection") all the coordinates in the Two Dimensional to Three Dimensional Map Data (0022,1531) shall lie on a sphere with a diameter that shall be equal to Ophthalmic Axial Length (0022,1019).

If Transformation Method Code Sequence (0022,1512) is (111792, DCM, "Surface contour mapping") the coordinates in the Two Dimensional to Three Dimensional Map Data (0022,1531) are based upon the contour of the eye, therefore it cannot be assumed to be a spherical surface.

C.8.17.12.1.2 Two Dimensional to Three Dimensional Map Data

Two Dimensional to Three Dimensional Map Data (0022,1531) is used to convey a sparsely sampled map of 2D image pixels (with sub pixel resolution) to 3D coordinates.

The origin of the 3D points shall be the Ophthalmic Coordinate System which is based upon the corneal vertex (i.e., the x, y and z coordinates of 0.0, 0.0, 0.0, in mm). See Section C.8.30.3.1.4.

All data points are encoded as a floating point 5-tuple where the values are:

1st value = 2D horizontal location (a sub pixel location between 0 and number of columns)

2nd value = 2D vertical location (a sub pixel location between 0 and number of rows)

3rd value = x 3D-coordinate

4th value = y 3D-coordinate

5th value = z 3D-coordinate

The ordering is 2D horizontal $location_1$, 2D vertical $location_1$, $3Dx_1$, $3Dy_1$, $3Dz_1$, … 2D horizontal $location_n$, 2D vertical $location_n$, $3Dx_n$, $3Dy_n$, $3Dz_n$.

C.8.17.13 Wide Field Ophthalmic Photography Quality Rating Module

Table C.8.17.13-1 specifies the Attributes that evaluate the quality of the projection or mapping used for a wide field ophthalmic photography image.

Table C.8.17.13-1. Wide Field Ophthalmic Photography Quality Rating Module Attributes

Attribute Name	Tag	Type	Attribute Description
Wide Field Ophthalmic Photography Quality Rating Sequence	(0022,1525)	1	Type of metric and metric value used to evaluate the quality of the projection or mapping used for the wide field ophthalmic photography image for this SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table 10-26 "Numeric Value Macro Attributes"			*DCID 4243 "Ophthalmic Quality Metric Type" shall be used for Concept Name Code Sequence (0040,A043).*
>Wide Field Ophthalmic Photography Quality Threshold Sequence	(0022,1526)	1	Quality threshold value and software algorithm used to provide the wide field ophthalmic photography projection or mapping quality rating for this SOP Instance. Only a single Item shall be included in this Sequence.
>>Wide Field Ophthalmic Photography Threshold Quality Rating	(0022,1527)	1	Quality rating threshold value for acceptable wide field ophthalmic photography projection or mapping. Note The units of this Attribute is the same as defined in Measurement Units Code Sequence (0040,08EA) of the Wide Field Ophthalmic Photography Quality Rating Sequence (0022,1525). The threshold value is not the same as the Attribute Numeric Value (0049,A30A) of the Wide Field Ophthalmic Photography Quality Rating Sequence (0022,1525). Therefore, it conveys the least stringent value that is acceptable, not the actual rating for this SOP Instance.
>Include Table 10-19 "Algorithm Identification Macro Attributes"			

C.8.17.14 Ophthalmic Optical Coherence Tomography En Face Image Module

Table C.8.17.14-1 specifies the Attributes that describe the Ophthalmic Optical Coherence Tomography En Face Image Module.

Table

Table C.8.17.14-1. Ophthalmic Optical Coherence Tomography En Face Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.17.14.1.5 for specialization.
Instance Number	(0020,0013)	1	A number that identifies this SOP Instance.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.17.14.1.6 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel ~~sample.See~~sample. See Section C.8.17.14.1.6 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample ~~data.Shall~~data. Shall be one less than the value in Bits Stored (0028,0101). See Section C.8.17.14.1.6 for specialization.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.17.14.1.4 for specialization.
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0**
Pixel Spacing	(0028,0030)	1	Nominal physical distance at the focal plane (in the retina) between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3for further explanation of the value order. Note Since a patient's retina is curved and the image representation is planar, there can be an error in using Pixel Spacing (0028,0030) for measurements in the periphery of the image. En face imaging does not support wide field measurements.
Content Time	(0008,0033)	1	The time the image pixel data creation started.
Content Date	(0008,0023)	1	The date the image pixel data creation started.
Source Image Sequence	(0008,2112)	1	A Sequence that identifies the Images that were used to derive this Image. One or more Items shall be included in this Sequence. See Section C.12.4.1.2 and Section C.8.17.14.1.1 for further explanation.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made, that is what role the source image or frame(s) played in the derivation of this image. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7202 “Source Image Purposes of Reference”.* *If the derived en face image is based upon OPT structure information, the Concept Code shall be (128250, DCM, "Structural image for image processing").* *If the derived en face image is based upon OPT flow information, the Concept Code shall be (128251, DCM, "Flow image for image processing").*
Derivation Algorithm Sequence	(0022,1612)	1	Software algorithm that performed the derivation. Only a single Item shall be included in this Sequence.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			*DCID 4270 “OCT-A Processing Algorithm Families” shall be used for Algorithm Family Code Sequence (0066,002F)*
Ophthalmic Image Type Code Sequence	(0022,1615)	1	En face image type used to identify this SOP Instance Only a single Item shall be included in this Sequence. See Section C.8.17.14.1.3 for further explanation.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4271 “En Face Image Types”*

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Image Type Description	(0022,1616)	3	Description of the en face image type.
Window Center	(0028,1050)	1	Window Center for display. See Section C.11.2.1.2 for further explanation. Note When Bits Allocated (0028,0100) is 8, the value is typically always set to 127 or 128.
Window Width	(0028,1051)	1	Window Width for display. See Section C.11.2.1.2 for further explanation. Note When Bits Allocated (0028,0100) is 8, the value is typically always set to 256.
Ophthalmic FOV	(0022,1517)	3	The horizontal field of view used to capture the ophthalmic image, in degrees. The field of view is the maximum image size displayed on the image plane, expressed as the angle subtended at the exit pupil of the eye by the maximum dimension 2r (where r equals the radius).
Referenced Surface Mesh Identification Sequence	(0022,1620)	1	Reference to the surface mesh(s) used in the creation of this SOP Instance. One or more Items shall be included in this Sequence. See Section C.8.17.14.1.2 for further explanation.
>Referenced SOP Instance UID	(0008,1155)	1	Referenced SOP Instance that contains the surface segmentation used in the creation of this SOP Instance.
>Referenced Surface Number	(0066,002C)	1	Reference to a Surface Number (0066,0003) present in Surface Sequence (0066,0002).
>Segmented Property Type Code Sequence	(0062,000F)	1	Sequence defining the specific property the surface represents. Only a single Item is permitted in this Sequence Note "Property" is used in the sense of meaning "what the surface represents", whether it be a physical or biological object, be real or conceptual, having spatial, temporal or functional extent or not. I.e., it is what the segment "is" (as opposed to some feature, Attribute, quality, or characteristic of it, like color or shape or size).
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4273 “Retinal Segmentation Surfaces”.*
>Surface Mesh Z-Pixel Offset	(0022,1658)	1	Offset in number of pixels along the z axis by which the mesh data has been shifted when generating this SOP Instance. The mesh data is the Attribute Point Coordinates Data (0066,0016) of the surface mesh referenced by Attribute Referenced SOP Instance UID (0008,1155). Note If no offset is used the value is set to 0.
Ophthalmic Axial Length	(0022,1019)	3	The axial length measurement, in mm.

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length Method	(0022,1515)	3	The method used to obtain the Ophthalmic Axial Length. Enumerated values: **MEASURED** Measured axial length. **ESTIMATED** An estimated value based upon performing the examination (i.e., based upon surrogate markers of axial length). **POPULATION** A length that represents a population norm (i.e., not based upon a measured axial length or surrogate markers of axial length).
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values Required if Photometric Interpretation (0028,0004) is MONOCHROME2
Calibration Image	(0050,0004)	3	Indicates whether a reference object (phantom) of known size is present in the image and was used for calibration. Enumerated Values: **YES** **NO**
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO**

C.8.17.14.1 Ophthalmic Optical Coherence Tomography En Face Image Module Attribute Descriptions

C.8.17.14.1.1 Source Image Sequence

An OCT en face image is derived from images obtained using OCT technology. The Source Image Sequence (0008,2112) shall convey the SOP Instances used to derive this en face SOP Instance.

If Attribute Purpose of Reference Code Sequence (0040,A170) is set to (128250, DCM, "Structural image for image processing"), the Source Image Sequence will reference an Ophthalmic Tomography SOP Instance.

If Attribute Purpose of Reference Code Sequence (0040,A170) is set to (128251, DCM, "Flow image for image processing"), the Source Image Sequence will reference an Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instance.

A typical example of the image processing stages performed to generate en face images is shown in Figure C.8.17.14-1.

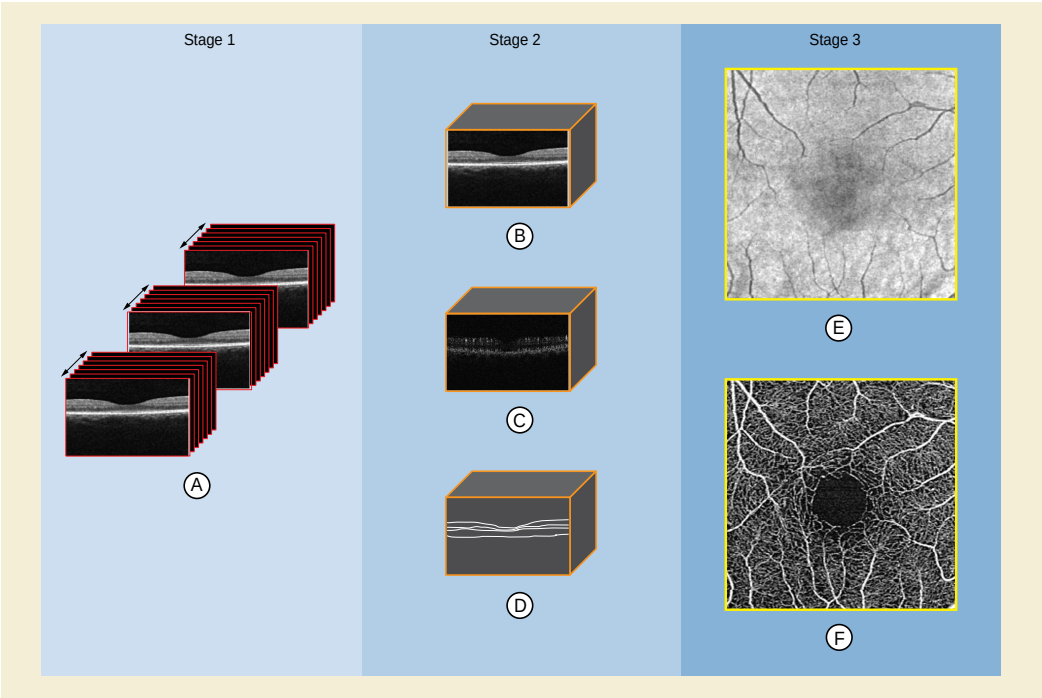


Figure C.8.17.14-1. Example of the Image Process Performed to Generate En Face Images

Figure Legend:

A. OCT proprietary B-scan data (possibly a DICOM Raw Data Instance)

B. Volumetric structural ophthalmic tomography image (Ophthalmic Tomography Image Instance)

C. OCT angiographic flow volume information (Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Instance)

D. OCT surface mesh (Surface Segmentation Instance)

E. Structural en face image (Ophthalmic Optical Coherence Tomography En Face Image Instance)

F. En Face angiographic flow image (Ophthalmic Optical Coherence Tomography En Face Image Instance)

Stage 1:OCT technology is used to acquire a volumetric ~~dataset~~data set from a retinal region of ~~interest.This volumetric dataset~~interest. This volumetric data set (A) consists of multiple B-scans in a raster pattern, and multiple frames are acquired at each B-scan location. The B-scans are acquired in the manufacturer's proprietary format for analysis and storage. If this information is stored in DICOM, it can use the Raw Data Storage SOP Class.

Stage 2: The OCT proprietary B-scan data (A) (or DICOM Raw Data SOP Instance) is then analyzed to derive the volumetric structural ophthalmic tomography image (B). From (B) one or more OCT surface meshes (D) are generated to delineate the anatomical boundaries. The difference in signal between the frames of each individual B-scan is analyzed to produce the OCT angiographic flow volume information (C).

Stage 3: Clinicians typically make their assessment based upon two types of OCT en face images. The structural OCT en face image (E) is derived by using pixel information in (B) and two surface meshes (C). The vascular OCT en face image (F) may be derived using the volumetric structural ophthalmic tomography image (B) , the OCT surface mesh (D) and the OCT angiographic flow volume information (C).

En face images are typically derived by the acquisition modality that generated the Ophthalmic Tomography Image, Surface Segmentation and Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instances or by image workstations that received the respective Ophthalmic Image, Surface Segmentation and Ophthalmic Optical Tomography B-scan Volume Analysis SOP Instances via DICOM Storage.

Note

Image workstations receiving ophthalmic tomography images may choose to evaluate the structural ophthalmic tomography image and generate a different set of segmented surfaces than defined by an acquisition device. The surface segmentation information can be stored in a separate Surface Segmentation SOP Instance.

The Ophthalmic Tomography Image, Surface Segmentation, Ophthalmic Optical Coherence Tomography B-scan Volume Analysis and the Ophthalmic Optical Coherence Tomography En Face Image SOP Instances all reside in different DICOM Series. They share the same spatial Frame of Reference which is identified in Attribute Frame of Reference UID (0020,0052) (i.e., the value of Frame of Reference UID (0020,0052) is the same in each SOP Instance). Figure C.8.17.14-2 illustrates the relationships between the OCT angiography based SOP Instances.

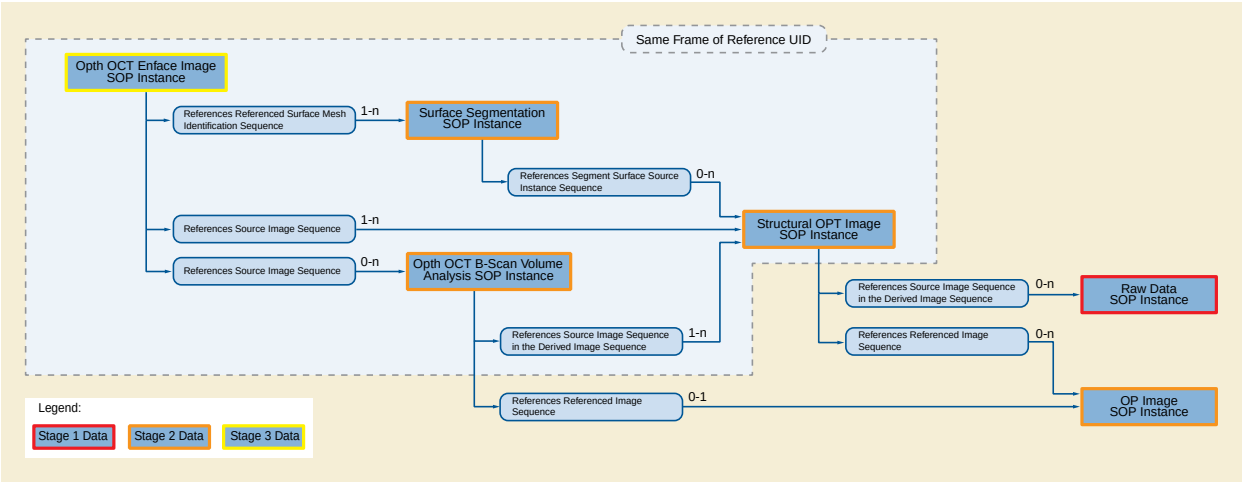


Figure C.8.17.14-2. Relationships Between OCT-A Based SOP Instances

C.8.17.14.1.2 Referenced Surface Mesh Identification Sequence

Referenced Surface Mesh Identification Sequence (0022,1620) identifies one or more segmentation surfaces used to generate the derived en face image. The segmented surfaces are described in the SOP Instance identified by Referenced SOP Instance UID (0008,1155) (e.g., Surface Segmentation Storage SOP Instance).

C.8.17.14.1.3 Ophthalmic Image Type Code Sequence

Implementations may generate many different types of derived en face images. Figure C.8.17.14-3 illustrates various derived enface image types. The Ophthalmic Image Type Code Sequence (0022,1615) is used to identify the type of derived en face image.

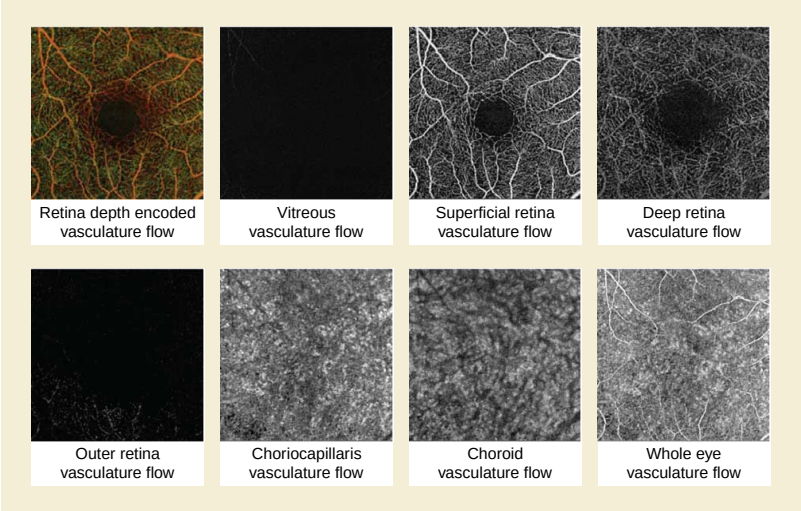


Figure C.8.17.14-3. Examples of En Face Images Types

C.8.17.14.1.4 Photometric Interpretation

Specifies the intended interpretation of the pixel data.

Enumerated Values:

MONOCHROME2
PALETTE
COLOR

C.8.17.14.1.5 Image Type

The Image Type (0008,0008) Attribute (General Image Module, Section C.7.6.1) identifies important image characteristics in a multiple valued Data Element. For the Ophthalmic Optical Tomography En Face Image IOD, Image Type is specified as a Type 1 Attribute and further specialized as follows:

- Value 1 shall identify the Pixel Data Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values for Value 1:
  DERIVED

- Value 2 shall identify the Patient Examination Characteristics in accordance with Section C.7.6.1.1.2.

  Enumerated Values for Value 2:
  PRIMARY

- Value 3 shall identify any Image IOD specific specialization in accordance with Section C.7.6.1.1.2 (optional).

  Defined Terms for Value 3:
  MONTAGE identifies a Montage Image

- Other Values that are implementation specific in accordance with Section C.7.6.1.1.2 (optional)

  Note

  A Montage Image is constructed out of several individual images, which also can be exchanged separately. The images used to create the montage image will be included in the Source Image Sequence (0008,2112) if those images are also exchanged. A Montage Image is identified as Image Type DERIVED\PRIMARY\MONTAGE.

C.8.17.14.1.6 Bits Allocated, Bits Stored, and High Bit

These Attributes shall be determined based upon the Photometric Interpretation (0028,0004):

Photometric Interpretation (0028,0004)	Bits Allocated (0028,0100)	Bits Stored (0028,0101)	High Bit (0028,0102)
MONOCHROME2	8	8	7
PALETTE COLOR	16	12	11
	16	16	15

C.8.17.14.1.7 Relationship Between Ophthalmic Tomography Image and Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IODs

When generating an angiographic en face Image SOP Instance implementations need to understand the relationship between the Ophthalmic Tomography Image SOP Instance(s) and the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instance.

The Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instance, which is a multi-frame SOP Instance, references one or more Ophthalmic Tomography Image SOP Instances using the Derivation Image Macro. The Derivation Image Macro defines Attributes at the Frame Level (i.e. each frame in the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis SOP Instance, references an Ophthalmic Tomography Image SOP Instance and the Ophthalmic Tomography Image SOP Instance frame number that was used to generate the specific Ophthalmic Optical Coherence Tomography B-scan Volume Analysis frame).

Examples are shown in Section UUU.2 “Relationship Between Ophthalmic Tomography Image and Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IODs” in PS3.17.

C.8.17.15 Ophthalmic Optical Coherence Tomography En Face Image Quality Rating Module

Table C.8.17.15-1 specifies the Attributes for evaluating the quality of the derived en face image.

Table C.8.17.15-1. Ophthalmic Optical Coherence Tomography En Face Image Quality Rating Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic En Face Image Quality Rating Sequence	(0022,1628)	1	Evaluation of the quality of the en face image. Only a single Item shall be included in this Sequence.
~~>*Include* Table 10-26 “Numeric Value Macro Attributes”~~			~~*Concept Name Code Sequence (0040,A043) D*CID 4243 “Ophthalmic Quality Metric Type”~~
>*Include* Table 10-26 “Numeric Value Macro Attributes”			*Concept Name Code Sequence (0040,A043) D*CID 4243 “Ophthalmic Quality Metric Type”
>Quality Threshold	(0022,1630)	1	Threshold for the quality value. If the Numeric Value (0040,A30A) of the Numeric Value Macro is equal or above the threshold, it is considered acceptable by the algorithm. The units of this Attribute shall be the same as defined in Measurement Units Code Sequence (0040,08EA) of the Numeric Value Macro.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-19 “Algorithm Identification Macro Attributes”			

C.8.17.16 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image Module

Table C.8.17.16-1 specifies the Attributes that describe the Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image Module.

Table C.8.17.16-1. Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. Enumerated Values for Value 1: **ORIGINAL** Enumerated Values for Value 2: **PRIMARY**
Instance Number	(0020,0013)	1	A number that identifies this SOP Instance.
Content Time	(0008,0033)	1	The time the image pixel data creation started.
Content Date	(0008,0023)	1	The date the image pixel data creation started.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Shall be one less than the value in Bits Stored (0028,0101).
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Value: MONOCHOME2
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **1**
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT such that the output of all grayscale transformations are defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime) , or is derived from lossy compressed images. Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.8.32.2.1 and Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if present in the source images or this IOD Instance has been compressed.
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if present in the source images or this IOD Instance has been compressed. See Section C.8.32.2.1.
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO**
Acquisition Method Algorithm Sequence	(0022,1423)	1	Software algorithm used by the acquisition method. Only a single Item shall be included in this Sequence.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			*For Algorithm Family Code Sequence (0066,002F) BCID 4270 “OCT-A Processing Algorithm Families”.*
OCT B-scan Analysis Acquisition Parameters Sequence	(0022,1640)	1	Conveys raw data parameters captured during the B-scan acquisition process. One or more Items are permitted in this Sequence. More than one Item indicates that multiple scan patterns have been used to acquire the raw data. See Section C.8.17.16.2 for further explanation.
>Scan Pattern Type Code Sequence	(0022,1618)	1	The scan pattern type used to generate this SOP Instance. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4272 “Opt Scan Pattern Types”*
>Number Of B-scans Per Frame	(0022,1642)	1	The number of B-scans performed at the same spatial location (B-scan slab). See Section C.8.17.16.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>B-scan Slab Thickness	(0022,1643)	1	Nominal thickness of each B-scan slab, in mm. See Section C.8.17.16.2 for further explanation.
>Distance Between B-scan Slabs	(0022,1644)	1	Nominal distance between adjacent B-scan slabs, in mm. See Section C.8.17.16.2 for further explanation.
>B-scan Cycle Time	(0022,1645)	1C	Nominal time (in msec) between individual B-scans. See Section C.8.17.16.1.1 for further explanation. Required if B-scan Cycle Time Vector (0022,1646) is absent.
>B-scan Cycle Time Vector	(0022,1646)	1C	An array that contains the real time increments (in msec) between B-scans. See Section C.8.17.16.1.1 for further explanation. Required if B-scan Cycle Time (0022,1645) is absent. Note scan time + latency between B-scans
>A-scan Rate	(0022,1649)	3	Frequency, in kHz, of the A-scan used to acquire the raw image data.
>B-scan Rate	(0022,1650)	3	Frequency, in Hz, of the B-scan used to acquire the raw image data.
Concatenation Frame Offset Number	(0020,9228)	1	Offset of the first frame in a multi-frame image of a concatenation. Enumerated Values: **0**
In-concatenation Number	(0020,9162)	1	Identifier for one SOP Instance belonging to a concatenation. Enumerated Values: **1**
In-concatenation Total Number	(0020,9163)	1	The number of SOP Instances sharing the same Concatenation UID (0020,9161). See Section C.8.17.16.3 for further explanation. Enumerated Values: **1**
Image Comments	(0020,4000)	3	User-defined comments about the image

C.8.17.16.1 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Image Module Attribute Descriptions

C.8.17.16.1.1 B-scan Cycle Time and B-scan Cycle Time Vector

The B-scan Cycle Time (0022,1645) is the nominal scan time (in milliseconds) plus the latency between the individual repeats of the B-scan at the same location. The B-scan Cycle Time Vector can be used if the time for the repeats are not uniform. Either the B-scan Cycle Time (0022,1645) or the B-scan Cycle Time Vector (0022,1646) are required.

B-scan Cycle Time shall be used in the following manner to calculate 'the relative time' for each B-scan:

B-scan Cycle 'Relative Time' (n) = B-scan Cycle Delay + B-scan Cycle Time * (n-1)

where:

n = number of B-scan cycles within the frame and the first B-scan number is one

Note

When there is only one B-scan present, B-scan Cycle Time (0022,1645) may have either a value of 0, or a nominal value that would apply if there were multiple B-scans.

B-scan Cycle Time Vector (0022,1646) is an array that contains the time increments (in milliseconds) between the nth B-scan cycle and the previous B-scan cycle for a frame. The first B-scan cycle always has a time increment of 0. The B-scan Cycle Time Vector shall be used in the following manner to calculate 'relative time' *T(n)*for B-scan Cycle *n*:

$$T(n) = \sum_{i=1}^{n} \Delta t_i$$

where Δt_i is the ith B-scan Cycle Time Vector component.

C.8.17.16.2 Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Acquisition Parameters Expected Use

The acquisition technique of ophthalmic tomography B-scan volume analysis (e.g., OCT angiography blood flow information) is based on the same mechanism as used for ophthalmic tomography images. Therefore, B-scans are used for individual image frames of the acquired volume. The frames of the resulting volume are calculated based on a number of repeated B-scans at the same spatial location. So the frame of an Ophthalmic Tomography B-scan Volume Analysis SOP Instance is not a B-scan, but a data aggregation of B-scans from the raw data of the acquisition.

To convey the information about the acquisition of the raw data, which are not typically in the scope of DICOM, the OCT B-scan Analysis Acquisition Parameters Sequence (0022,1640) is used. The parameters are provided for the user to assess the quality of the resulting B-scan volume analysis as well as to provide a means to compare volumes created by different devices. Furthermore the user is able to identify if a vendor-recommended protocol has been used to acquire the raw data.

The OCT B-scan Analysis Acquisition Parameters Sequence contains at least one Item. It can contain more than one if multiple scan patterns have been used to acquire the raw data and are used to calculate the volume data.

Number of B-scans Per Frame (0022,1642) can be used to provide an indication about the resulting image quality. In principal, the more B-scans averaged the better but as a high number of scans slows down the acquisition process, the resulting data becomes prone to noise introduced by eye movements, which are not related to blood flow. Furthermore, the number of B-scans averaged can be used to determine whether the acquisition was based on a vendor-specific protocol, or if the user changed the protocol.

The B-scan Slab Thickness (0022,1643) and Distance Between B-scan Slabs (0022,1644) provide information about the density of the sampling pattern used to acquire the volume data. The calculation of the volume (Ophthalmic Tomography B-scan Volume Analysis SOP Instance) is based on this information.

C.8.17.16.3 Data Subsets

Applications may find it useful to break up an OPT image or B-scan volume into multiple data subsets. There are two mechanisms in DICOM to achieve this: Concatenations and Multiple SOP Instances.

Concatenations are not permitted in the Ophthalmic Tomography Image and Ophthalmic Optical Coherence Tomography B-scan Volume Analysis IODs.

However, an OPT image or a B-scan volume can be encoded in multiple SOP Instances. For example:

1. All frames of the volume are collected and transmitted in one multi-frame SOP Instance (e.g., one SOP Instance with 30 frames).
2. Each frame of the volume is transmitted in one SOP Instance where the number of frames is equal to one (e.g., 30 SOP Instances with 1 frame each).
3. The frames in the volume are transmitted in multiple SOP Instances (e.g., 3 SOP Instances with 10 frames each).

C.8.17.17 Ophthalmic Tomography En Face Series Module

Table C.8.17.17-1 specifies the Attributes that identify and describe general information about the Ophthalmic Tomography En Face Series.

Table C.8.17.17-1. Ophthalmic Tomography En Face Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **OPTENF** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.17.18 Ophthalmic Tomography B-scan Volume Analysis Series Module

Table C.8.17.18-1 specifies the Attributes that identify and describe general information about the Ophthalmic Tomography B-scan Volume Analysis Series.

Table C.8.17.18-1. Ophthalmic Tomography B-scan Volume Analysis Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **OPTBSV** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.18 Stereometric Modules

C.8.18.1 Stereometric Series Module

Table C.8.18.1-1 specifies the Attributes that describe a Stereometric Series produced by Ophthalmic Photography equipment (OP) imaging Modalities.

Table C.8.18.1-1. Stereometric Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Source equipment that produced the Stereometric Series. Enumerated Values: **SMR**

C.8.18.2 Stereometric Relationship Module

The stereometric relationship Module is used to identify pairs of images that may be viewed in stereo. It is possible that the same image or frame may be a member of multiple pairs. The images forming a pair shall be in different SOP Instances. The images forming a pair can be in different Series. All Instances referenced in this Module shall be in the same Study as the Instance in which the Module occurs.

Table C.8.18.2-1. Stereometric Relationship Module Attributes

Attribute Name	Tag	Type	Attribute Description
Stereo Pairs Sequence	(0022,0020)	1	Sequence of Items identifying pairs of images. One or more Items shall be included in this Sequence.
>Stereo Baseline Angle	(0022,0010)	3	Stereo separation angle in degrees
>Stereo Baseline Displacement	(0022,0011)	3	Horizontal displacement of instrument between left and right image in mm
>Stereo Horizontal Pixel Offset	(0022,0012)	3	Horizontal displacement of right image relative to left image in pixels for optimal display. Offset of right image to right means positive value.
>Stereo Vertical Pixel Offset	(0022,0013)	3	Vertical displacement of right image relative to left image in pixels for optimal display. Offset of right image downwards means positive value.
>Stereo Rotation	(0022,0014)	3	Rotation of right image relative to left image in degrees for optimal display. The rotation of the right image against the left image counterclockwise is positive, rotation around the center is assumed.
>Left Image Sequence	(0022,0021)	1	Left Image of the Pair. Only a single Item shall be included in this Sequence.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			*The Referenced SOP Instance UID (0008,1155) shall not be the same as the Referenced SOP Instance UID (0008,1155) of the Right Image Sequence (0022,0022).*
>Right Image Sequence	(0022,0022)	1	Right Image of the Pair. Only a single Item shall be included in this Sequence.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			*The Referenced SOP Instance UID (0008,1155) shall not be the same as the Referenced SOP Instance UID (0008,1155) of the Left Image Sequence (0022,0021).*

C.8.18.2.1 Stereometric Relationship Module Attribute Descriptions

C.8.18.2.1.1 Left and Right Image Sequences

The images referenced by the Left Image Sequence (0022,0021) and Right Image Sequence (0022,0022) in a single Stereo Pairs Sequence (0022,0020) Item shall have the same values for Rows (0028,0010) and the same values for Columns (0028,0011).

The reference may be to images with a single frame, all the frames of images with multiple frames, or one or more selected frames within an image with multiple frames. If multiple frames are selected, the same number of frames shall be referenced from both Sequences.

C.8.19 Enhanced XA/XRF Image

C.8.19.1 XA/XRF Series Module

The XA/XRF X-Ray IODs use the General Series Module, specialized by the XA/XRF Series Module, to describe the DICOM Series Entity specified in Section A.47 and Section A.48. It is defining what constitutes a Series for the context of projection XA/XRF device.

Table C.8.19.1-1 specifies the Attributes that identify and describe general information about the XA/XRF Series.

Table C.8.19.1-1. XA/XRF Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **XA** **RF** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.19.2 Enhanced XA/XRF Image Module

This section describes the Enhanced XA/XRF Image Module. Table C.8.19.2-1 contains IOD Attributes that describe a XA/XRF Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional Attributes.

Table C.8.19.2-1. Enhanced XA/XRF Image Module Table

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.19.2.1.1 for specialization.
Planes in Acquisition	(0018,9410)	1	The multiplicity of planes used simultaneously during the acquisition. See Section C.8.19.2.1.3.

Attribute Name	Tag	Type	Attribute Description
Plane Identification	(0018,9457)	1C	Identification of the plane used to acquire this image. Defined Terms: **MONOPLANE** **PLANE A** **PLANE B** Note 1. MONOPLANE ~~may only~~is only permitted to be used for a single plane system 2. PLANE A and PLANE B must be used for two plane systems, independent if the acquisition is single plane or biplane. 3. The value has to be in accordance with the value of Planes in Acquisition (0018,9410). If this value is SINGLE PLANE all three Defined Term are applicable. Required if Planes in Acquisition (0018,9410) is not equal to UNDEFINED.
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. Enumerated Values: **8** **9** **10** **11** **12** **13** **14** **15** **16** See Section C.8.19.2.1.2 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).

Attribute Name	Tag	Type	Attribute Description
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image shall have a value of 1.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Shall have the value: 0000H = Unsigned Integer.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME1** **MONOCHROME2**
Acquisition Protocol Name	(0018,9423)	3	User defined name of the protocol used to acquire this image.
Acquisition Protocol Description	(0018,9424)	3	User defined description of the protocol used to acquire this image.
Scan Options	(0018,0022)	3	Identifies any acquisition technique that was used during the acquisition of the image. Defined Terms: **TOMO** Tomography **CHASE** Bolus Chasing **STEP** Stepping **ROTA** Rotation
Content Qualification	(0018,9004)	1	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation.
Patient Orientation Code Sequence	(0054,0410)	1C	Sequence that describes the orientation of the patient with respect to gravity. See Section C.8.11.5.1.2 for further explanation. Only a single Item shall be included in this Sequence. Required if Positioner Type (0018,1508) equals CARM and C-arm Positioner Tabletop Relationship (0018,9474) equals YES. May be present otherwise.
>Include Table 8.8-1 “Code Sequence Macro Attributes” .			*BCID 19 “Patient Orientation”.*
>Patient Orientation Modifier Code Sequence	(0054,0412)	1C	Patient Orientation Modifier. Required if needed to fully specify the orientation of the patient with respect to gravity. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 20 “Patient Orientation Modifier”.*

Attribute Name	Tag	Type	Attribute Description
Patient Gantry Relationship Code Sequence	(0054,0414)	2C	Sequence that describes the orientation of the patient with respect to the head of the table. See Section C.8.4.6.1.3 for further explanation. Zero or one Item shall be included in this Sequence. Required if Positioner Type (0018,1508) equals CARM and C-arm Positioner Tabletop Relationship (0018,9474) equals YES. May be present otherwise.
>Include Table 8.8-1 "Code Sequence Macro Attributes" .			*BCID 21 "Patient Equipment Relationship".*
Examined Body Thickness	(0010,9431)	3	Body thickness in mm at examination location perpendicular to the table top for this Series. Note 1. This is intended for estimation of the thickness of the patient at the tabletop, not for precise calculation of the size of the object in the X-Ray beam (see Calculated Anatomy Thickness (0018,9452) Attribute). 2. For example, used to estimate the value range of the Distance Object to Table Top (0018,9403) Attribute.
Burned In Annotation	(0028,0301)	1	Indicates whether or not the image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Referenced Other Plane Sequence	(0008,9410)	1C	The images of the corresponding plane for a Biplane acquisition device. Only a single Item shall be included in this Sequence. Required if Planes in Acquisition (0018,9410) is BIPLANE.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referred to inside the Referenced Image Sequences of this SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Source Image Evidence Sequence	(0008,9154)	1C	Full set of Composite SOP Instances referred to inside the Source Image Sequences of this SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Source Image Sequence (0008,2112) is present.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Referenced Instance Sequence	(0008,114A)	3	Non-image Composite SOP Instances that are significantly related to this Image, including waveforms that may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the SOP Instances. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7004 "Waveform Purposes of Reference" for referenced waveforms.*
Image Comments	(0020,4000)	3	User-defined comments about the image.
Quality Control Image	(0028,0300)	3	Indicates whether or not this image is a quality control or phantom image. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not be a quality control or phantom image.

Attribute Name	Tag	Type	Attribute Description
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*
Presentation LUT Shape	(2050,0020)	1	Specifies a predefined identity transformation for the Presentation LUT such that the output of all grayscale transformations, if any, are defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME2 **INVERSE** output after inversion is in P-Values - shall be used if Photometric Interpretation (0028,0004) is MONOCHROME1.

C.8.19.2.1 Enhanced XA/XRF Image Module Attribute Description

C.8.19.2.1.1 Image Type and Frame Type

In addition to the requirements specified in Section C.8.16.1 Image Type, the following additional requirements and Defined Terms are specified.

C.8.19.2.1.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.19.2.1.1.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.19.2.1.1.3 Image Flavor

Value 3 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.3. No additional requirements or Defined Terms.

C.8.19.2.1.1.4 Derived Pixel Contrast

Value 4 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.4. The value shall be NONE.

C.8.19.2.1.2 Bits Allocated and Bits Stored

Table C.8.19.2-2 specifies the allowed combinations of Bits Allocated (0028,0100) and Bits Stored (0028,0101).

Table C.8.19.2-2. Allowed Combinations of Attribute Values for Bits Allocated and Bits Stored

Bits Allocated	Bits Stored
8	8
16	9 to 16

C.8.19.2.1.3 Planes in Acquisition

The Planes in Acquisition (0018,9410) Attribute identifies the multiplicity of planes used simultaneously during the acquisition.

Enumerated Values:

SINGLE PLANE Image is a single plane acquisition

BIPLANE Image is part of a Bi-plane acquisition

UNDEFINED Image is created by using data from one or two planes (e.g., reconstructed projection). ~~May~~Shall only be used when Image Type Value 1 equals DERIVED.

C.8.19.3 XA/XRF Acquisition Module

Table C.8.19.3-1 specifies the Attributes of the XA/XRF Acquisition Module.

Table C.8.19.3-1. XA/XRF Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	1	Average of the peak kilo voltage outputs of the X-Ray generator used for all frames.
Radiation Setting	(0018,1155)	1	Identify the general level of X-Ray dose exposure. Enumerated Values: **SC** low dose exposure generally corresponding to fluoroscopic settings (e.g., preparation for diagnostic quality image acquisition) **GR** high dose for diagnostic quality image acquisition (also called digital spot or cine)
X-Ray Tube Current in mA	(0018,9330)	1C	Average of the nominal X-Ray tube currents in milliamperes for all frames. Required if Exposure in mAs (0018,9332) is not present. May be present otherwise.
Exposure Time in ms	(0018,9328)	1C	Duration of X-Ray exposure in milliseconds. See Section C.8.7.2.1.1. Required if Exposure in mAs (0018,9332) is not present. May be present otherwise.
Exposure in mAs	(0018,9332)	1C	The exposure expressed in milliampereseconds, for example calculated from Exposure Time and X-Ray Tube Current. Required if either Exposure Time in ms (0018,9328) or X-Ray Tube Current in mA (0018,9330) are not present. May be present otherwise.
Average Pulse Width	(0018,1154)	1	Average width of X-Ray pulse in msec.
Acquisition Duration	(0018,9073)	1	The time in seconds needed for the complete acquisition. See Section C.7.6.16.2.2.1 for further explanation
Radiation Mode	(0018,115A)	1	Specifies X-Ray radiation mode. Defined Terms: **CONTINUOUS** **PULSED**
Focal Spot(s)	(0018,1190)	3	Nominal focal spot size in mm used to acquire this image.
Anode Target Material	(0018,1191)	3	The primary material in the anode of the X-Ray source. Defined Terms: **TUNGSTEN** **MOLYBDENUM** **RHODIUM**

Attribute Name	Tag	Type	Attribute Description
Rectification Type	(0018,1156)	3	Type of rectification used in the X-Ray generator. Defined Terms: **SINGLE PHASE** **THREE PHASE** **CONST POTENTIAL**
X-Ray Receptor Type	(0018,9420)	1	Identifies with type of X-Ray receptor is used. Enumerated Values: **IMG_INTENSIFIER** **DIGITAL_DETECTOR**
Distance Receptor Plane to Detector Housing	(0018,9426)	2	Distance in mm between the receptor plane and the detector housing. The direction of the distance is positive from receptor plane to X-Ray source. Note 1. A negative value is allowed in the case of an image intensifier the receptor plane can be a virtual plane located outside the detector housing depending the magnification factor of the intensifier. A negative value is not applicable for the digital detector. 2. Used to calculate the pixel size of the plane in the patient when markers are used, and they are placed on the detector housing.
Positioner Type	(0018,1508)	1	Defined Terms: **CARM** **COLUMN** Note 1. The term CARM can apply to any positioner with 2 degrees of freedom of rotation of the X-Ray beam about the Imaging Subject. 2. The term COLUMN can apply to any positioner with 1 degree of freedom of rotation of the X-Ray beam about the Imaging Subject.
C-arm Positioner Tabletop Relationship	(0018,9474)	1C	Describes for C-arm positioner type systems if positioner and tabletop has the same geometrical reference system. Enumerated Values: **YES** **NO** Note The value NO is intended for mobile systems where there is no table fixed to the system Required if Positioner Type (0018,1508) equals CARM.

Attribute Name	Tag	Type	Attribute Description
Acquired Image Area Dose Product	(0018,9473)	2	X-Ray dose, measured in dGy*cm*cm, to which the patient was exposed for the acquisition of this image only. Note 1. The sum of the Image Area Dose Product of all images of a Series or a Study may not result in the actual area dose product to which the patient was exposed. 2. This may be an estimated value based on assumptions about the patient's body size and habitus.

C.8.19.4 X-Ray Image Intensifier Module

Table C.8.19.4-1 specifies the Attributes of the X-Ray Image Intensifier Module.

Table C.8.19.4-1. X-Ray Image Intensifier Module Attributes

Attribute Name	Tag	Type	Attribute Description
Intensifier Size	(0018,1162)	1	Physical diameter of the maximum active area X-Ray intensifier in mm. Note This Attribute does not specify the field of view. The Attribute Field of View Dimension(s) in Float (0018,9461) is intended for this value.
Intensifier Active Shape	(0018,9427)	1	Shape of the active area used for acquiring this image. Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL** Note This may be different from the Field of View Shape (0018,1147), and should not be assumed to describe the stored image.
Intensifier Active Dimension(s)	(0018,9428)	1	Dimensions in mm of the active area used for acquiring this image. If Intensifier Active Shape (0018,9427) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of the circle circumscribing the hexagon. Note This may be different from the Field of View Dimension(s) in Float (0018,9461), and should not be assumed to describe the stored image.

C.8.19.5 X-Ray Detector Module

Table C.8.19.5-1 contains IOD Attributes that describe an X-Ray detector.

Table C.8.19.5-1. X-Ray Detector Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-71b "Digital X-Ray Detector Macro Attributes"			
Physical Detector Size	(0018,9429)	1	Dimensions of the physical detector measured in mm as a row size followed by a column size.
Position of Isocenter Projection	(0018,9430)	1C	Position of the Isocenter projection on the detector plane measured in fractional physical detector elements as a distance along the column direction followed by a distance along the row direction from the center of the TLHC detector element of a rectangle circumscribing the physical detector area. Required if Isocenter Reference System Sequence (0018,9462) is present.

C.8.19.6 Enhanced XA/XRF Image Functional Group Macros

The following sections contain Functional Group Macros specific to the Enhanced XA Image IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".".

C.8.19.6.1 X-Ray Frame Characteristics Macro

Table C.8.19.6-1 specifies the Attributes of the XA/XRF Frame Characteristics Functional Group Macro.

Table C.8.19.6-1. X-Ray Frame Characteristics Macro Attributes

Attribute Name	Tag	Type	Attribute Description
XA/XRF Frame Characteristics Sequence	(0018,9412)	1	A Sequence that describes general characteristics of this frame. Only a single Item shall be included in this Sequence.
>Derivation Description	(0008,2111)	3	A text description of how this frame was derived. See Section C.8.7.1.1.5 for further explanation.
>Derivation Code Sequence	(0008,9215)	3	A coded description of how this frame was derived. See Section C.12.4.1.1 for further explanation. One or more Items are permitted in this Sequence. More than one Item indicates that successive derivation steps have been applied.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7203 "Image Derivation".*
>Acquisition Device Processing Description	(0018,1400)	3	Indicates any visual processing performed on the frame prior to exchange. See Section C.8.7.1.1.3.

Attribute Name	Tag	Type	Attribute Description
>Acquisition Device Processing Code	(0018,1401)	3	Code representing the device-specific processing associated with the frame (e.g., Organ Filtering code) Note This Code is manufacturer specific but provides useful annotation information to the knowledgeable observer.

C.8.19.6.2 X-Ray Field of View Macro

Table C.8.19.6-2 specifies the Attributes of the X-Ray Field of View Functional Group Macro.

Table C.8.19.6-2. X-Ray Field of View Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Field of View Sequence	(0018,9432)	1	Sequence containing the field of view for this frame. Only a single Item shall be included in this Sequence.
>Field of View Shape	(0018,1147)	3	Shape of the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010). Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL**
>Field of View Dimension(s) in Float	(0018,9461)	3	Dimensions in mm of the Field of View, that is the image pixels stored in Pixel Data (7FE0,0010). If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of the circle circumscribing the hexagon.
>Field of View Origin	(0018,7030)	1C	Offset of the TLHC of a rectangle circumscribing the Field of View, i.e., the image pixels stored in Pixel Data (7FE0,0010) before rotation or flipping, from the TLHC of the physical detector area measured in physical detector pixels as a row offset followed by a column offset. See Section C.8.11.4.1.1 for further explanation. Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR. May be present otherwise.
>Field of View Rotation	(0018,7032)	1	Clockwise rotation in degrees of Field of View, i.e., the image pixels stored in Pixel Data (7FE0,0010), relative to the physical detector. Enumerated Values: **270** **180** **90** **0** See Section C.8.11.4.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Field of View Horizontal Flip	(0018,7034)	1	Whether or not a horizontal flip has been applied to the Field of View, i.e., the image pixels stored in Pixel Data (7FE0,0010), after rotation relative to the physical detector as described in Field of View Rotation (0018,7032). Enumerated Values: **NO** **YES** See Section C.8.11.4.1.1 for further explanation.
>Field of View Description	(0018,9433)	3	Manufacturer defined description of the field of view selected during acquisition.

C.8.19.6.3 X-Ray Exposure Control Sensing Regions Macro

Table C.8.19.6-3 specifies the Attributes that describe the region targeted as area where the X-Ray dose value is estimated.

Table C.8.19.6-3. X-Ray Exposure Control Sensing Regions Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Exposure Control Sensing Regions Sequence	(0018,9434)	1	Sequence containing the Exposure Control Sensing Region for this frame. One or more Items shall be included in this Sequence.
>Exposure Control Sensing Region Shape	(0018,9435)	1	Shape of the Exposure Control Sensing Region. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL**
>Exposure Control Sensing Region Left Vertical Edge	(0018,9436)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is RECTANGULAR. Location of the left edge of the rectangular Exposure Control Sensing Region expressed as effective pixel column. See Section C.8.19.6.3.1.
>Exposure Control Sensing Region Right Vertical Edge	(0018,9437)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is RECTANGULAR. Location of the right edge of the rectangular Exposure Control Sensing Region expressed as effective pixel column. See Section C.8.19.6.3.1.
>Exposure Control Sensing Region Upper Horizontal Edge	(0018,9438)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is RECTANGULAR. Location of the upper edge of the rectangular Exposure Control Sensing Region expressed as effective pixel row. See Section C.8.19.6.3.1.
>Exposure Control Sensing Region Lower Horizontal Edge	(0018,9439)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is RECTANGULAR. Location of the lower edge of the rectangular Exposure Control Sensing Region expressed as effective pixel row. See Section C.8.19.6.3.1.
>Center of Circular Exposure Control Sensing Region	(0018,9440)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is CIRCULAR. Location of the center of the circular Exposure Control Sensing Region expressed as effective pixel row and column. See Section C.8.19.6.3.1.
>Radius of Circular Exposure Control Sensing Region	(0018,9441)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is CIRCULAR. Radius of the circular Exposure Control Sensing Region expressed as effective number of pixels along the row direction. See Section C.8.19.6.3.1.

Attribute Name	Tag	Type	Attribute Description
>Vertices of the Polygonal Exposure Control Sensing Region	(0018,9442)	1C	Required if Exposure Control Sensing Region Shape (0018,9435) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex; column of the origin vertex. Two or more pairs of values follow and are the effective pixel row and column coordinates of the other vertices of the polygon Exposure Control Sensing Region. Polygon Exposure Control Sensing Regions are implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices. See Section C.8.19.6.3.1.

C.8.19.6.3.1 X-Ray Exposure Control Sensing Regions Attributes

The Exposure Control Sensing Region Left Vertical Edge (0018,9436), Exposure Control Sensing Region Right Vertical Edge (0018,9437), Exposure Control Sensing Region Upper Horizontal Edge (0018,9438), Exposure Control Sensing Region Lower Horizontal Edge (0018,9439) and Center of Circular Exposure Control Sensing Region (0018,9440) may have a negative value when the point defined by the Attribute lies outside the left or upper border of the pixel data matrix. The top left pixel of the image has a pixel row and column value of 1.

C.8.19.6.4 X-Ray Frame Pixel Data Properties Macro

Table C.8.19.6-4 specifies the Attributes of the X-Ray Frame Pixel Data Properties Functional Group Macro.

Table C.8.19.6-4. X-Ray Frame Pixel Data Properties Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Pixel Data Properties Sequence	(0028,9443)	1	Sequence containing the pixel data properties for this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the values of Image Type (0008,0008). See Section C.8.19.2.1.1.
>Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel and the X-Ray beam intensity. See Section C.8.19.6.4.1.1.
>Pixel Intensity Relationship Sign	(0028,1041)	1	The sign of the relationship between the Pixel sample values stored in Pixel Data (7FE0,0010) and the X-Ray beam intensity. Enumerated Values: **+1** Lower pixel values correspond to less X-Ray beam intensity **-1** Higher pixel values correspond to less X-Ray beam intensity See Section C.8.11.3.1.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Imager Pixel Spacing	(0018,1164)	1C	Physical distance measured at the receptor plane of the detector between the centers of each pixel specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. See Section 10.7.1.3 for further explanation of the value order. The value of this Attribute shall never be adjusted to account for calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose. It is only allowed to be adjusted to compensate for the change of the Field of View Dimension(s) in Float (0018,9461) Attribute. See Section C.8.19.6.4.1.2 Required if Image Type (0008,0008) Value 1 equals ORIGINAL. May be present otherwise. Note These values are the actual pixel spacing distances of the stored pixel values of an image.
>Pixel Data Area Origin Relative To FOV	(0018,7036)	3	Offset of the TLHC of the image stored in Pixel Data (7FE0,0010) from the TLHC of the Field Of View Area after FOV rotation and Flip. It is measured in image stored pixels as a row offset followed by a column offset. Note Due to the differences in image stored pixel and detector element spacing, one may expect this Attribute to have non-integer values. See Section C.8.19.6.4.1.3.
>Pixel Data Area Rotation Angle Relative To FOV	(0018,7038)	3	Angle clockwise of the row direction of the image stored in Pixel Data (7FE0,0010) relative to the row direction of the Field Of View Area after FOV rotation and Flip. It is measured in degrees. See Section C.8.19.6.4.1.3.
>Geometrical Properties	(0028,9444)	1	Geometrical characteristics of the pixel data to indicate whether pixel spacing is uniform for all pixels or not. Enumerated Values: **UNIFORM** **NON_UNIFORM**
>Geometric Maximum Distortion	(0028,9445)	2C	The percentage of the maximum deviation of the pixel spacing values of images for which the geometric properties are non-uniform. Note This Attribute may be used to judge the result of measurements, 3D reconstructions, etc. Required if Geometrical Properties (0028,9444) equals NON_UNIFORM.

Attribute Name	Tag	Type	Attribute Description
>Image Processing Applied	(0028,9446)	1	The type or a combination of types of image processing applied to the pixel data before being stored. Defined Terms: **DIGITAL_SUBTR** **HIGH_PASS_FILTER** **LOW_PASS_FILTER** **MULTI_BAND_FLTR** **FRAME_AVERAGING** **NONE**

C.8.19.6.4.1 X-Ray Frame Pixel Data Properties Attributes

C.8.19.6.4.1.1 Pixel Intensity Relationship

Pixel Intensity Relationship (0028,1040) shall identify the relationship of the pixel values to the X-Ray beam intensity.

Defined Terms:

LIN Approximately proportional to X-Ray beam intensity.
LOG Non-linear "Log Function"; A Pixel Intensity Relationship LUT shall be included with the image to allow it to be mapped back to its proportional value to X-Ray beam intensity.
OTHER Not proportional to X-Ray beam intensity. If a TO_LINEAR Pixel Intensity Relationship LUT Item is supplied, scaling back to X-Ray beam intensity is possible.

Note

1. When the relationship can be better defined (e.g., square root data) a more precise Defined Term can be used than OTHER.

2. Providing a TO_LINEAR Pixel Intensity Relationship LUT is encouraged.

C.8.19.6.4.1.2 Imager Pixel Spacing

The two values of the Imager Pixel Spacing (0018,1164) Attribute are related to the value(s) of the Field of View Dimension(s) in Float (0018,9461) Attribute in the X-Ray Field of View Functional Group of this frame and the values of the Rows (0028,0010) and Columns (0028,0011) Attributes.

The value(s) of Field of View Dimension(s) in Float (0018,9461) may change on a frame by frame base. The values of the Rows and Columns Attributes are equal for all frames. The relationship between the Attributes depends on the Field of View Shape (0018,1147) Attribute:

If the Field of View Shape (0018,1147) Attribute equals RECTANGLE:

$\text{Imager Pixel Spacing}_{\text{row spacing}} = \text{FOV Dimension}_{\text{row dimension}} / \text{Rows}$

$\text{Imager Pixel Spacing}_{\text{column spacing}} = \text{FOV Dimension}_{\text{column dimension}} / \text{Columns}$

If the Field of View Shape (0018,1147) Attribute equals ROUND or HEXAGONAL:

$\text{Imager Pixel Spacing}_{\text{row spacing}} = \text{FOV Dimension}_{\text{diameter}} / \text{Rows}$

$\text{Imager Pixel Spacing}_{\text{column spacing}} = \text{FOV Dimension}_{\text{diameter}} / \text{Columns}$

C.8.19.6.4.1.3 Pixel Data Area Relative to FOV

In the case where the Field of View does not have the same size as the stored Pixel Data (7FE0,0010), the stored Pixel Data (7FE0,0010) may be the result of cropping, rotation, resizing and/or padding of the Field of View. The following Attributes specify the relationship of the Pixel Data area to the Field Of View Area:

- Pixel Data Area Origin Relative to FOV (0018,7036)

- Pixel Data Area Rotation Angle Relative to FOV (0018,7038)

  Note

  In order to make use of the Pixel Data Area Origin Relative to FOV (0018,7036), the Imager Pixel Spacing (0018,1164) is needed.

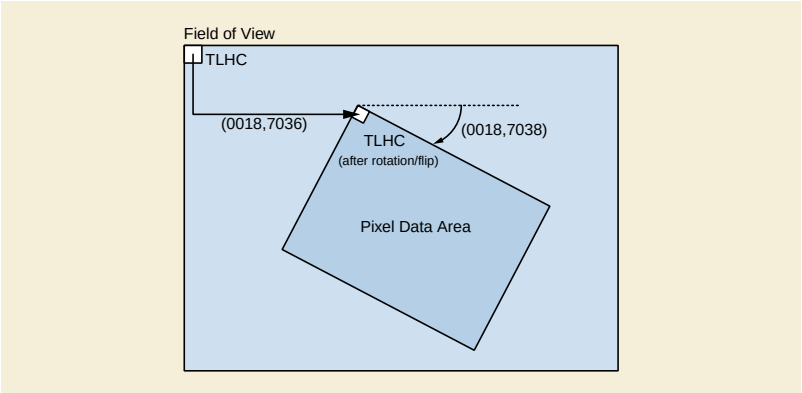


Figure C.8.19.6.4-1. Explanation of Pixel Data Area Attributes

C.8.19.6.5 X-Ray Frame Detector Parameters Macro

Table C.8.19.6-5 specifies the Attributes containing the X-Ray Frame Detector Parameters Functional Group Macro.

Table C.8.19.6-5. X-Ray Frame Detector Parameters Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Detector Parameters Sequence	(0018,9451)	1	Sequence containing the detector properties for this frame. Only a single Item shall be included in this Sequence.
>Detector Active Time	(0018,7014)	3	Time in mSec that the detector is active during acquisition of this image. Note This activation window overlaps the time of the X-Ray exposure as defined by Exposure Time in ms (0018,9328) and Detector Activation Offset From Exposure (0018,7016).
>Detector Activation Offset From Exposure	(0018,7016)	3	Offset time in mSec that the detector becomes active after the X-Ray beam is turned on during acquisition of this image. May be negative.

C.8.19.6.6 X-Ray Calibration Device Usage Macro

Table C.8.19.6-6 specifies the Attributes containing the X-Ray Calibration Device Usage Functional Group Macro.

Table C.8.19.6-6. X-Ray Calibration Device Usage Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Calibration Sequence	(0018,9455)	1	Sequence containing the calibration flag for this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Calibration Image	(0050,0004)	1	Indicates whether a reference object (phantom) of known size is present in the frame and was used for calibration. Enumerated Values: **YES** **NO** Note Device is identified using the Device Module. See Section C.7.6.12.

C.8.19.6.7 X-Ray Object Thickness Macro

Table C.8.19.6-7 specifies the Attributes containing the X-Ray Object Thickness Group Macro.

Table C.8.19.6-7. X-Ray Object Thickness Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Object Thickness Sequence	(0018,9456)	1	Sequence containing object thickness for this frame. Only a single Item shall be included in this Sequence.
>Calculated Anatomy Thickness	(0018,9452)	1	The physical thickness in mm of the anatomic region of interest as specified in the Anatomic Region Sequence (0008,2218) in the direction of the center of the beam. Note The value takes in account the position relative to object and the X-Ray source - detector axis.

C.8.19.6.8 X-Ray Frame Acquisition Macro

Table C.8.19.6-8 specifies the Attributes containing the X-Ray Frame Acquisition Functional Group Macro.

Table C.8.19.6-8. X-Ray Frame Acquisition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Acquisition Sequence	(0018,9417)	1	Sequence containing the acquisition parameters for this frame. Only a single Item shall be included in this Sequence.
>KVP	(0018,0060)	1	Exact peak kilo voltage output of the X-Ray generator used for this frame.
>X-Ray Tube Current in mA	(0018,9330)	1	Exact Nominal X-Ray tube current in milliamperes applied during Acquisition Duration (0018,9220) for this frame.

C.8.19.6.8.1 X-Ray Frame Acquisition Sequence Attributes

These Attributes may only be used if the information is available on a frame-by-frame base. The average values for these Attributes of all frames shall be stored in the same Attribute in the XA/XRF Acquisition Module or in the Enhanced Mammography Image Module.

C.8.19.6.9 X-Ray Projection Pixel Calibration Macro

Table C.8.19.6-9 specifies the Attributes of the X-Ray Projection Pixel Calibration Functional Group Macro.

Table C.8.19.6-9. X-Ray Projection Pixel Calibration Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Projection Pixel Calibration Sequence	(0018,9401)	1	A Sequence that describes the geometrical position of the patient relative to the equipment. Only a single Item shall be included in this Sequence.
>Distance Object to Table Top	(0018,9403)	2	Distance between the anatomic region of interest of observation and table top in mm. Note 1. This value is always positive, the object is assumed to be above the table. 2. The value of this Attribute is depending on the patient position on the tabletop (supine, left or right decubitus, etc.)
>Object Pixel Spacing in Center of Beam	(0018,9404)	1C	Physical distance within the anatomic region of interest in the center of the beam and perpendicular to the beam between the center of each pixel, specified by a numeric pair adjacent row spacing (delimiter) adjacent column spacing in mm. See Section C.8.19.6.9.2. See Section 10.7.1.3 for further explanation of the value order. Required if Distance Object to Table Top (0018,9403) is not empty. Note This value is provided besides the values that are the input parameters of the calibration algorithm.
>Table Height	(0018,1130)	1C	The distance of the top of the patient table to the center of rotation of the source (i.e., the isocenter) in mm. A positive value indicates that the tabletop is below the isocenter. Note All the distances are measured perpendicular to the Table Top plane. Required if Image Type (0008,0008) Value 1 is ORIGINAL, may be present otherwise.
>Beam Angle	(0018,9449)	1C	The equipment related angle in degrees of the X-Ray beam relative to the perpendicular to the tabletop plane. An angle from 0 to +90 degrees indicates that the X-Ray source is below the table. The valid range is 0 to +180 degrees. Required if Image Type (0008,0008) Value 1 is ORIGINAL, may be present otherwise.

C.8.19.6.9.1 Projection Calibration Method

The X-Ray Projection Pixel Calibration Macro defines the Attributes needed to completely describe the specific inputs and results from projection image pixel calibration based on isocenter reference. The Attributes are provided to allow usage of calibration result as well as recalibration. Figure C.8.19.6-1 and Figure C.8.19.6-2 illustrate the relationship of the Attributes.

In Figure C.8.19.6-1 and Figure C.8.19.6-2, the object of interest of size D (in mm) is projected on the stored image over a distance of #Px (in pixels). The pixel spacing on the stored image is called DPx. The "Source to Isocenter Distance" is called ISO. The "Source Image Receptor Distance" is called SID. The shortest distance from the tabletop plane to the Isocenter and to the object of interest are called respectively TH and TO. The angle between the X-Ray beam and the axis perpendicular to the tabletop plane is called

Beam Angle. Finally, the distance from the X-Ray source to the object of interest in the direction of the X-Ray beam is called SOD and is calculated from the other distances.

DPx: Imager Pixel Spacing (0018,1164)

ISO: Source Isocenter Distance (0018,9402)

SID: Distance Source to Detector (0018,1110)

TH: Table Height (0018,1130)

TO: Distance Object to Table Top (0018,9403)

Beam Angle: Beam Angle (0018,9449)

Note

The equipment related Beam Angle (0018,9449) Attribute shall be consistent with the patient oriented Positioner Primary Angle (0018,1510) and Positioner Secondary Angle (0018,1511) together with the patient orientation on the table specified in Patient Orientation Code Sequence (0054,0410) Attributes.

Figure C.8.19.6-1 and Figure C.8.19.6-2 illustrate the usage of the Attributes under the conditions laid out above.

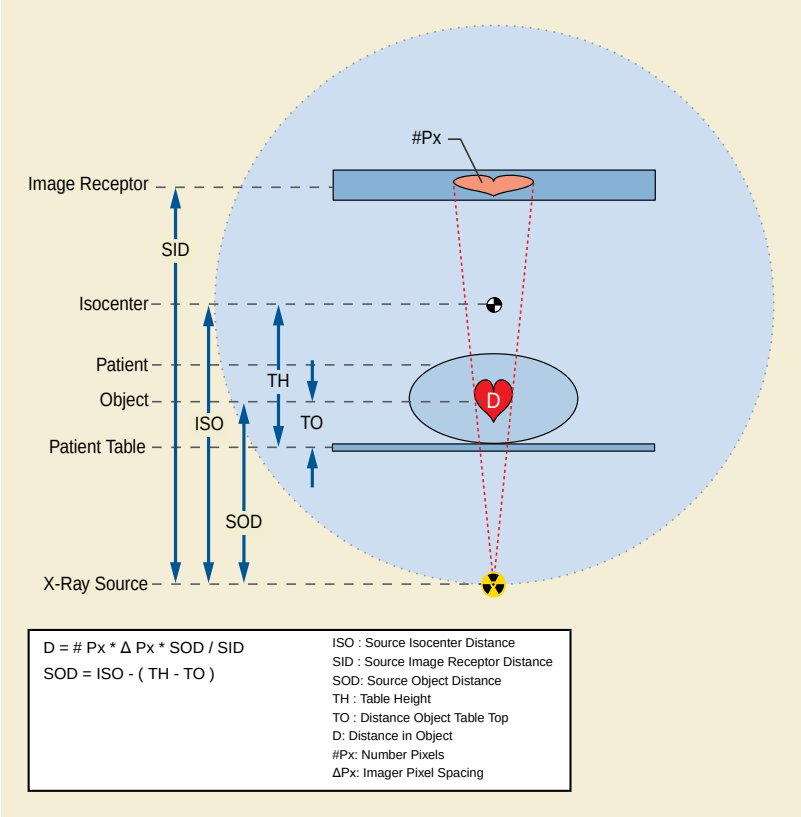


Figure C.8.19.6-1. Projection Calibration Without Angulation of the X-Ray Beam (Beam Angle = 0)

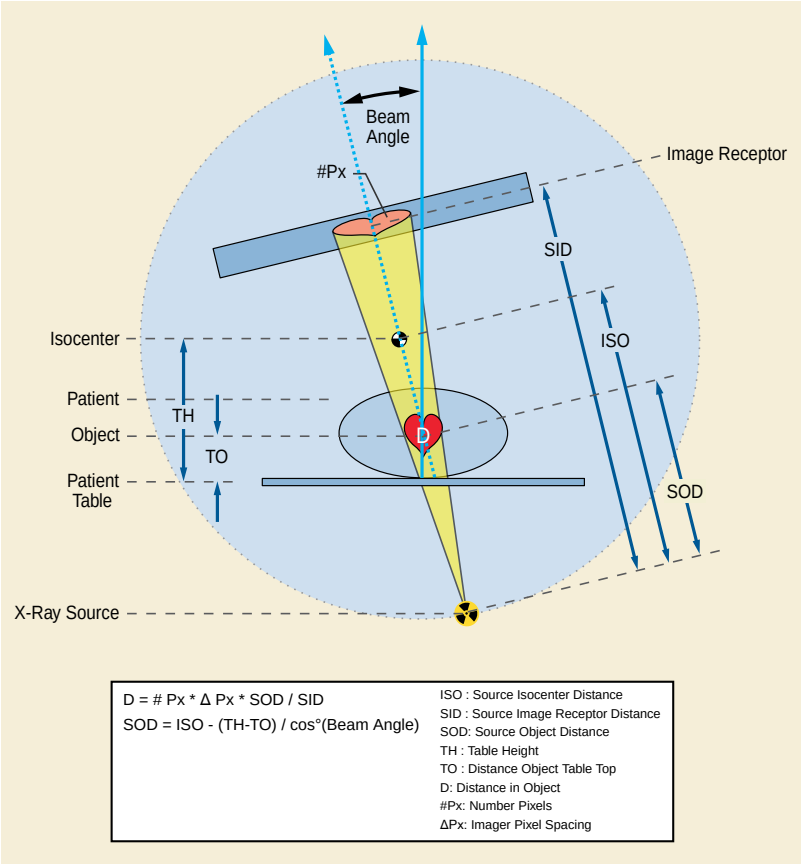


Figure C.8.19.6-2. Projection Calibration With Angulation of the X-Ray Beam (Beam Angle Not Equal to 0)

C.8.19.6.9.2 Object Pixel Spacing in Center of Beam

The value provided for Beam Angle (0018,9449) shall correspond to the other Attribute values within this Module and according to the mathematic terms listed in Section C.8.19.6.9.1.

The terms listed will result in infinite result when used with 90-degree beam angles.

It is outside the scope of this Standard to define reasonable limits for single input values in the above-mentioned terms, or to define the mathematical accuracy of applications using those terms.

Note

It may be reasonable to limit automatic calculations to a narrow range of +/- 60 degrees for Beam Angle and inform users about possible deviations in the calibration result when exceeding such range limits.

C.8.19.6.10 X-Ray Positioner Macro

Table C.8.19.6-10 specifies the Attributes of the X-Ray Positioner Functional Group Macro. If included into the Shared Functional Groups Sequence (5200,9229) no DYNAMIC motion was performed during acquisition. If included in the Per-frame Functional Groups Sequence (5200,9230) the indication of a DYNAMIC motion is given.

Table C.8.19.6-10. X-Ray Positioner Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Positioner Position Sequence	(0018,9405)	1	A Sequence that describes the geometrical position of the positioner. Only a single Item shall be included in this Sequence.
>Positioner Primary Angle	(0018,1510)	1C	Position of the X-Ray Image Intensifier about the patient from the RAO to LAO direction where movement from RAO to vertical is positive. See Section C.8.7.5.1.2. Required if Positioner Type (0018,1508) equals CARM.
>Positioner Secondary Angle	(0018,1511)	1C	Position of the X-Ray Image Intensifier about the patient from the CAU to CRA direction where movement from CAU to vertical is positive. See Section C.8.7.5.1.2 Required if Positioner Type (0018,1508) equals CARM.
>Column Angulation (Patient)	(0018,9447)	1C	Angle of the X-Ray beam in degree relative to an orthogonal axis to the detector plane. Positive values indicate that the tilt is towards the head of the patient. Note 1. The detector plane is assumed to be parallel to the table plane 2. This Attribute differentiates form the Attribute Column Angulation (0018,1450) by using the Patient-Based Coordinate System instead of the Equipment-Based Coordinate System. Required if Positioner Type (0018,1508) equals COLUMN.

C.8.19.6.11 X-Ray Table Position Macro

Table C.8.19.6-11 specifies the Attributes of the X-Ray Table Position Functional Group Macro.

Table C.8.19.6-11. X-Ray Table Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Table Position Sequence	(0018,9406)	1	A Sequence that describes the geometrical position of the table top. Only a single Item shall be included in this Sequence.
>Table Top Vertical Position	(300A,0128)	1	Table Top Vertical position with respect to an arbitrary chosen reference by the equipment in (mm). Table motion downwards is positive
>Table Top Longitudinal Position	(300A,0129)	1	Table Top Longitudinal position with respect to an arbitrary chosen reference by the equipment in (mm). Table motion towards LAO is positive assuming that the patient is positioned supine and its head is in normal position.
>Table Top Lateral Position	(300A,012A)	1	Table Top Lateral position with respect to an arbitrary chosen reference by the equipment in (mm). Table motion towards CRA is positive assuming that the patient is positioned supine and its head is in normal position.
>Table Horizontal Rotation Angle	(0018,9469)	1	Rotation of the table in the horizontal plane (clockwise when looking from above the table).

Attribute Name	Tag	Type	Attribute Description
>Table Head Tilt Angle	(0018,9470)	1	Angle of the head-feet axis of the table in degrees relative to the horizontal plane. Positive values indicate that the head of the table is upwards.
>Table Cradle Tilt Angle	(0018,9471)	1	Angle of the left-right axis of the table in degrees relative to the horizontal plane. Positive values indicate that the left of the table is upwards.

C.8.19.6.11.1 X-Ray Table Position Macro Attribute Description

The Table Top Position Attributes of the Table Position Sequence (0018,9406) specify the geometrical position of the Table in the three spatial directions (i.e., Vertical, Longitudinal and Lateral) relative to the Table Top plane (see Figure C.8.19.6-3). The absolute reference point to which the Table positions are related is arbitrarily defined by the manufacturer.

The Table Angle Attributes of the Table Position Sequence (0018,9406) specify the rotation and tilt of the Table Top Plane with respect to a plane arbitrarily defined by the manufacturer (usually the horizontal plane).

The Table Top Position Attributes allow to describe the incremental translation of the Table top between frames of the same Multi-frame image, and between frames of different images, provided that the Table Angles are not modified between these frames.

When the table angles are modified between two frames, the Table Position Sequence (0018,9406) does not allow to characterize the relationship between the two table positions in an absolute reference coordinate system. For this purpose, the X-Ray Isocenter Reference System Macro has to be used.

Note

The incremental table translation may be used, in conjunction with the Positioner Position Sequence Attributes (0018,9405), for simple 2D-2D registration applications (object tracking, pixel shift…), assuming that the patient position is fixed on the table. For more complex registration applications, and in order to properly handle the changes in the table angles, it is recommended to use the X-Ray Isocenter Reference System Macro Attributes.

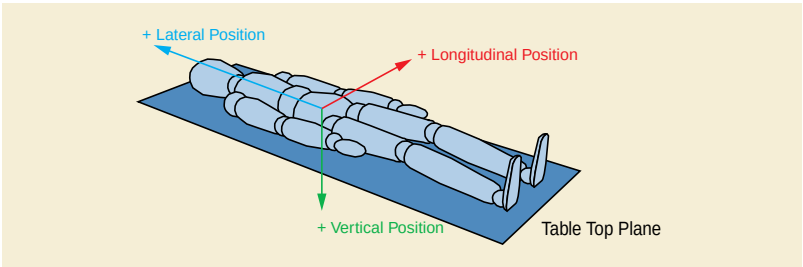


Figure C.8.19.6-3. Table Position Vectors

C.8.19.6.12 X-Ray Collimator Macro

Table C.8.19.6-12 specifies the Attributes of the X-Ray Collimator Functional Group Macro.

Table C.8.19.6-12. X-Ray Collimator Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Collimator Shape Sequence	(0018,9407)	1	A Sequence that describes the collimator shape. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Collimator Shape	(0018,1700)	1	Shape(s) of the collimator. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL** This multi-valued Attribute shall contain at most one of each Enumerated Value.
>Collimator Left Vertical Edge	(0018,1702)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the left edge of the rectangular collimator expressed as effective pixel column. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Collimator Right Vertical Edge	(0018,1704)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the right edge of the rectangular collimator expressed as effective pixel column. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Collimator Upper Horizontal Edge	(0018,1706)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the upper edge of the rectangular collimator expressed as effective pixel row. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Collimator Lower Horizontal Edge	(0018,1708)	1C	Required if Collimator Shape (0018,1700) is RECTANGULAR. Location of the lower edge of the rectangular collimator expressed as effective pixel row. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Center of Circular Collimator	(0018,1710)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Location of the center of the circular collimator expressed as effective pixel row and column. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Radius of Circular Collimator	(0018,1712)	1C	Required if Collimator Shape (0018,1700) is CIRCULAR. Radius of the circular collimator expressed as effective number of pixels along the row direction. See Section C.8.7.3.1.1 and Section C.8.19.6.12.1.
>Vertices of the Polygonal Collimator	(0018,1720)	1C	Required if Collimator Shape (0018,1700) is POLYGONAL. Multiple Values where the first set of two values are: row of the origin vertex; column of the origin vertex. Two or more pairs of values follow and are the effective pixel row and column coordinates of the other vertices of the polygon collimator. Polygon collimators are implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices. See Section C.8.19.6.12.1.

C.8.19.6.12.1 X-Ray Collimator Attributes

The top left pixel of the image has a pixel row and column value of 1.

C.8.19.6.13 X-Ray Isocenter Reference System Macro

Table C.8.19.6-13 specifies the Attributes of the X-Ray Isocenter Reference System Functional Group Macro.

Table C.8.19.6-13. X-Ray Isocenter Reference System Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Isocenter Reference System Sequence	(0018,9462)	1	A Sequence that describes the Isocenter Reference Coordinate System (O, X, Y, Z). Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Positioner Isocenter Primary Angle	(0018,9463)	1	Position of the X-Ray center beam in the isocenter reference system in the X direction (deg). See Section C.8.19.6.13.1.2 for further explanation.
>Positioner Isocenter Secondary Angle	(0018,9464)	1	Position of the X-Ray center beam in the isocenter reference system in the Z direction (deg). See Section C.8.19.6.13.1.2 for further explanation.
>Positioner Isocenter Detector Rotation Angle	(0018,9465)	1	Rotation of the X-Ray detector plane (deg). See Section C.8.19.6.13.1.2 for further explanation.
>Table X Position to Isocenter	(0018,9466)	1	X position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.
>Table Y Position to Isocenter	(0018,9467)	1	Y position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.
>Table Z Position to Isocenter	(0018,9468)	1	Z position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.
>Table Horizontal Rotation Angle	(0018,9469)	1	Rotation of the table in the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.
>Table Head Tilt Angle	(0018,9470)	1	Angle of the head-feet axis of the table in degrees relative to the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.
>Table Cradle Tilt Angle	(0018,9471)	1	Angle of the left-right axis of the table in degrees relative to the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.

C.8.19.6.13.1 Isocenter Reference System Attribute Description

The Isocenter Reference System Attributes describe the 3D geometry of the X-Ray equipment composed by the X-Ray positioner and the X-Ray table.

These Attributes define three coordinate systems in the 3D space:

- Isocenter coordinate system
- Positioner coordinate system
- Table coordinate system

The Isocenter Reference System Attributes describe the relationship between the 3D coordinates of a point in the table coordinate system and the 3D coordinates of such point in the positioner coordinate system (both systems moving in the equipment), by using the Isocenter coordinate system that is fixed in the equipment.

Note

Annex FFF “Enhanced XA/XRF Encoding Examples (Informative)” in PS3.17 describes the transformations necessary to transpose between coordinate systems.

C.8.19.6.13.1.1 Isocenter Coordinate System

The Isocenter coordinate system (O,X,Y,Z) of the equipment is defined as follows:

- Origin O is on the System Isocenter
- +Y DOWNWARD (gravity)
- +X, +Z directions in the horizontal plane (gravity plane). Directions arbitrarily defined by the manufacturer

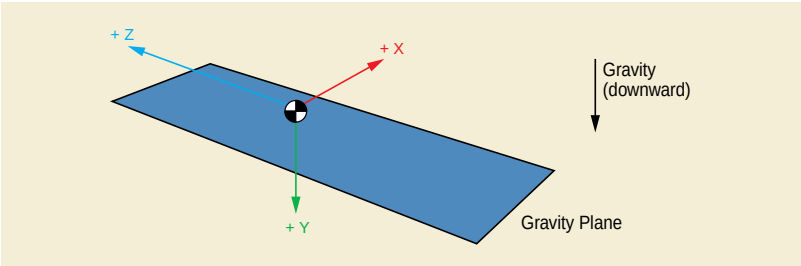


Figure C.8.19.6-4. Isocenter Coordinate System

C.8.19.6.13.1.2 Positioner Coordinate System

The Positioner Coordinate System (O_p, X_p, Y_p, Z_p) is defined as follows:

- Origin O_p, is the origin of the Isocenter coordinate system O
- X_p axis is parallel to the horizontal scan-lines of the detector (rows). Positive direction from left to right of the detector plane looking towards the source.
- Z_p axis is parallel to the vertical scan-lines of the detector (columns). Positive direction from bottom to top of the detector plane looking towards the source.
- Y_p is the axis from the isocenter to the X-Ray source. Positive direction from the Isocenter to the X-Ray Source. This axis is so-called the X-Ray center beam.

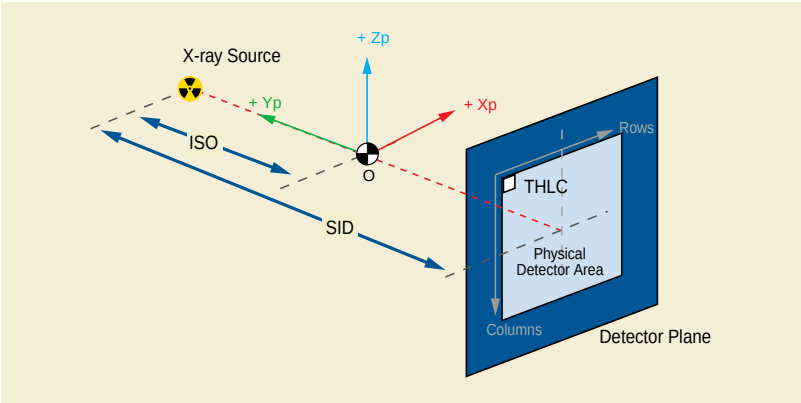


Figure C.8.19.6-5. Positioner Coordinate System

Note

The quantities SID and ISO are specified by the Attributes Distance Source to Detector (0018,1110) and Distance Source to Isocenter (0018,9402) respectively.

The Positioner Coordinate System (O_p, X_p, Y_p, Z_p) is characterized, with respect to the Isocenter Coordinate System (O, X, Y, Z), by two angles describing the X-Ray center beam, and a third angle describing the rotation of the X-Ray detector plane. These angles are relative to the Isocenter reference system, and independent from the patient position on the equipment.

Positioner Isocenter Primary Angle (0018,9463) (so-called Ap_1 in Figure C.8.19.6-6) is defined in the plane XY, as the angle between the plane YZ and the plane Y_pZ. The axis of rotation of this angle is the Z axis. Angle from -Y to +X is positive. The valid range of this angle is -180 to +180 degrees.

Positioner Isocenter Secondary Angle (0018,9464) (so-called Ap_2 in Figure C.8.19.6-6) is defined in the plane Y_pZ, as the angle of the X-Ray Center Beam (i.e., Y_p) relative to the XY plane. The axis of rotation of this angle is perpendicular to the plane Y_pZ. Angle from the plane XY to +Z is positive. The valid range of this angle is -180 to +180 degrees.

Positioner Isocenter Detector Rotation Angle (0018,9465) (so-called Ap_3 in Figure C.8.19.6-6 and in Figure C.8.19.6-7) is defined in the detector plane, as the angle of the vertical scan-lines of the detector (i.e., Z_p) relative to the intersection between the detector plane and the plane Y_pZ. The sign of this angle is positive clockwise when facing on to the detector plane (see Figure C.8.19.6-7). The valid range of this angle is -180 to +180 degrees.

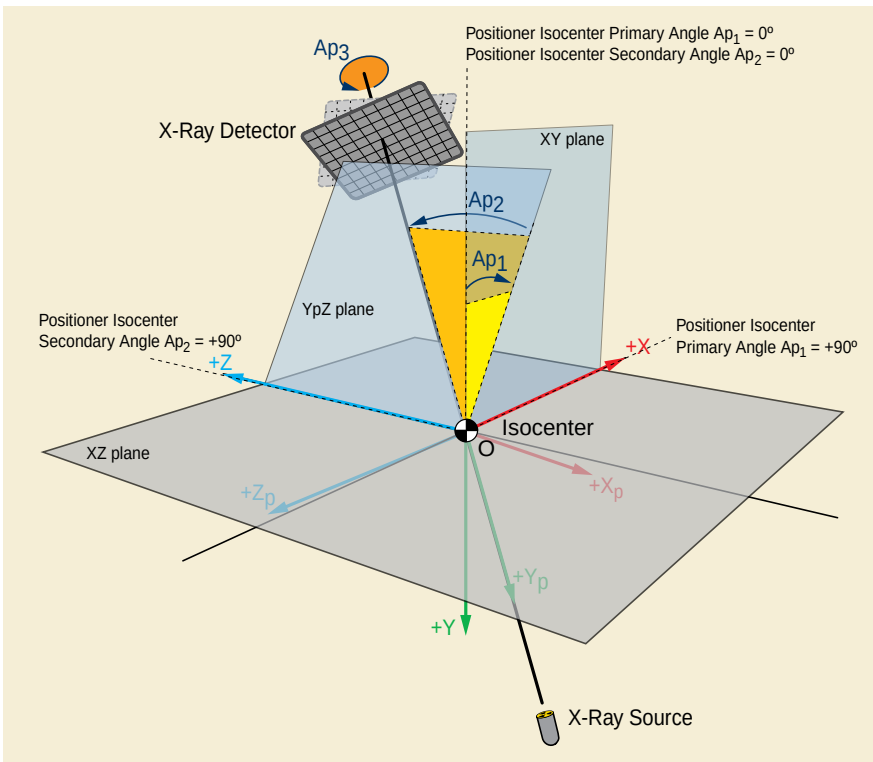


Figure C.8.19.6-6. Positioner Isocenter Angles

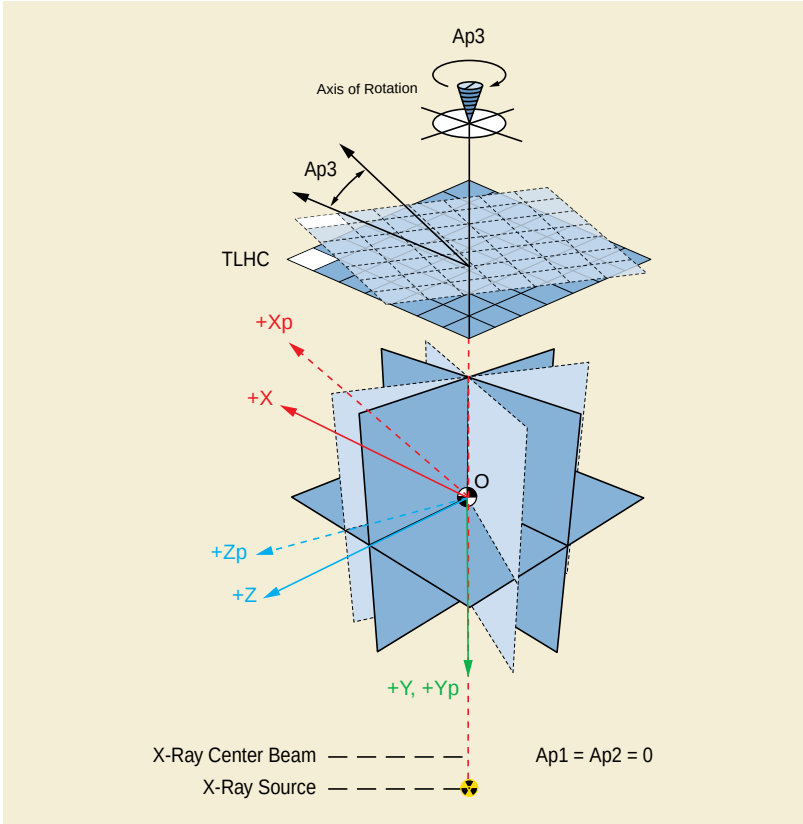


Figure C.8.19.6-7. Positioner Isocenter Detector Rotation Angle when Ap_1 = 0 and Ap_2 = 0

C.8.19.6.13.1.3 Table Coordinate System

The table coordinate system (O_t, X_t, Y_t, Z_t) is defined as follows:

- Origin O_t, so-called Table Reference Point, is on the Table Top plane

- $+X_t$ direction to the TABLE LEFT

- $+Z_t$ direction to the TABLE HEAD

- $+Y_t$ direction to the TABLE DOWN

The table coordinate system (O_t, X_t, Y_t, Z_t) is characterized, with respect to the Isocenter coordinate system (O, X, Y, Z), by a 3D translation and 3 angles describing the tilting and rotation:

Table X Position to Isocenter (0018,9466) (so-called $\mathbf{T_X}$ in Figure C.8.19.6-8) is defined as the translation of the Table Reference Point O_t with respect to the Isocenter Coordinate System in the X direction. Table motion toward +X is positive.

Table Y Position to Isocenter (0018,9467) (so-called $\mathbf{T_Y}$ in Figure C.8.19.6-8) is defined as the translation of the Table Reference Point O_t with respect to the Isocenter Coordinate System in the Y direction. Table motion toward +Y is positive.

Table Z Position to Isocenter (0018,9468) (so-called $\mathbf{T_Z}$ in Figure C.8.19.6-8) is defined as the translation of the Table Reference Point O_t with respect to the Isocenter Coordinate System in the Z direction. Table motion toward +Z is positive.

Note

A translation of ($\mathbf{T_X,T_Y,T_Z}$) = (0, 0, 0) means that the Table Reference Point O_t is at the System Isocenter.

Table Horizontal Rotation Angle (so-called $\mathbf{At_1}$ in Figure C.8.19.6-9) is defined in the horizontal plane XZ, as the angle of the projection of the +Zt axis in the XZ plane relative to the +Z axis. The axis of rotation of this angle is the vertical axis crossing the Table Reference Point Ot. Zero value is defined when the projection of +Zt in the XZ plane is equal to +Z. Angle from +Z to +X is positive. The valid range of this angle is -180 to +180 degrees.

Table Head Tilt Angle (so-called $\mathbf{At_2}$ in Figure C.8.19.6-9) is defined in the vertical plane containing Z_t (i.e., YZ_t), as the angle of the $+Z_t$ axis relative to the horizontal plane XZ. The axis of rotation of this angle is defined as the intersection between the horizontal plane XZ and the plane X_tY_t. Zero value is defined when $+Z_t$ is contained in the horizontal plane XZ. Angle from horizontal (plane XZ) to -Y direction (upwards) is positive, indicating that the head of the table is above the horizontal plane. The valid range of this angle is -45 to +45 degrees.

Table Cradle Tilt Angle (so-called $\mathbf{At_3}$ in Figure C.8.19.6-9) is defined in the X_tY_t plane, as the angle of the $+X_t$ axis relative to the intersection between the X_tY_t plane and the horizontal plane XZ. The axis of rotation of this angle is the axis Z_t. Zero value is defined when $+X_t$ is contained in the horizontal plane XZ. Angle from horizontal (plane XZ) to -Y direction (upwards) is positive, indicating that the left of the table is above the horizontal plane. The valid range of this angle is -45 to +45 degrees.

Note

The angles $\mathbf{At_1}$, $\mathbf{At_2}$ and $\mathbf{At_3}$ are independent from any specific mechanical design of the table rotation axis defined by a manufacturer. In particular, they don't require the three rotation axis to cross on a single point. If a mechanical rotation axis does not cross the Table Reference Point O_t, a mechanical rotation around this axis will generate a change in one or more table angles as well as a translation of the Table Reference Point.

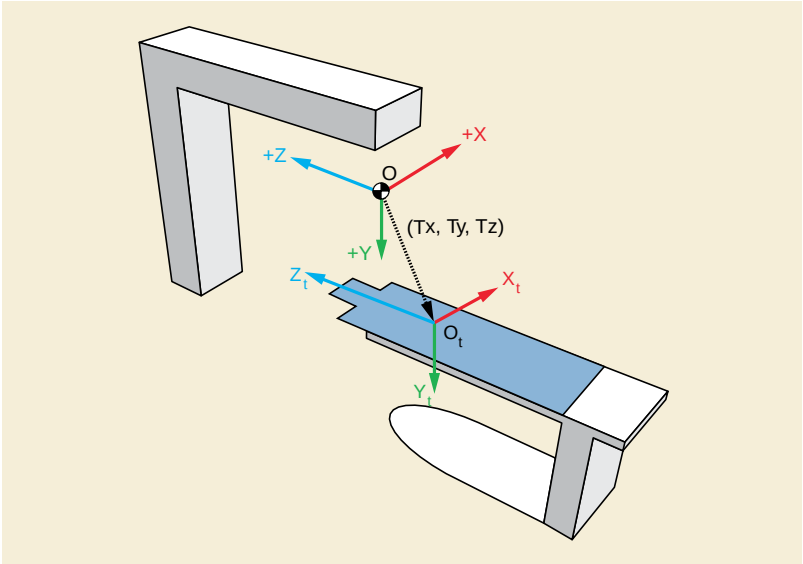


Figure C.8.19.6-8. Table Translation with respect to the Isocenter Reference System

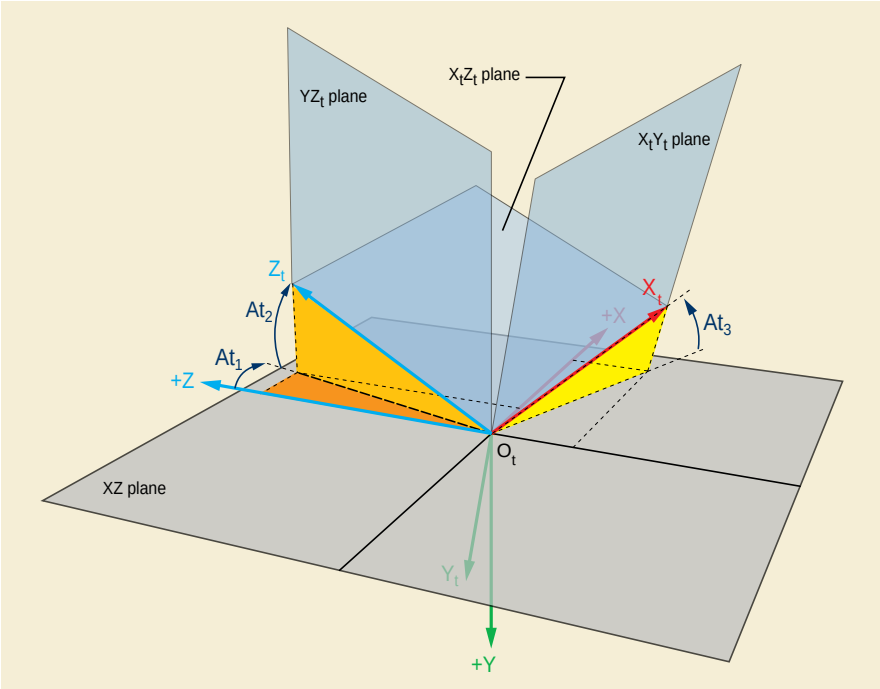


Figure C.8.19.6-9. Table Angulations with respect to the Isocenter Reference System

C.8.19.6.13.2 Relationship Patient Coordinate System

The Isocenter Reference System Attributes allow expressing the positioner angulations (i.e., X-Ray Center Beam direction) as a vector in the table coordinate system. If the relationship between the X-Ray table and the patient is known, it is possible to express any vector of the table coordinate system as a direction in the patient.

Therefore, the Isocenter Reference System Attributes allow calculating the positioner angulations in the Patient-Based Coordinate System if the following Attributes are present:

- Patient Orientation Code Sequence (0054,0410)
- Patient Orientation Modifier Code Sequence (0054,0412)

Further, the Isocenter Reference System Attributes allow calculating the patient anatomical directions (i.e., left, right, head, feet, anterior, posterior) of the rows and columns of the stored image, if the following Attributes are present:

- Patient Orientation Code Sequence (0054,0410)
- Patient Orientation Modifier Code Sequence (0054,0412)
- Field of View Rotation (0018,7032)
- Field of View Horizontal Flip (0018,7034)

For registration purposes, a given point fixed in the patient (object of interest) that is defined in the table coordinate system can be expressed as row and column coordinates of the stored image if the relationship between the positioner coordinate system and the stored image is fully characterized. Therefore, the Isocenter Reference System Attributes allow calculating the projection of a point of the patient as row and column coordinates of the stored image, if the following Attributes are present:

- Frame of Reference UID (0020,0052) and must be equal for all images involved in the registration
- Field of View Rotation (0018,7032)
- Field of View Horizontal Flip (0018,7034)

- Imager Pixel Spacing (0018,1164)
- Distance Source to Isocenter (0018,9402)
- Distance Source to Detector (0018,1110)

In addition for a system equipped with a digit al detector the following Attributes need to be present:

- Detector Element Spacing (0018,7022)
- Field of view Origin (0018,7030)
- Position of Isocenter Projection (0018,9430)

C.8.19.6.14 X-Ray Geometry Macro

Table C.8.19.6-14 specifies the Attributes containing the X-Ray Geometry Functional Group Macro.

Table C.8.19.6-14. X-Ray Geometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray Geometry Sequence	(0018,9476)	1	Sequence containing the geometric properties for this frame. Only a single Item shall be included in this Sequence.
>Distance Source to Isocenter	(0018,9402)	1	Distance from source to isocenter in mm.
>Distance Source to Detector	(0018,1110)	1	Distance from source to receptor plane perpendicular to the receptor plane in mm. Note This value is traditionally referred to as Source Image Receptor Distance (SID).

C.8.19.7 XA/XRF Multi-frame Presentation Module

Table C.8.19.7-1 specifies the Attributes of a XA/XRF Multi-frame Presentation Module.

Table C.8.19.7-1. XA/XRF Multi-frame Presentation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Preferred Playback Sequencing	(0018,1244)	3	Describes the preferred playback sequencing for a multi-frame image. Enumerated Values: **0** Looping (1,2…n,1,2,…n,1,2,….n,…) **1** Sweeping (1,2,…n,n -1,…2,1,2,…n,…)
Frame Display Sequence	(0008,9458)	3	Sequence that specifies the display frame rate of a selected set of frames. The Items are ordered in increasing frame number. The range of the frames may not overlap and the ranges shall be adjacent. One or more Items are permitted in this Sequence.
>Start Trim	(0008,2142)	1	The Frame Number of the first frame of the set of frames to be displayed in this Item.
>Stop Trim	(0008,2143)	1	The Frame Number of the last frame of the set of frames to be displayed in this Item.

Attribute Name	Tag	Type	Attribute Description
>Skip Frame Range Flag	(0008,9460)	1	A flag indicating that the range of frames in this Item may be skipped. Defined Terms: **DISPLAY** **SKIP**
>Recommended Display Frame Rate in Float	(0008,9459)	1	Recommended rate at which the frames of this Item should be displayed in frames/second.
>Recommended Viewing Mode	(0028,1090)	2	Specifies the recommended viewing protocol(s). When this Attribute is present with a value, this value shall override the value of Recommended Viewing Mode (0028,1090) specified in the Mask Module. Defined Terms: **SUB** subtraction with mask images **NAT** native viewing of image as stored Note If an implementation does not recognize the Defined Term for Recommended Viewing Mode (0028,1090), reverting to native display mode is recommended.
>Display Filter Percentage	(0028,9411)	2	Edge enhancement filter percentage that is recommended by the pixel data creator as filter presetting for display purposes. The value of 100 corresponds to the maximum filter strength that can be applied by a specific application displaying the image.
>Mask Visibility Percentage	(0028,9478)	1C	The percentage of visibility of the mask frame during a subtracted display. A value of 0 corresponds to subtracted display, a value of 100 corresponds to un-subtracted display (native). See Section C.8.19.7.1. Note The value of 100 is equivalent to Recommended Viewing Mode (0028,1090) having a value of NAT. Required if Recommended Viewing Mode (0028,1090) equals SUB.

C.8.19.7.1 Multi-frame Presentation Attributes

C.8.19.7.1.1 Mask Visibility Percentage (Informative)

An example of the usage of the Mask Visibility Percentage (0028,9478) Attribute is illustrated below.

Assume that P_{sub} is the output pixel level of a subtracted frame, its calculation can be expressed as followed:

$P_{contrast}$: Pixel level of the contrast frame in the logarithmic domain

P_{mask}: Pixel level of the mask frame in the logarithmic domain

X: Mask Visibility Percentage (0028,9478): 0 <= X <= 100

$P_{sub} = P_{contrast} - (1 - X/100) * P_{mask}$

C.8.20 Segmentation

This section describes the specific Modules for the Segmentation IOD.

C.8.20.1 Segmentation Series Module

Table C.8.20-1 defines the general Attributes of the Segmentation Series Module.

Table C.8.20-1. Segmentation Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type Enumerated Values: **SEG**
Series Number	(0020,0011)	1	A number that identifies this Series
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.20.2 Segmentation Image Module

Table C.8.20-2 defines the general Attributes of the Segmentation Image Module.

Table C.8.20-2. Segmentation Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Value 1 shall be DERIVED. Value 2 shall be PRIMARY. No other values shall be present.
Include Table 10-12 “Content Identification Macro Attributes”			
Total Pixel Matrix Columns	(0048,0006)	1C	Total number of columns in pixel matrix; i.e., width of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Total Pixel Matrix Rows	(0048,0007)	1C	Total number of rows in pixel matrix; i.e., height of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Total Pixel Matrix Focal Planes	(0048,0303)	1C	Total number of focal planes (Z locations) in the pixel matrix; i.e., depth of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise. Note Total Pixel Matrix Focal Planes (0048,0303) describes the number of focal planes separately encoded, and is distinct from Number of Focal Planes (0048,0013), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).

Attribute Name	Tag	Type	Attribute Description
Total Pixel Matrix Origin Sequence	(0048,0008)	1C	Location of pixel 1\1 of the total pixel matrix in the Slide Coordinate System Frame of Reference. Only a single Item shall be included in this Sequence. See Section C.8.12.4.1.4 and Section C.8.12.2.1.1 for further explanation. Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in millimeters from the Origin of the Slide Coordinate System.
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in millimeters from the Origin of the Slide Coordinate System.
Image Orientation (Slide)	(0048,0102)	1C	The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4. Required if Plane Position (Slide) Sequence (0048,021A) is present within a Functional Group Sequence or Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Samples Per Pixel	(0028,0002)	1	Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Enumerated Values: **MONOCHROME2**
Pixel Representation	(0028,0103)	1	Enumerated Values: **0**
Bits Allocated	(0028,0100)	1	See Section C.8.20.2.1. Enumerated Values if Segmentation Type (0062,0001) is BINARY: **1** Enumerated Values if Segmentation Type (0062,0001) is not BINARY: **8**
Bits Stored	(0028,0101)	1	See Section C.8.20.2.1. Enumerated Values if Segmentation Type (0062,0001) is BINARY: **1** Enumerated Values if Segmentation Type (0062,0001) is not BINARY: **8**
High Bit	(0028,0102)	1	See Section C.8.20.2.1. Enumerated Values if Segmentation Type (0062,0001) is BINARY: **0** Enumerated Values if Segmentation Type (0062,0001) is not BINARY: **7**

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime), or is derived from lossy compressed images. Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.8.20.2.2 and Section C.7.6.1.1.5, “Lossy Image Compression”.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if present in the source images or this IOD Instance has been compressed.
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if present in the source images or this IOD Instance has been compressed. See Section C.8.20.2.2.
Segmentation Type	(0062,0001)	1	The type of encoding used to indicate the presence of the segmented property at a pixel/voxel location. Enumerated Values: **BINARY** **FRACTIONAL** See Section C.8.20.2.3.
Segmentation Fractional Type	(0062,0010)	1C	For fractional segmentation encoding, the meaning of the fractional value. Required if Segmentation Type (0062,0001) is FRACTIONAL. See Section C.8.20.2.3 for Enumerated Values.
Maximum Fractional Value	(0062,000E)	1C	Specifies the value that represents a probability of 1 or complete occupancy. There shall be no values in Pixel Data (7FE0,0010) greater than this value. Required if Segmentation Type (0062,0001) is FRACTIONAL.

Attribute Name	Tag	Type	Attribute Description
Segments Overlap	(0062,0013)	3	Whether or not any segments in this Instance overlap. I.e., whether or not any pixel is or might be in more than one segment. Enumerated Values: **YES** Some segments overlap **UNDEFINED** Some segments might overlap **NO** No segments overlap See Section C.8.20.2.3. Note If the value is NO, then a receiving application to which this matters can be assured that no segments overlap and does not need to check every pixel. If the value is UNDEFINED or YES, or the Attribute is absent, then a receiving application might need to check every pixel in every segment.
Segment Sequence	(0062,0002)	1	Describes the segments that are contained within the data. One or more Items shall be included in this Sequence.
>Include Table C.8.20-4 "Segment Description Macro Attributes"			
>Segment Algorithm Name	(0062,0009)	1C	Name of algorithm used to generate the segment. Required if Segment Algorithm Type (0062,0008) is not MANUAL.
>Segmentation Algorithm Identification Sequence	(0062,0007)	3	A description of how this segment was derived. Algorithm Name (0066,0036) within this Sequence may be identical to Segment Algorithm Name (0062,0009). Only a single Item is permitted in this Sequence. Note Previously, the Segment Surface Generation Algorithm Identification Code Sequence (0066,002D) was used, but it has been replaced in this Module, since not all segmentation algorithms involve surface generation. See PS3.3 2016d.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			*BCID 7162 "Surface Processing Algorithm Families".*
>Recommended Display Grayscale Value	(0062,000C)	3	A default single gray unsigned value in which it is recommended that the maximum pixel value in this segment be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Recommended Display CIELab Value	(0062,000D)	3	A default triplet value in which it is recommended that segment be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

C.8.20.2.1 Bits Allocated and Bits Stored

As a consequence of the enumerated Bits Allocated and Bits Stored Attribute values, single bit pixels shall be packed 8 to a byte as defined by the encoding rules in PS3.5.

C.8.20.2.2 Lossy Image Compression and Lossy Image Compression Method

If Lossy Image Compression (0028,2110) in any of the source images is "01", the value shall be "01" for the Segmentation Instance.

The process of segmentation itself is defined not to be lossy compression, even though it involves loss. If the Segmentation Instance is encoded using a lossy compression Transfer Syntax, then the value shall be set to "01".

Note

It is not advisable to lossy compress a Segmentation SOP Instance. In particular, a binary segmentation should not be lossy compressed.

C.8.20.2.3 Segmentation Type, Segmentation Fractional Type and Segments Overlap

A Segmentation Type (0062,0001) of BINARY indicates the segmented property is present with a value of 1 and absent with a value of 0.

For a Segmentation Type (0062,0001) of FRACTIONAL the segmented property is defined as a value from zero to the Maximum Fractional Value (0062,000E). A FRACTIONAL segmentation shall be further specified via Segmentation Fractional Type (0062,0010).

Enumerated Values of Segmentation Fractional Type (0062,0010):

PROBABILITY Defines the probability, as a ratio of the pixel value to the Maximum Fractional Value, that the segmented property occupies the spatial area defined by the voxel.

OCCUPANCY Defines the proportion of the pixel volume occupied by the segmented property as the ratio of the pixel value to the Maximum Fractional Value.

Note

Binary Segmentation Instances may be transformed into or from "label maps", in which each pixel contains a coded value that indicates the segment, rather than the Segmentation IOD representation that encodes separate ~~bitplanes~~bit planes for each segment. This conversion is facilitated by knowing whether or not any segment ~~bitplanes~~biplanes overlap. A Segments Overlap (0062,0013) value of NO indicates they can be converted into (or may have been converted from) a label map representation without the need to check every pixel.

C.8.20.2.4 Segment Number

Segment Number (0062,0004) shall be unique within each Instance, start at a value of 1, and increase monotonically by 1.

C.8.20.3 Segmentation Functional Group Macros

The following sections contain Functional Group Macros specific to the Segmentation IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean "for all frames".

C.8.20.3.1 Segmentation Macro

Table C.8.20-3 specifies the Attributes of the Segmentation Functional Group Macro.

Table C.8.20-3. Segmentation Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Segment Identification Sequence	(0062,000A)	1	Identifies the characteristics of this frame. Only a single Item shall be included in this Sequence.
>Referenced Segment Number	(0062,000B)	1	Uniquely identifies the segment described in Segment Sequence (0062,0002) by reference to Segment Number (0062,0004). Referenced Segment Number (0062,000B) shall not be multi-valued.

C.8.20.4 Segmentation Macros

The following sections contain Macros specific to the Segmentation IOD.

C.8.20.4.1 Segment Description Macro

Table C.8.20-4 specifies the Attributes of the Segment Description Macro.

Table C.8.20-4. Segment Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Segment Number	(0062,0004)	1	Identification number of the segment. The value of Segment Number (0062,0004) shall be unique within the Segmentation Instance in which it is created. See Section C.8.20.2.4.
Segment Label	(0062,0005)	1	User-defined label identifying this segment. This may be the same as Code Meaning (0008,0104) of Segmented Property Type Code Sequence (0062,000F).
Segment Description	(0062,0006)	3	User-defined description for this segment.
Segment Algorithm Type	(0062,0008)	1	Type of algorithm used to generate the segment. Enumerated Values: **AUTOMATIC** calculated segment **SEMIAUTOMATIC** calculated segment with user assistance **MANUAL** user-entered segment
Include Table 10-7b "Multiple Site General Anatomy Optional Macro Attributes"			*May not be necessary if the anatomy is implicit in the Segmented Property Type Code Sequence.* *More than one Item in Anatomic Region Sequence (0008,2218) may be used when a region of interest spans multiple anatomical locations and there is not a single pre-coordinated code describing the combination of locations. There is no requirement that the multiple locations be contiguous.*
Segmented Property Category Code Sequence	(0062,0003)	1	Sequence defining the general category of the property the segment represents. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7150 "Segmentation Property Categories".*

Attribute Name	Tag	Type	Attribute Description
Segmented Property Type Code Sequence	(0062,000F)	1	Sequence defining the specific property the segment represents. Note "Property" is used in the sense of meaning "what the segmented voxels represent", whether it be a physical or biological object, be real or conceptual, having spatial, temporal or functional extent or not. I.e., it is what the segment "is" (as opposed to some feature, attribute, quality, or characteristic of it, like color or shape or size). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7151 “Segmentation Property Types”.*
>Segmented Property Type Modifier Code Sequence	(0062,0011)	3	Sequence defining the modifier of the property type of this segment. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 244 “Laterality”.* Note For Retinal Segmentation Surfaces, laterality is not typically specified.
Tracking ID	(0062,0020)	1C	A text label used for tracking a finding or feature, potentially across multiple reporting objects, over time. This label shall be unique within the domain in which it is used. Required if Tracking UID (0062,0021) is present. Note 1. May or may not have the same value as Segment Label (0062,0005). 2. Related SR Instances may exist, for example, to record measurements related to this segment, but need not exist for this Attribute to be used. 3. This Attribute will have the same value as the value of the (112039, DCM, "Tracking Identifier") Content Item in SR Instances that reference this Segment in this Segmentation Instance.
Tracking UID	(0062,0021)	1C	A unique identifier used for tracking a finding or feature, potentially across multiple reporting objects, over time. Required if Tracking ID (0062,0020) is present. Note 1. Related SR Instances may exist, for example, to record measurements related to this segment, but need not exist for this Attribute to be used. 2. This Attribute will have the same value as the value of the (112040, DCM, "Tracking Unique Identifier") Content Item in SR Instances that reference this Segment in this Segmentation Instance.

Attribute Name	Tag	Type	Attribute Description
Definition Source Sequence	(0008,1156)	3	Instances containing the source of the Segment information. Only a single Item is permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes".			
>Referenced ROI Number	(3006,0084)	1C	The value of ROI Number (3006,0022) in the referenced SOP Instance that identifies the ROI that is the origin of the Segment information. Required if Referenced SOP Class UID (0008,1150) is RT Structure Set Storage ("1.2.840.10008.5.1.4.1.1.481.3").

C.8.21 X-Ray 3D

C.8.21.1 X-Ray 3D Image Module

This section describes the X-Ray 3D Image Module. Table C.8.21.1-1 contains IOD Attributes that describe a X-Ray 3D Image by specializing Attributes of the General Image Module and Image Pixel Module, and adding additional Attributes.

Table C.8.21.1-1. X-Ray 3D Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.21.1.1.1 for specialization.
Include Table C.8-131 "Common CT/MR Image Description Macro Attributes"			
Bits Allocated	(0028,0100)	1	Number of bits allocated for each voxel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each voxel sample. Each sample shall have the same number of bits stored. Enumerated Values: **8** **9** **10** **11** **12** **13** **14** **15** **16**
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Samples per Pixel	(0028,0002)	1	Number of samples (color planes) in this image shall have a value of 1.

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the voxel data. Enumerated Values: **MONOCHROME2**
Content Qualification	(0018,9004)	1	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation.
Burned In Annotation	(0028,0301)	1	Indicates whether or not the image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".

Attribute Name	Tag	Type	Attribute Description
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referred to inside the Referenced Image Sequences of this SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Image Comments	(0020,4000)	3	User-defined comments about the image.
Quality Control Image	(0028,0300)	3	Indicates whether or not this image is a quality control or phantom image. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not be a quality control or phantom image.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*
Presentation LUT Shape	(2050,0020)	1	Specifies a predefined identity transformation for the Presentation LUT such that the output of all grayscale transformations, if any, are defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values
Source Irradiation Event Sequence	(0008,3011)	3	The set of Irradiation Events that were produced in this acquisition context. See C.8.21.1.1.4. One or more Items shall be included in this Sequence.
>Irradiation Event UID	(0008,3010)	1	Unique identification of the irradiation event(s) associated with the acquisition of this image.

C.8.21.1.1 X-Ray 3D Image Module Attribute Description

C.8.21.1.1.1 Image Type and Frame Type

In addition to the requirements specified in Section C.8.16.1 Image Type, the following additional requirements and Defined Terms are specified.

C.8.21.1.1.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.21.1.1.1.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.21.1.1.1.3 Image Flavor

Value 3 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.3. No additional requirements or Defined Terms.

C.8.21.1.1.1.4 Derived Pixel Contrast

Value 4 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.4. The value shall be NONE.

C.8.21.1.1.2 Volumetric Properties Attribute

The value of Volumetric Properties (0008,9206) is discussed in Section C.8.16.2.1.2.

Note

1. For regularly sampled tomosynthesis slices reconstructed from projection X-Ray data, a value of VOLUME or SAMPLED is appropriate.
2. For slabs constructed by averaging adjacent regularly sampled tomosynthesis slices to produce thicker slices, a value of SAMPLED is appropriate.
3. For mathematically generated 2D views (e.g., constructed as Maximum Intensity Projections) of regularly sampled tomosynthesis slices, a value of SAMPLED is appropriate.

C.8.21.1.1.3 Volume Based Calculation Technique Attribute

The value of Volume Based Calculation Technique (0008,9207) is discussed in Section C.8.16.2.1.3.

Table C.8.21.1.1.3-1 specifies the additional Defined Terms for the Volume Based Calculation Technique (0008,9207) Attribute to those in Table C.8-134 in Section C.8.16.2.1.3.

Table C.8.21.1.1.3-1. Additional Volume Based Calculation Technique Attribute Values for X-Ray 3D

Defined Term Name	Defined Term Description
TOMOSYNTHESIS	Construction of tomographic slices or slabs from limited angle projection data.

Note

1. For tomosynthesis slices or slabs reconstructed from projection X-Ray data, a value of TOMOSYNTHESIS is appropriate.
2. For mathematically generated 2D views constructed as Maximum Intensity Projections of tomosynthesis slices, a value of MAX_IP is appropriate.

C.8.21.1.1.4 Source Irradiation Event Sequence

The Source Irradiation Event Sequence (0008,3011) contains the Irradiation Event UIDs of all the original projection images that were used in the 3D reconstruction process of this X-Ray 3D Image, regardless whether the projection images are encoded as DICOM images or not. Therefore, it allows relating the reconstructed X-Ray 3D image to its contributing irradiation events contained in the Radiation Dose SR.

The equipment generating the projection images associates these images to one or more Irradiation Event UIDs. All these UIDs are then included in the Radiation Dose SR as well as in the appropriate projection DICOM images. An X-Ray 3D image reconstructed from a set of projection images will include those Irradiation Event UIDs of the images that participated to that 3D reconstruction. In case the projection images are not encoded as DICOM images, the X-Ray equipment is responsible for including the contributing Irradiation Event UIDs in any further X-Ray 3D image reconstructed on that equipment.

An X-Ray 3D image derived from one or more X-Ray 3D images will include in the derived image all the Irradiation Event UIDs of the source images.

C.8.21.2 X-Ray 3D Contributing Image Sources Modules

This section describes the X-Ray 3D Image Contributing Sources Modules.

Note

1. These Modules supply general information of the sources without the need to have access to all the contributing SOP Instances or when these SOP Instances do not exist.

2. These Modules do not contain specific information of the X-Ray acquisition itself. For this purpose the X-Ray 3D Acquisition Modules may be used.

C.8.21.2.1 X-Ray 3D Angiographic Image Contributing Sources Module

This section describes the X-Ray 3D Angiographic Image Contributing Sources Module. The Attributes in this Module specify the overall characteristics of one or more sources that were used to create a X-Ray 3D Angiographic Image SOP Instance. Table C.8.21.2.1-1 contains the relevant IOD Attributes that describe X-Ray 3D Angiographic Image Contributing Sources.

Table C.8.21.2.1-1. X-Ray 3D Angiographic Image Contributing Sources Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contributing Sources Sequence	(0018,9506)	1	A Sequence that describes characteristics of the sources that are used to create a derived SOP Instance. One or more Items shall be included in this Sequence.
>Include Table 10-13 “General Contributing Sources Macro Attributes”			
>Include Table 10-14 “Contributing Image Sources Macro Attributes”			
>Acquisition Device Processing Description	(0018,1400)	1C	Indicates any visual processing performed on the frame prior to exchange. See Section C.8.7.1.1.3. Required if present and consistent in the contributing SOP Instances.
>Acquisition Device Processing Code	(0018,1401)	1C	Code representing the device-specific processing associated with the frame (e.g., Organ Filtering code) Required if present and have an equal value in the contributing SOP Instances.
>Plane Identification	(0018,9457)	1C	Identification of the plane used to acquire this image. Defined Terms: **MONOPLANE** **PLANE A** **PLANE B** Required if present and consistent in the contributing SOP Instances.
>Imager Pixel Spacing	(0018,1164)	1C	Physical distance measured at the receptor plane of the detector between the centers of each pixel specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. Required if present and consistent in the contributing SOP Instances.

C.8.21.2.2 X-Ray 3D Craniofacial Image Contributing Sources Module

This section describes the X-Ray 3D Craniofacial Image Contributing Sources Module. The Attributes in this Module specify the overall characteristics of one or more sources that were used to create a X-Ray 3D Craniofacial Image SOP Instance. Table C.8.21.2.2-1 contains the relevant IOD Attributes that describe X-Ray 3D Craniofacial Image Contributing Sources.

Table C.8.21.2.2-1. X-Ray 3D Craniofacial Image Contributing Sources Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contributing Sources Sequence	(0018,9506)	1	A Sequence that describes characteristics of the sources that are used to create a derived SOP Instance. One or more Items shall be included in this Sequence.
>Include Table 10-13 "General Contributing Sources Macro Attributes"			
>Include Table 10-14 "Contributing Image Sources Macro Attributes"			
>Acquisition Device Processing Description	(0018,1400)	1C	Indicates any visual processing performed on the frame prior to exchange. See Section C.8.7.1.1.3. Required if present and consistent in the contributing SOP Instances.
>Acquisition Device Processing Code	(0018,1401)	1C	Code representing the device-specific processing associated with the frame (e.g., Organ Filtering code). Required if present and have an equal value in the contributing SOP Instances.
>Imager Pixel Spacing	(0018,1164)	1C	Physical distance measured at the receptor plane of the detector between the centers of each pixel specified by a numeric pair - row spacing value (delimiter) column spacing value in mm. Required if present and consistent in the contributing SOP Instances.

C.8.21.2.3 Breast Tomosynthesis Contributing Sources Module

This section describes the Breast Tomosynthesis Contributing Sources Module. The Attributes in this Module specify the overall characteristics of one or more source images that were used to create a Breast Tomosynthesis Image SOP Instance. Table C.8.21.2.3-1 contains the IOD Attributes that describe Breast Tomosynthesis Contributing Sources.

Note

The intention of this Module is to supply acquisition information without the need to have access to all the source projection images.

Table C.8.21.2.3-1. Breast Tomosynthesis Contributing Sources Module Attributes

Attribute Name	Tag	Type	Attribute Description
Contributing Sources Sequence	(0018,9506)	1	A Sequence that describes characteristics of the sources that are used to create a derived SOP Instance. One or more Items shall be included in this Sequence.
>Include Table 10-13 "General Contributing Sources Macro Attributes"			
>Include Table 10-14 "Contributing Image Sources Macro Attributes"			
>Detector Type	(0018,7004)	1	The type of detector used to acquire this image. Defined Terms: **DIRECT** X-Ray photoconductor **SCINTILLATOR** Phosphor used **STORAGE** Storage phosphor

Attribute Name	Tag	Type	Attribute Description
>Detector ID	(0018,700A)	1	The ID or serial number of the detector used to acquire this image.
>Date of Last Detector Calibration	(0018,700C)	1	The date on which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
>Time of Last Detector Calibration	(0018,700E)	1	The time at which the detector used to acquire this image as identified in Detector ID (0018,700A) was last calibrated.
>Detector Element Spacing	(0018,7022)	1	Physical distance between the center of each detector element, specified by a numeric pair: row spacing value (delimiter) column spacing value in mm. See Section 10.7.1.3 for further explanation of the value order. Note This may not be the same as the Imager Pixel Spacing (0018,1164), and should not be assumed to describe the stored image.

C.8.21.3 X-Ray 3D Acquisition Modules

This section describes the X-Ray 3D Acquisition Modules and Macros to specify the acquisition context information used as input for one or more reconstructions. The Macros in this section define the Attributes that are common for all modalities. The Macros are used in the modality specific Modules.

The Attributes of each Item in the X-Ray 3D Acquisition Sequence (0018,9507) define the acquisition characteristics of the projection images that were used to create one or more reconstructions.

Note

1. The intention of this Sequence is to supply acquisition information without the need to have access to all the contributing SOP Instances or when these SOP Instances do not exist.

2. The number of frames referenced in this Sequence is not necessarily the same as the number of projection images.

For each Item of the X-Ray 3D Reconstruction Sequence (0018,9530) in the X-Ray 3D Reconstruction Module, the values of Acquisition Index (0020,9518) specify the Items in the X-Ray 3D Acquisition Sequence (0018,9507) that contribute to the reconstruction.

Note

For example, a SOP Instance consists of two volumes in two sets of frames. The first volume is calculated from an acquisition without contrast and a second volume is calculated from the acquisitions with and without contrast. In this case the X-Ray 3D Acquisition Sequence (0018,9507) contains two Items. The first Item describes the acquisition details of the frames that are acquired without contrast. The second Item describes the acquisition details of the frames that are acquired with contrast. For the frames of the second volume both acquisitions contribute to the calculation. See Figure C.8.21.3-1, Figure C.8.21.3-2, Figure C.8.21.3-3, Figure C.8.21.3-4 and Figure C.8.21.3-5.

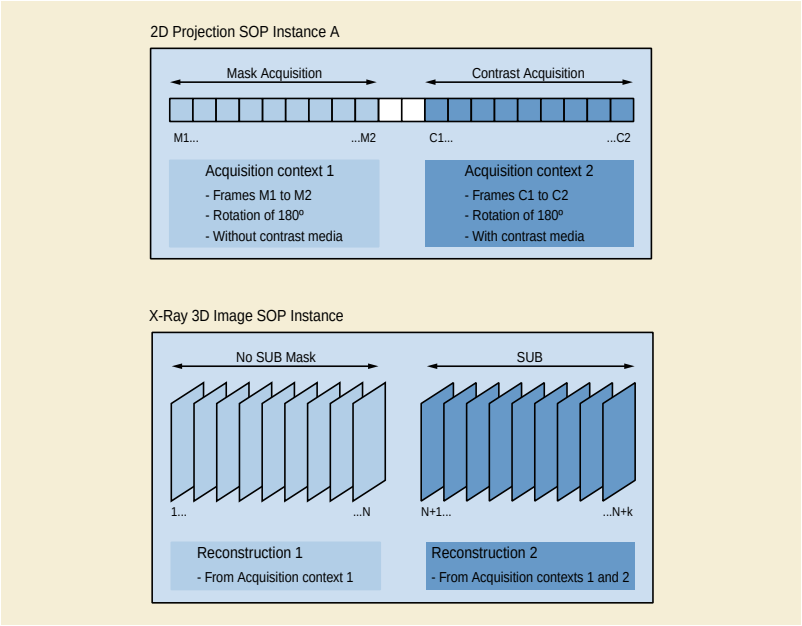


Figure C.8.21.3-1. Example of Usage Acquisition

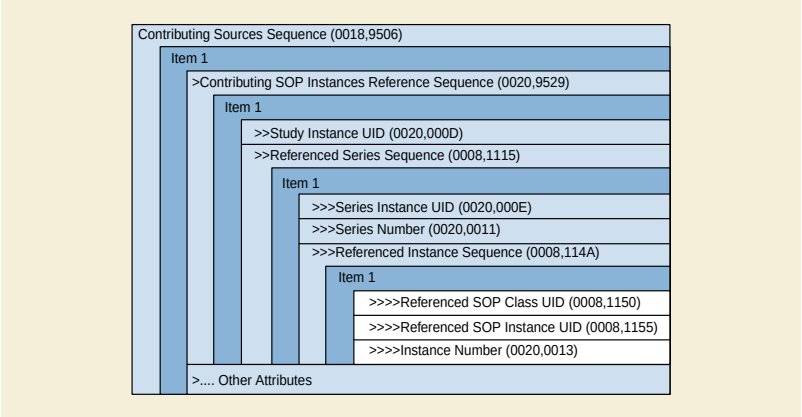


Figure C.8.21.3-2. Example of Contents of Contributing Sources Sequence

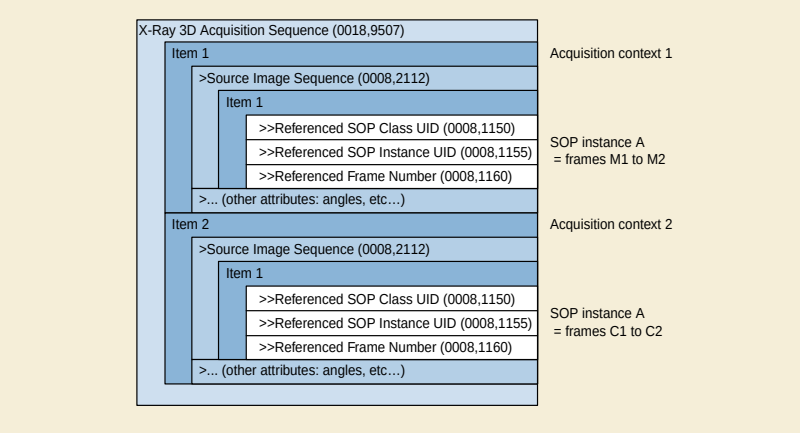


Figure C.8.21.3-3. Example of Contents of X-Ray 3D Acquisition Sequence

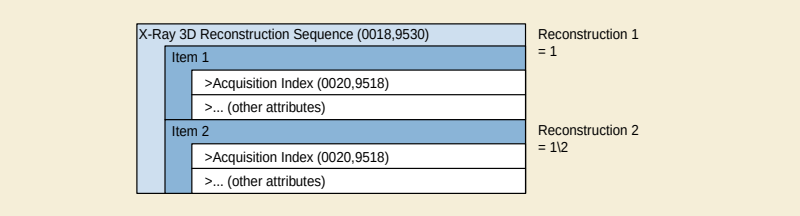


Figure C.8.21.3-4. Example of Contents of X-Ray 3D Reconstruction Sequence

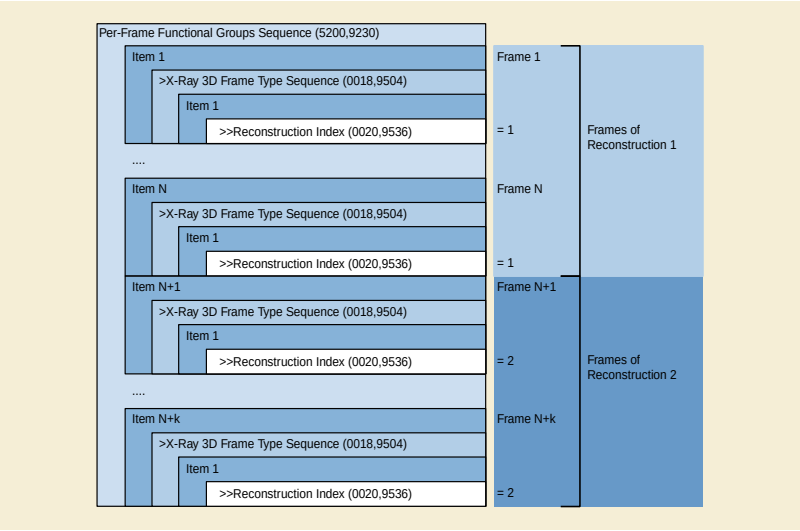


Figure C.8.21.3-5. Example of Contents of X-Ray 3D Frame Type Sequences

C.8.21.3.1 X-Ray 3D General Acquisition Macros

This section describes the X-Ray 3D General Acquisition Macros. These Macros specify the Attributes of the acquisition context common for the family of X-Ray 3D image SOP Classes.

C.8.21.3.1.1 X-Ray 3D General Shared Acquisition Macro

Table C.8.21.3.1.1-1 describes the X-Ray 3D General Shared Acquisition Macro that specifies the Attributes that are applicable for all the projection images belonging to this acquisition context.

Table C.8.21.3.1.1-1. X-Ray 3D General Shared Acquisition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Source Image Sequence	(0008,2112)	1C	A Sequence that identifies the set of Images that constitute this acquisition context. Required if the reconstruction is created from DICOM SOP Instances. Note The Attribute is absent in the case where the images used to create the volume are not available as SOP Instances, e.g., the volume was directly generated by acquisition system. One or more Items shall be included in this Sequence.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
Field of View Dimension(s) in Float	(0018,9461)	1C	Dimensions in mm of the Field of View in the source projection images. If Field of View Shape (0018,1147) is: RECTANGLE: row dimension followed by column. ROUND: diameter. HEXAGONAL: diameter of the circle circumscribing the hexagon. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Field of View Origin	(0018,7030)	1C	Offset of the TLHC of a rectangle circumscribing the Field of View in the referenced images, before rotation or flipping, from the TLHC of the physical detector area measured in physical detector pixels as a row offset followed by a column offset. See Section C.8.11.4.1.1 for further explanation. Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR.
Field of View Rotation	(0018,7032)	1C	Clockwise rotation in degrees of Field of View in the referenced images, relative to the physical detector. Enumerated Values: **270** **180** **90** **0** See Section C.8.11.4.1.1 for further explanation. Required if present and consistent in the contributing SOP Instances.

Attribute Name	Tag	Type	Attribute Description
Field of View Horizontal Flip	(0018,7034)	1C	Whether or not a horizontal flip has been applied to the Field of View in the referenced images, after rotation relative to the physical detector as described in Field of View Rotation (0018,7032). Enumerated Values: **NO** **YES** See Section C.8.11.4.1.1 for further explanation. Required if present and consistent in the contributing SOP Instances.
Grid	(0018,1166)	1C	Identifies the grid. May be multi-valued. See Attribute Description in Section C.8.7.11 for Defined Terms. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Include Table C.8-36b "X-Ray Grid Description Macro Attributes"			
KVP	(0018,0060)	1C	Average of the peak kilo voltage outputs of the X-Ray generator used for all frames. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
X-Ray Tube Current in mA	(0018,9330)	1C	Average of the nominal X-Ray tube currents in milliamperes for all frames. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Exposure Time in ms	(0018,9328)	1C	Total (cumulative) duration of X-Ray exposure for all frames in milliseconds. See Section C.8.7.2.1.1. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Exposure in mAs	(0018,9332)	1C	The total (cumulative) exposure for all frames expressed in milliampereseconds, for example calculated from Exposure Time and X-Ray Tube Current. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Contrast/Bolus Agent	(0018,0010)	1C	Contrast or bolus agent. Required if present and consistent in the contributing SOP Instances.
Contrast/Bolus Agent Sequence	(0018,0012)	1C	Sequence that identifies the contrast agent. One or more Items shall be included in this Sequence. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG and contrast media was applied.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 12 "Radiographic Contrast Agent".*
Start Acquisition DateTime	(0018,9516)	1C	Start date and time of that part of an acquisition used for this acquisition context. Required if present and consistent in the contributing SOP Instances.

Attribute Name	Tag	Type	Attribute Description
End Acquisition DateTime	(0018,9517)	1C	End date and time of that part of an acquisition used for this acquisition context. Required if present and consistent in the contributing SOP Instances.

C.8.21.3.1.2 X-Ray 3D General Per Projection Acquisition Macro

Table C.8.21.3.1.2-1 describes the X-Ray 3D General Per Projection Acquisition Macro that specifies the Attributes that are applicable for a single projection belonging to this acquisition context.

Table C.8.21.3.1.2-1. X-Ray 3D General Per Projection Acquisition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
KVP	(0018,0060)	1C	Exact peak kilo voltage output of the X-Ray generator used for this projection. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
X-Ray Tube Current in mA	(0018,9330)	1C	Exact Nominal X-Ray tube current in milliamperes applied during the Frame Acquisition Duration (0018,9220) for this projection. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Frame Acquisition Duration	(0018,9220)	1C	The actual amount of time [in milliseconds] that was used to acquire data for this projection. See Section C.7.6.16.2.2.1 and Section C.7.6.16.2.2.3 for further explanation. Required if present and consistent in the contributing SOP Instances.
Collimator Shape	(0018,1700)	1C	Shape(s) of the collimator. Enumerated Values: **RECTANGULAR** **CIRCULAR** **POLYGONAL** This multi-valued Attribute shall contain at most one of each Enumerated Value. Required if present and consistent in the contributing SOP Instances.
Include Table C.8-28b "X-Ray Collimator Dimensions Macro Attributes"			

C.8.21.3.1.3 X-Ray 3D General Positioner Movement Macro

Table C.8.21.3.1.3-1 describes the X-Ray 3D General Positioner Movement Macro that specifies the Attributes that describe the movement of a positioner during the acquisition of more than one projection.

Table C.8.21.3.1.3-1. X-Ray 3D General Positioner Movement Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Primary Positioner Scan Arc	(0018,9508)	1C	Total amount of rotation of the primary positioner in degrees. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.

Attribute Name	Tag	Type	Attribute Description
Primary Positioner Scan Start Angle	(0018,9510)	1C	Start position of the primary positioner in degrees. See Section C.8.7.5.1.2 or Section C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances. Required if Modality (0008,0060) is MG.
Primary Positioner Increment	(0018,9514)	1C	Constant increment of the primary positioner angle in degrees. Positive increment indicates an increasing value of the primary positioner angle. See Section C.8.7.5.1.2 or Section C.8.11.7 for the sign conventions depending on modality and positioner type. See Section C.8.21.3.1.3.1 for further explanation. Required if present and consistent in the contributing SOP Instances.
Primary Positioner Increment Sign	(0018,9518)	3	Direction of the primary positioner rotation. Defined Terms: **+1** indicates a positive primary positioner angle increment **-1** indicates a negative primary positioner angle increment See Section C.8.7.5.1.2 or Section C.8.11.7 for the sign conventions depending on modality and positioner type. See Section C.8.21.3.1.3.1 for further explanation.
Secondary Positioner Scan Arc	(0018,9509)	1C	Total amount of rotation of the secondary positioner in degrees. Required if present and consistent in the contributing SOP Instances.
Secondary Positioner Scan Start Angle	(0018,9511)	1C	Start position of the secondary positioner in degrees. See Section C.8.7.5.1.2 or Section C.8.11.7, depending on modality and positioner type. Required if present and consistent in the contributing SOP Instances.
Secondary Positioner Increment	(0018,9515)	1C	Constant increment of the secondary positioner angle in degrees. Positive increment indicates an increasing value of the secondary positioner angle. See Section C.8.7.5.1.2 or Section C.8.11.7 for the sign conventions depending on modality and positioner type. See Section C.8.21.3.1.3.1 for further explanation. Required if present and consistent in the contributing SOP Instances.
Secondary Positioner Increment Sign	(0018,9519)	3	Direction of the secondary positioner rotation. Defined Terms: **+1** indicates a positive secondary positioner angle increment **-1** indicates a negative secondary positioner angle increment See Section C.8.7.5.1.2 or Section C.8.11.7 for the sign conventions depending on modality and positioner type. See Section C.8.21.3.1.3.1 for further explanation.

C.8.21.3.1.3.1 Positioner Angle Increments

If the increments of the positioner angles are constant during the acquisition of the X-Ray projections, the Attributes Primary Positioner Increment (0018,9514) and the Secondary Positioner Increment (0018,9515) describe this angular change between projections.

If the change in positioner angle is not constant between the projections, omit the Positioner Angle Increment Attributes and record the individual positioner angle values in the Positioner Angle Attributes within each Item of the Per Projection Acquisition Sequence

(0018,9538). In such case, the Attributes Primary Positioner Increment Sign (0018,9518) and Secondary Positioner Increment Sign (0018,9519) are used to describe the direction of the positioner rotation.

C.8.21.3.2 X-Ray 3D Angiographic Acquisition Module

This section describes the X-Ray 3D Angiographic Acquisition Module.

Table C.8.21.3.2-1. X-Ray 3D Angiographic Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018,9507)	1	Each Item represents an acquisition context related to one or more reconstructions. The values of Acquisition Index (0020,9518) may be used as index to Items in this Sequence. One or more Items shall be included in this Sequence.
>Field of View Shape	(0018,1147)	1C	Shape of the Field of View in the referenced images. Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL** Required if present and consistent in the contributing SOP Instances.
>X-Ray Receptor Type	(0018,9420)	1C	Identifies the type of X-Ray receptor used. Enumerated Values: **IMG_INTENSIFIER** **DIGITAL_DETECTOR** Required if present and consistent in the contributing SOP Instances.
>Include Table C.8.21.3.1.1-1 “X-Ray 3D General Shared Acquisition Macro Attributes”			
>Include Table C.8-71b “Digital X-Ray Detector Macro Attributes”			
>Physical Detector Size	(0018,9429)	1C	Dimensions of the physical detector measured in mm as a row size followed by a column size. Required if present and consistent in the contributing SOP Instances.
>Position of Isocenter Projection	(0018,9430)	1C	Position of the Isocenter measured in physical detector elements as a row offset followed by a column offset from the TLHC of a rectangle circumscribing the physical detector area. Required if Isocenter Reference System Sequence (0018,9462) is present and if the values are present and consistent in the contributing SOP Instances.

Attribute Name	Tag	Type	Attribute Description
>Distance Source to Detector	(0018,1110)	1C	Distance from source to receptor plane perpendicular to the receptor plane in mm or distance in mm from source to detector center on the chest wall line. See Section C.8.11.7.1.1. Required if present and consistent in the contributing SOP Instances. Note This value is traditionally referred to as Source Image Receptor Distance (SID).
>Distance Source to Isocenter	(0018,9402)	1C	Distance from source to isocenter in mm. Required if present and consistent in the contributing SOP Instances.
>Focal Spot(s)	(0018,1190)	1C	Nominal focal spot size in mm used to acquire this image. Required if present and consistent in the contributing SOP Instances.
>Filter Type	(0018,1160)	1C	Type of filter(s) inserted into the X-Ray beam (e.g., wedges). See Attribute Description in Section C.8.7.10 for Defined Terms. Note Multiple type of filters can be expressed by a combination, e.g., BUTTERFLY+WEDGE. Required if present and consistent in the contributing SOP Instances.
>Filter Material	(0018,7050)	1C	The X-Ray absorbing material used in the filter. May be multi-valued. See Attribute Description in Section C.8.7.10 for Defined Terms. Required if present and consistent in the contributing SOP Instances.
>Filter Thickness Minimum	(0018,7052)	1C	See Attribute Description in Section C.8.7.10. Required if present and consistent in the contributing SOP Instances.
>Filter Thickness Maximum	(0018,7054)	1C	See Attribute Description in Section C.8.7.10. Required if present and consistent in the contributing SOP Instances.
>Filter Beam Path Length Minimum	(0018,7056)	1C	See Attribute Description in Section C.8.7.10. Required if present and consistent in the contributing SOP Instances.
>Filter Beam Path Length Maximum	(0018,7058)	1C	See Attribute Description in Section C.8.7.10. Required if present and consistent in the contributing SOP Instances.
>Table X Position to Isocenter	(0018,9466)	3	X position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Table Y Position to Isocenter	(0018,9467)	3	Y position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.
>Table Z Position to Isocenter	(0018,9468)	3	Z position of the Table Reference Point with respect to the Isocenter (mm). See Section C.8.19.6.13.1.3 for further explanation.
>Table Horizontal Rotation Angle	(0018,9469)	3	Rotation of the table in the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.
>Table Head Tilt Angle	(0018,9470)	3	Angle of the head-feet axis of the table in degrees relative to the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.
>Table Cradle Tilt Angle	(0018,9471)	3	Angle of the left-right axis of the table in degrees relative to the horizontal plane. See Section C.8.19.6.13.1.3 for further explanation.
>Include Table C.8.21.3.1.3-1 "X-Ray 3D General Positioner Movement Macro Attributes"			
>Per Projection Acquisition Sequence	(0018,9538)	1C	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. One or more Items shall be included in this Sequence. Required if present and consistent in the contributing SOP Instances.
>>Include Table C.8.21.3.1.2-1 "X-Ray 3D General Per Projection Acquisition Macro Attributes"			
>>Positioner Isocenter Primary Angle	(0018,9463)	1C	Position of the X-Ray center beam for this projection in the isocenter reference system in the X direction (deg). See Section C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.
>>Positioner Isocenter Secondary Angle	(0018,9464)	1C	Position of the X-Ray center beam for this projection in the isocenter reference system in the Z direction (deg). See Section C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.
>>Positioner Isocenter Detector Rotation Angle	(0018,9465)	1C	Rotation of the X-Ray detector plane for this projection (deg). See Section C.8.19.6.13.1.2 for further explanation. Required if present and consistent in the contributing SOP Instances.
>>Positioner Primary Angle	(0018,1510)	3	Position of the X-Ray Image Intensifier about the patient from the RAO to LAO direction where movement from RAO to vertical is positive. See Section C.8.7.5.1.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>>Positioner Secondary Angle	(0018,1511)	3	Position of the X-Ray Image Intensifier about the patient from the CAU to CRA direction where movement from CAU to vertical is positive. See Section C.8.7.5.1.2 for further explanation.

C.8.21.3.3 X-Ray 3D Craniofacial Acquisition Module

This section describes the X-Ray 3D Craniofacial Acquisition Module.

Table C.8.21.3.3-1. X-Ray 3D Craniofacial Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018,9507)	1	Each Item represents a acquisition context related to a set of frames of SOP Instance defined by this IOD, The values of Acquisition Index (0020,9518) may be used as index to Items in this Sequence. One or more Items shall be included in this Sequence.
>Field of View Shape	(0018,1147)	1C	Shape of the Field of View in the referenced images. Enumerated Values: **RECTANGLE** **ROUND** **HEXAGONAL** Required if present and consistent in the contributing SOP Instances.
>X-Ray Receptor Type	(0018,9420)	1C	Identifies the type of X-Ray receptor used. Enumerated Values: **DIGITAL_DETECTOR** Required if present and consistent in the contributing SOP Instances.
>Include Table C.8.21.3.1.1-1 "X-Ray 3D General Shared Acquisition Macro Attributes"			
>Include Table C.8-71b "Digital X-Ray Detector Macro Attributes"			
>Per Projection Acquisition Sequence	(0018,9538)	1C	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. One or more Items shall be included in this Sequence. Required if present and consistent in the contributing SOP Instances.
>>Include Table C.8.21.3.1.2-1 "X-Ray 3D General Per Projection Acquisition Macro Attributes"			

C.8.21.3.4 Breast Tomosynthesis Acquisition Module

This section describes the Breast Tomosynthesis Acquisition Module.

Table C.8.21.3.4-1. Breast Tomosynthesis Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Acquisition Sequence	(0018,9507)	1	Each Item represents an acquisition context related to one or more reconstructions. The values of Acquisition Index (0020,9518) may be used as index in this Sequence. One or more Items shall be included in this Sequence.
>Field of View Shape	(0018,1147)	1	Shape of the Field of View in the source projection images. Enumerated Values: **RECTANGLE**
>X-Ray Receptor Type	(0018,9420)	1	Identifies the type of X-Ray receptor used. Enumerated Values: **DIGITAL_DETECTOR**
>Include Table C.8.21.3.1.1-1 "X-Ray 3D General Shared Acquisition Macro Attributes"			
>Include Table C.8.21.3.1.3-1 "X-Ray 3D General Positioner Movement Macro Attributes"			
>Distance Source to Detector	(0018,1110)	1	Distance in mm from source to detector center on the chest wall line. Note 1. This value is traditionally referred to as Source Image Distance (SID). 2. See Section C.8.11.7.1.1.
>Distance Source to Patient	(0018,1111)	1	Distance in mm from source to the breast support side that is closest to the Imaging Subject, as measured along the X-Ray beam vector. Note 1. This value is traditionally referred to as Source Object Distance (SOD). 2. See notes for this Attribute in Section C.8.11.5 DX Positioning Module. 3. See Section C.8.11.7.1.1 for description of X-Ray beam vector.
>Estimated Radiographic Magnification Factor	(0018,1114)	1	Ratio of Source Image Receptor Distance (SID) over Source Object Distance (SOD).
>Anode Target Material	(0018,1191)	1	The primary material in the anode of the X-Ray source. Defined Terms: **TUNGSTEN** **MOLYBDENUM** **RHODIUM**
>Body Part Thickness	(0018,11A0)	1	The average thickness in mm of the body part examined when compressed, if compression has been applied during exposure.

Attribute Name	Tag	Type	Attribute Description
>Exposure Control Mode	(0018,7060)	1	Type of exposure control. Defined Terms: **MANUAL** **AUTOMATIC**
>Exposure Control Mode Description	(0018,7062)	1	Text description of the mechanism of exposure control. May describe the number and type of exposure sensors or position of the sensitive area of the imaging detector.
>Half Value Layer	(0040,0314)	1	The thickness of Aluminum in mm required to reduce the X-Ray Output (0040,0312) by a factor of two. Note This value may be a calibrated value rather than measured during the exposure.
>Organ Dose	(0040,0316)	3	Organ dose value measured in dGy representing the collective total for all acquired frames described in this Sequence Item. Note This may be an estimated value.
>Entrance Dose in mGy	(0040,8302)	3	Entrance dose value measured in mGy at the surface of the patient representing the collective total for all acquired frames described in this Sequence Item. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
>Entrance Dose Derivation	(0040,8303)	3	Describes what type of dose is represented by the values of Entrance Dose in mGy (0040,8302). Enumerated Values: **IAK** Represents air kerma at the entrance surface, no backscatter included, no air kerma to tissue dose conversion applied. **ESAK** Represents air kerma at the entrance surface, with backscatter included, no air kerma to tissue dose conversion applied. **ESDBS** Represents absorbed dose in tissue at the entrance surface, with backscatter included. **ESDNOBS** Represents absorbed dose in tissue at the entrance surface, without backscatter included. Only meaningful if Entrance Dose in mGy (0040,8302) is present.
>Focal Spot(s)	(0018,1190)	1	Nominal focal spot size in mm used to acquire the projection images.
>Detector Binning	(0018,701A)	1C	Number of active detectors used to generate a single pixel. Specified as number of row detectors per pixel then column. Required if detector binning was applied to the projection images.
>Detector Temperature	(0018,7001)	1	Detector temperature during exposure in degrees Celsius.
>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam (e.g., wedges). See Attribute Description in Section C.8.7.10 for Defined Terms.

Attribute Name	Tag	Type	Attribute Description
>Filter Material	(0018,7050)	1	The X-Ray absorbing material used in the filter. May be multi-valued. See Attribute Description in Section C.8.7.10 for Defined Terms.
>Filter Thickness Minimum	(0018,7052)	3	See Attribute Description in Section C.8.7.10.
>Filter Thickness Maximum	(0018,7054)	3	See Attribute Description in Section C.8.7.10.
>Filter Beam Path Length Minimum	(0018,7056)	3	See Attribute Description in Section C.8.7.10.
>Filter Beam Path Length Maximum	(0018,7058)	3	See Attribute Description in Section C.8.7.10.
>Compression Force	(0018,11A2)	1	The compression force applied to the body part during exposure, measured in Newtons.
>Compression Pressure	(0018,11A3)	3	The average compression pressure applied to the body part during exposure, calculated in kPa.
>Compression Contact Area	(0018,11A5)	3	The area of the body part to which compression has been applied during exposure, measured in mm2. Note Area information is useful in addition to the Compression Pressure (0018,11A3) and Compression Force (0018,11A2) in the event that unusual values are encountered.
>Paddle Description	(0018,11A4)	1	Description of the compression paddle, if compression was applied to the body part during exposure.
>Per Projection Acquisition Sequence	(0018,9538)	1	Sequence containing detailed acquisition context of each individual projection used in this acquisition context. One or more Items shall be included in this Sequence.
>>Include Table C.8.21.3.1.2-1 "X-Ray 3D General Per Projection Acquisition Macro Attributes"			
>>Positioner Primary Angle	(0018,1510)	1	Signed position in degrees of the X-Ray beam vector in the coronal anatomical plane as if the patient were standing facing the equipment where vertical is zero.
>>Positioner Primary Angle Direction	(0018,9559)	3	The interpretation of the sign of the Positioner Primary Angle (0018,1510). Enumerated Values: **CW** Clockwise. Positioner Primary Angle movement is positive when movement is from vertical to the patient's right (with patient standing, facing equipment). **CC** Counter clockwise. Positioner Primary Angle is positive when movement is from vertical to the patient's left (with patient standing, facing the equipment). See Section C.8.31.2.1.
>>Positioner Secondary Angle	(0018,1511)	1C	Position in degrees of the X-Ray beam vector in the sagittal anatomical plane as if the patient were standing where movement of the X-Ray source from anterior to posterior is positive, and vertical is zero. Required if secondary positioner was used during acquisition.
>>Exposure Time in ms	(0018,9328)	1	Duration of X-Ray exposure in milliseconds. See Section C.8.7.2.1.1.
>>Exposure in mAs	(0018,9332)	1	The exposure expressed in milliampereseconds, for example calculated from Exposure Time and X-Ray Tube Current.

Attribute Name	Tag	Type	Attribute Description
>>Relative X-Ray Exposure	(0018,1405)	1	Indication of the applied dose, in manufacturer specific units. Note 1. This value is intended to provide a single location where manufacturer specific information can be found for annotation on a display or film, that has meaning to a knowledgeable observer. 2. This may be a calculated or measured value. Examples are the detector entrance dose (K_B), the CR sensitivity value (S), or the logarithmic median (lgM). 3. This value is manufacturer-specific. DICOM specifies Standard Attributes in Table 10-23 'Exposure Index Macro', which are recommended.
>>Organ Dose	(0040,0316)	3	Average organ dose value measured in dGy. Note This may be an estimated value.
>>Entrance Dose in mGy	(0040,8302)	3	Average entrance dose value measured in mGy at the surface of the patient during the acquisition of this projection image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
>>Entrance Dose Derivation	(0040,8303)	3	Describes what type of dose is represented by the values of Entrance Dose in mGy (0040,8302). Enumerated Values: **IAK** Represents air kerma at the entrance surface, no backscatter included, no air kerma to tissue dose conversion applied. **ESAK** Represents air kerma at the entrance surface, with backscatter included, no air kerma to tissue dose conversion applied. **ESDBS** Represents absorbed dose in tissue at the entrance surface, with backscatter included. **ESDNOBS** Represents absorbed dose in tissue at the entrance surface, without backscatter included. Only meaningful if Entrance Dose in mGy (0040,8302) is present.
>>Include Table 10-23 “Exposure Index Macro Attributes”			
>>Irradiation Event UID	(0008,3010)	3	Unique identification of the irradiation event(s) associated with the acquisition of this image.

C.8.21.4 X-Ray 3D Reconstruction Module

This section describes the X-Ray 3D Reconstruction Module. Table C.8.21.4-1 contains IOD Attributes that describe the reconstructions used to create this SOP Instance. A single SOP Instance may contain the result of one or more reconstructions (e.g., a set of volumes). Each Item in the X-Ray 3D Reconstruction Sequence specifies the characteristics of such a result.

Table C.8.21.4-1. X-Ray 3D Reconstruction Module Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Reconstruction Sequence	(0018,9530)	1	A Sequence of Items each describing the characteristics of one 3D reconstruction included in this SOP Instance. One or more Items shall be included in this Sequence.
>Reconstruction Description	(0018,9531)	3	Free text description of the purpose of the reconstruction, e.g., mask volume.
>Application Name	(0018,9524)	1	Name of the application that created the reconstruction.
>Application Version	(0018,9525)	1	Version of the application that created the reconstruction.
>Application Manufacturer	(0018,9526)	1	Name of the manufacturer of the application that created the reconstruction.
>Algorithm Type	(0018,9527)	1	Type of algorithm used to create the reconstruction. Defined Terms: **FILTER_BACK_PROJ** **ITERATIVE**
>Algorithm Description	(0018,9528)	3	Description of the algorithm used to create the reconstruction.
>Acquisition Index	(0020,9518)	1	The Item number(s) of the X-Ray 3D Acquisition Sequence (0018,9507) that describes the acquisition context(s) contributing to this reconstruction.

C.8.21.5 X-Ray 3D Image Functional Group Macros

The following sections contain Functional Group Macros specific to the X-Ray 3D IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".".

C.8.21.5.1 X-Ray 3D Frame Type Macro

Table C.8.21.5.1-1 specifies the Attributes of the X-Ray 3D Frame Type Functional Group Macro.

Table C.8.21.5.1-1. X-Ray 3D Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray 3D Frame Type Sequence	(0018,9504)	1	A Sequence that describes general characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed. See Section C.8.21.1.1.1. For Breast Tomosynthesis Image See Section C.8.21.6.1.1.
>Include Table C.8-131 “Common CT/MR Image Description Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Reconstruction Index	(0020,9536)	1C	The Item number of the X-Ray 3D Reconstruction Sequence (0018,9530) that describes the characteristics of the 3D Reconstruction to which this frame is part of. Required if the X-Ray 3D Reconstruction Sequence (0018,9530) is present.

C.8.21.5.2 Breast Biopsy Target Macro

Table C.8.21.5.2-1 specifies the Attributes of the Breast Biopsy Target Functional Group Macro.

Table C.8.21.5.2-1. Breast Biopsy Target Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Biopsy Target Sequence	(0018,2041)	1C	Sequence that identifies the targets of a biopsy procedure. One or more Items are permitted in this Sequence for this frame, where the coordinate system is the same for all Items within a pair of stereo images. Required if one or more biopsy targets are present for this frame.
>Target UID	(0018,2042)	1	Unique identifier for the target. Note To identify the same target in corresponding stereo images.
>Localizing Cursor Position	(0018,2043)	1	Coordinates of localizing cursor position with respect to pixels in the image specified by a column (delimiter) row pair. The values shall be in the range 0\0 (TLHC) to Columns\Rows (BRHC).
>Calculated Target Position	(0018,2044)	1	The calculated target position (x, y, z) in mm in an equipment relative right-handed coordinate system where the origin is under the central X-Ray beam at the chest wall, and a z value of zero is located at the surface that the breast is in contact with that is closest to the detector. X is parallel to the chest wall, y is positive toward the patient's nipple, and z is positive toward the X-Ray source.
>Displayed Z Value	(0018,2046)	1	The z value in mm displayed to the user at the time of biopsy. Note 1. This may be the same as the z value of Calculated Target Position or different in direction or reference point, such as relative to the compression paddle. 2. This is not the distance that the needle was inserted, particularly for a lateral (parallel) approach.
>Target Label	(0018,2045)	3	Target description.

C.8.21.6 Breast View Module

Table C.8.21.6-1 contains IOD Attributes that describe the view of a digital breast tomosynthesis image.

Table C.8.21.6-1. Breast View Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.21.6.1.1 for specialization.

Attribute Name	Tag	Type	Attribute Description
View Code Sequence	(0054,0220)	1	Sequence that describes the view of the patient anatomy in this image. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes" .			*DCID 4014 "View for Mammography".*
>View Modifier Code Sequence	(0054,0222)	2	Sequence that provides modifiers for the view of the patient anatomy. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 4015 "View Modifier for Mammography".*
Breast Implant Present	(0028,1300)	1C	Whether or not the imaged breast contains a breast implant regardless of the visibility of a breast implant in the Pixel Data. Enumerated Values: **YES** **NO** Required if Modality (0008,0060) is MG. May be present otherwise. Note The value is expected to be YES for all images acquired on a breast that contains a breast implant, even when a breast implant is displaced during image acquisition.
Partial View	(0028,1350)	3	Indicates whether this image is a partial view, that is a subset of a single view of the breast. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not be a partial view. Note This may occur when a breast is larger than the active area of the detector. If this Attribute is present, its value shall be NO if there is a View Modifier Code Sequence (0054,0222) Item of value (399163009, SCT, "Magnification") or (399055006, SCT, "Spot Compression").
Partial View Code Sequence	(0028,1352)	1C	Sequence that describes the portion or section of the breast captured in a partial view image. One or two Items shall be included in this Sequence. See Section C.8.11.7.1.3. Required if Partial View (0028,1350) is present with a value of YES.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4005 "Partial View Section for Mammography".*

C.8.21.6.1 Breast View Module Attribute Description

C.8.21.6.1.1 Image Type and Frame Type

In addition to the requirements specified in Section C.8.21.1.1.1 Image Type and Frame Type, the following Defined Terms are specified for Value 3 of Image Type (0008,0008) and Frame Type (0008,9007):

Table C.8.21.6-1a. Defined Terms of Image Type (0008,0008) Value 3 for Contrast Enhanced, Tomosynthesis and Biopsy

Defined Term	Definition	ACR MQCM Equivalent
Contrast		
PRE_CONTRAST	Collected before contrast was administered.	n/a
POST_CONTRAST	Collected during or after contrast was administered.	n/a
Tomosynthesis		
TOMO_PROJ	Identifies the image as a digital breast tomosynthesis projection image.	n/a
TOMOSYNTHESIS	Tomographic reconstruction from limited angle projection data.	n/a
Biopsy		
TOMO_SCOUT	A localizer image set that may be used to determine positioning coordinates prior to needle positioning.	…SC
PREFIRE	An image set obtained with the biopsy needle in position prior to needle deployment.	…PRF
POSTFIRE	An image set obtained with the biopsy needle in position following needle deployment through the targeted lesion.	…POF
POSTBIOPSY	An image set obtained following tissue acquisition with the X-Ray source in the scout position.	…POB
POSTMARKER	An image set obtained following micromarker placement with the X-Ray source in the scout position.	…POM

Note

There is no need for _MINUS or _PLUS because a single digital breast tomosynthesis acquisition produces a projection and/or reconstruction image set that replaces the _MINUS and _PLUS image pair used in conventional 2D breast biopsy imaging (see Section C.8.11.7.1.4).

If more than one characteristic (biopsy, tomosynthesis, contrast enhanced) applies to an image, Value 3 shall contain the biopsy image type. If biopsy is not involved, Value 3 shall contain the tomosynthesis image type.

Note

For example, Attributes of the Enhanced Contrast/Bolus Module may be used to identify contrast enhanced characteristics of a biopsy and/or tomosynthesis image that is also contrast enhanced.

Value 4 shall be NONE except for applicable contrast enhanced images, mathematically generated 2D images and other tomosynthesis reconstructions. The following Defined Terms are specified for Value 4 of Image Type (0008,0008) and Frame Type (0008,9007). For additional Defined Terms see Section C.8.16.1.4.

Table C.8.21.6-1b. Defined Terms of Image Type (0008,0008) Value 4 for Contrast Enhanced and Tomosynthesis

Defined Term	Definition
Tomosynthesis	
GENERATED_2D	Mathematically generated 2D view.
MAXIMUM	Created through Pixel by pixel maximum operation.
MEAN	Created through Pixel by pixel mean operation.
Contrast	
ADDITION	Created through Pixel by pixel addition operation.
SUBTRACTION	Created through Pixel by pixel subtraction operation.

If more than one characteristic (contrast enhanced, tomosynthesis) applies to an image, Value 4 shall contain the contrast enhanced image type. If contrast enhanced is not involved, Value 4 shall contain the tomosynthesis image type.

Value 5 shall be present for images acquired using contrast enhanced digital X-Ray imaging of the breast, but may be empty if none of the Defined Terms applies. For non-contrast images Value 5 remains optional and implementation specific.

Table C.8.21.6-1c. Defined Terms of Image Type (0008,0008) Value 5 for Contrast Enhanced Images

Enumerated Value	Definition
LOW_ENERGY	Low energy image.
HIGH_ENERGY	High energy image.

Note

A recipient may use the different values for biopsy, tomosynthesis and contrast views to determine how to display them, for example in hanging protocols:

	Image Type Value 3	Image Type Value 4	Image Type Value 5
Tomosynthesis thin reconstructed slices	TOMOSYNTHESIS	NONE	-
Tomosynthesis thick reconstructed slices	TOMOSYNTHESIS	MAXIMUM	-
Tomosynthesis generated 2D	TOMOSYNTHESIS	GENERATED_2D	-
Tomosynthesis projections	TOMO_PROJ	NONE	-
Tomosynthesis thin reconstructed slices biopsy post-fire	POSTFIRE	NONE	-
Tomosynthesis thick reconstructed slices post-biopsy	POSTBIOPSY	MEAN	-
Tomosynthesis generated 2D biopsy pre-fire	PREFIRE	GENERATED_2D	-
Tomosynthesis projections biopsy scout	TOMO_SCOUT	NONE	-
Tomosynthesis thick reconstructed slices pre-contrast	TOMOSYNTHESIS	MAXIMUM	empty
Tomosynthesis thin reconstructed slices post-contrast subtraction	TOMOSYNTHESIS	SUBTRACTION	empty
Tomosynthesis thick reconstructed slices post-contrast subtraction	TOMOSYNTHESIS	SUBTRACTION	empty
Tomosynthesis generated 2D post-contrast addition	TOMOSYNTHESIS	ADDITION	empty
Tomosynthesis generated 2D post-contrast low energy	TOMOSYNTHESIS	GENERATED_2D	LOW_ENERGY
Tomosynthesis projections post-contrast high energy	TOMO_PROJ	NONE	HIGH_ENERGY
Tomosynthesis thick reconstructed slices biopsy scout pre-contrast	TOMO_SCOUT	MAXIMUM	empty
Tomosynthesis thin reconstructed slices biopsy pre-fire post-contrast subtraction	PREFIRE	SUBTRACTION	empty
Tomosynthesis thick reconstructed slices biopsy post-fire post-contrast subtraction	POSTFIRE	SUBTRACTION	empty
Tomosynthesis generated 2D post-biopsy post-contrast addition	POSTBIOPSY	ADDITION	empty
Tomosynthesis generated 2D biopsy scout post-contrast low energy	TOMO_SCOUT	GENERATED_2D	LOW_ENERGY
Tomosynthesis projections post-biopsy post-contrast high energy	POSTBIOPSY	NONE	HIGH_ENERGY

C.8.22 Enhanced PET Modules

This section describes the specific Modules for the Enhanced PET Image IOD.

C.8.22.1 Enhanced PET Series Module

The Enhanced PET IODs use the General Series Module, specialized by the Enhanced PET Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of PET device.

Table C.8.22-1 specifies the Attributes that identify and describe general information about the Enhanced PET Series.

Table C.8.22-1. Enhanced PET Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **PT** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Related Series Sequence	(0008,1250)	1C	Identifying the Series that was used for attenuation purposes. See Section C.7.3.1 Required if another Series was used to perform attenuation correction and the SOP Class UID is not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted). May be present otherwise. One or more Items shall be included in this Sequence.
>Study Instance UID	(0020,000D)	1	Instance UID of Study to which the related Series belongs
>Series Instance UID	(0020,000E)	1	Instance UID of Related Series
>Purpose of Reference Code Sequence	(0040,A170)	2	Describes the purpose for which the reference is made. Zero or more Items shall be included in this Sequence. When absent, implies that the reason for the reference is unknown.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7210 “Related Series Purposes of Reference”.*

C.8.22.2 Enhanced PET Acquisition Module

Table C.8.22-2 specifies the Attributes that describe PET Acquisitions.

Table C.8.22-2. Enhanced PET Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Start Condition	(0018,0073)	1C	Description of how the data collection was started. See Section C.8.22.2.1.1 for Defined Terms. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Start Density Threshold	(0018,9715)	1C	The count density that triggered the start of the acquisition, in counts/sec. Required if Acquisition Start Condition (0018,0073) equals DENS.
Start Relative Density Difference Threshold	(0018,9716)	1C	The relative count density that triggered the start of the acquisition, in counts/sec. Required if Acquisition Start Condition (0018,0073) equals RDD.
Start Cardiac Trigger Count Threshold	(0018,9717)	1C	The number of cardiac triggers that occurred before starting the acquisition. Required if Acquisition Start Condition (0018,0073) equals CARD_TRIG.
Start Respiratory Trigger Count Threshold	(0018,9718)	1C	The number of respiratory triggers that occurred before starting the acquisition. Required if Acquisition Start Condition (0018,0073) equals RESP_TRIG.
Acquisition Termination Condition	(0018,0071)	1C	Description of how the data collection for the Series was stopped. See Section C.8.22.2.1.2 for Defined Terms. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Termination Counts Threshold	(0018,9719)	1C	The count value that triggered the termination of the acquisition. Required if Acquisition Termination Condition (0018,0071) equals CNTS.
Termination Density Threshold	(0018,9720)	1C	The count density that triggered the termination of the acquisition, in counts/sec. Required if Acquisition Termination Condition (0018,0071) equals DENS.
Termination Relative Density Threshold	(0018,9721)	1C	The count relative density that triggered the termination of the acquisition, in counts/sec. Required if Acquisition Termination Condition (0018,0071) equals RDD.
Termination Time Threshold	(0018,9722)	1C	The time duration after which the acquisition was terminated, in sec. Required if Acquisition Termination Condition (0018,0071) equals TIME
Termination Cardiac Trigger Count Threshold	(0018,9723)	1C	The number of cardiac triggers that triggered the termination of the acquisition. Required if Acquisition Termination Condition (0018,0071) equals CARD_TRIG
Termination Respiratory Trigger Count Threshold	(0018,9724)	1C	The number of respiratory triggers that triggered the termination of the acquisition. Required if Acquisition Termination Condition (0018,0071) equals RESP_TRIG

Attribute Name	Tag	Type	Attribute Description
Type of Detector Motion	(0054,0202)	1C	Describes the type of detector motion during acquisition. Defined Terms: **STATIONARY** No motion **STEP AND SHOOT** Interrupted motion, acquire only while detectors are stationary **CONTINUOUS** Gantry motion and acquisition are simultaneous and continuous **WOBBLE** wobble motion **CLAMSHELL** clamshell motion Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Detector Geometry	(0018,9725)	1C	Physical arrangement of the detectors in the acquisition system. The radiation entrance surface of a detector may be curved or flat. A curved surface is referred to as cylindrical. Detectors may simultaneously subtend all possible transverse angles from the center of the field of view. Detectors that do not are referred to as partial. Defined Terms: **CYLINDRICAL_RING** **CYL_RING_PARTIAL** **MULTIPLE_PLANAR** **MUL_PLAN_PARTIAL** Required if Image Type (0008,0008) Value 1 is ORIGINAL and Type of Detector Motion (0054,0202) equals STATIONARY. May be present otherwise, if Image Type (0008,0008) Value 1 is DERIVED and Type of Detector Motion (0054,0202) equals STATIONARY.
Transverse Detector Separation	(0018,9726)	1C	Distance between opposing detectors, in mm. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Axial Detector Dimension	(0018,9727)	1C	Axial detector size in mm. Size of the detector along the table axis. Required if Image Type (0008,0008) Value 1 is ORIGINAL May be present otherwise.
Collimator Type	(0018,1181)	1C	Collimator Type. Defined Terms: **NONE** no collimator **RING** transverse septa Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Coincidence Window Width	(0054,1210)	1C	The width of the coincidence-timing window, in nanoseconds. The maximum time difference between two single events in two opposing detectors that will be accepted as a coincidence event. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Energy Window Range Sequence	(0054,0013)	1C	Sequence of Items that describes the energy windows used for this Image. One or more Items shall be included in this Sequence. See Section C.8.22.2.1.3 for explanation. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
>Energy Window Lower Limit	(0054,0014)	1	The lower limit of the energy window, in KeV.
>Energy Window Upper Limit	(0054,0015)	1	The upper limit of the energy window, in KeV.
Table Motion	(0018,1134)	1	Enumerated Values: **STATIC** Table is stationary during data acquisition. **DYNAMIC** Table is moving during data acquisition.
Time of Flight Information Used	(0018,9755)	1	Specifies whether or not Time-of-Flight information was used in creation of the image. Enumerated Values: **TRUE** **FALSE**
Include Table 10-24 “Mandatory View and Slice Progression Direction Macro Attributes”			
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
Scan Progression Direction	(0054,0501)	3	The anatomical order in which the slices were acquired. Enumerated Values: **FEET_TO_HEAD** Slices closest to the patient's feet were acquired first. **HEAD_TO_FEET** Slices closest to the patient's head were acquired first.

C.8.22.2.1 Enhanced PET Acquisition Module Attribute Descriptions

C.8.22.2.1.1 Acquisition Start Condition

Acquisition Start Condition (0018,0073) is the method of starting acquisition data collection.

Defined Terms:

DENS preset count density (counts/sec) was reached
RDD preset relative count density difference (change in counts/sec) was reached
MANU acquisition was started manually
AUTO start automatically, when ready
CARD_TRIG preset number of cardiac triggers was reached
RESP_TRIG preset number of respiratory triggers was reached

C.8.22.2.1.2 Acquisition Termination Condition

Acquisition Termination Condition (0018,0071) is the method of acquisition termination that has actually applied to the data collection.

Defined Terms:

CNTS preset counts was reached
DENS preset count density (counts/sec) was reached
RDD preset relative count density difference (change in counts/sec) was reached
MANU acquisition was terminated manually
OVFL data overflow occurred
TIME preset time limit was reached
CARD_TRIG preset number of cardiac triggers was reached
RESP_TRIG preset number of respiratory triggers was reached

C.8.22.2.1.3 Energy Window Range Sequence

Multiple energy windows are allowed in order to allow coincidence events based on additional Energy Windows (e.g., Compton events scattered in the detector). All energy windows are assumed to contribute to all frames in this image.

C.8.22.3 Enhanced PET Image Module

Table C.8.22-3 specifies the Attributes of the Enhanced PET Image Module.

Table C.8.22-3. Enhanced PET Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.22.3.1.1.
Include Table C.8-131 "Common CT/MR Image Description Macro Attributes"			
Acquisition Number	(0020,0012)	3	A number identifying the single continuous gathering of data over a period of time that resulted in this image, which may include multiple bed positions. Note This number is not required to be unique across SOP Instances in a Series. See also the description of the Referenced Raw Data Sequence (0008,9121).
Acquisition DateTime	(0008,002A)	1C	The date and time that the acquisition of data started. Note 1. The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800). 2. See Section C.7.6.16.2.2.1 for an overview of all acquisition related timing Attributes. Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted), may be present otherwise.
Acquisition Duration	(0018,9073)	1C	The time in seconds needed to complete the acquisition of data. See Section C.7.6.16.2.2.1 for further explanation. Required if Image Type (0008,0008) Value 1 of this frame is ORIGINAL and SOP Class UID is not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted), may be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Referenced Raw Data Sequence	(0008,9121)	3	A Sequence that identifies the set of Raw Data SOP Class/Instance pairs of the Raw data that were used to derive this Image. One or more Items are permitted in this Sequence. Note The Items of in this Sequence may identify raw data that has not been stored or encoded as a DICOM object. This allows recognition that images and spectra in different Instances have been reconstructed from the same raw data. For such Items the SOP Class UID would be "1.2.840.10008.5.1.4.1.1.66" (Raw Data SOP Class) and the SOP Instance UID would be any appropriate UID.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Referenced Waveform Sequence	(0008,113A)	3	References to waveforms acquired in conjunction with this image. These Waveforms may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			*DCID 7004 “Waveform Purposes of Reference”.*
Referenced Image Evidence Sequence	(0008,9092)	1C	Full set of Composite SOP Instances referring to image SOP Instances inside the frames of this Enhanced PET Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Referenced Image Sequence (0008,1140) is present.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Source Image Evidence Sequence	(0008,9154)	1C	Full set of Composite SOP Instances used as source image SOP Instances inside the frames of this Enhanced PET Image SOP Instance. See Section C.8.13.2.1.2 for further explanation. One or more Items shall be included in this Sequence. Required if the Source Image Sequence (0008,2112) is present.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. This value shall be 1.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2** See Section C.7.6.3.1.2 for definition of this term.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. This value shall be 16.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. This value shall be 16.

Attribute Name	Tag	Type	Attribute Description
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall be one less than the value in Bits Stored (0028,0101).
Content Qualification	(0018,9004)	1	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation.
Image Comments	(0020,4000)	3	User-defined comments about the image
Burned in Annotation	(0028,0301)	1C	Indicates that the image does not contain burned in annotations. Enumerated Values: **NO** This means that images that contain this Module shall not contain burned in annotations. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted), may be present otherwise.
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.
Lossy Image Compression	(0028,2110)	1C	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5. Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted). May be present otherwise.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*

C.8.22.3.1 Enhanced PET Image Description Attribute Description

C.8.22.3.1.1 Image Type and Frame Type

The Image Type Attribute (0008,0008) and Frame Type (0008,9007) identifies important image characteristics in a multiple valued Data Element. In addition to the requirements specified in Section C.8.16.1 Image Type and Frame Type, the following additional requirements and Defined Terms are specified:

C.8.22.3.1.1.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

C.8.22.3.1.1.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

C.8.22.3.1.1.3 Image Flavor

Value 3 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.3. No additional requirements or Defined Terms.

C.8.22.3.1.1.4 Derived Pixel Contrast

Value 4 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.4. No additional requirements or Defined Terms.

C.8.22.3.1.2 Attenuation Correction Source

The Attribute Attenuation Correction Source (0018,9738) contains the source of the attenuation map information used for attenuation correction.

Defined Terms:

CT
MR
POSITRON SOURCE
SINGLE PHOTON
CALCULATED Emission data is used to calculate the correction map.

C.8.22.3.1.3 Attenuation Correction Temporal Relationship

The Attribute Attenuation Correction Temporal Relationship (0018,9770) specifies the temporal relationship between the attenuation correction source image and the PET image data.

Defined Terms:

CONCURRENT The attenuation correction source image is acquired at approximately the same time and with the patient in the same body position as the PET image; for example, as acquired on a hybrid scanner

SEPARATE The attenuation correction source image is acquired at a different time, on a different system, or the patient has been moved significantly enough to cause soft tissue movement; for example, an attenuation correction source image acquired on a separate CT scanner, so that the patient must move from one bed to another

SIMULTANEOUS The attenuation correction source image is acquired at the same time and with the patient in the same body position as the PET image

C.8.22.4 Enhanced PET Isotope Module

Table C.8.22-9 contains IOD Attributes that describe a PET Isotope.

Table C.8.22-9. Enhanced PET Isotope Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiopharmaceutical Information Sequence	(0054,0016)	1	Sequence of Items that describe isotope information. One or more Items shall be included in this Sequence.
>Radiopharmaceutical Agent Number	(0018,9729)	1	Identifying number, unique within this SOP Instance, of the agent administered. Used to reference this particular agent from the Radiopharmaceutical Functional Group Macro. The number shall be 1 for the first Item and increase by 1 for each subsequent Item.
>Radionuclide Code Sequence	(0054,0300)	1	Sequence that identifies the radionuclide. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4020 “PET Radionuclide”.*
>Administration Route Code Sequence	(0054,0302)	1	Sequence that identifies the administration route of the radiopharmaceutical. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 11 “Route of Administration”.*
>Radiopharmaceutical Volume	(0018,1071)	3	Volume of administered radiopharmaceutical in cubic cm.
>Radiopharmaceutical Start DateTime	(0018,1078)	1	Time of start of administration. The actual time of radiopharmaceutical administration to the patient for imaging purposes.
>Radiopharmaceutical Stop DateTime	(0018,1079)	3	Time of end of administration. The actual ending time of radiopharmaceutical administration to the patient for imaging purposes.
>Radionuclide Total Dose	(0018,1074)	2	The radiopharmaceutical dose administered to the patient measured in MegaBecquerels (MBq) at the Radiopharmaceutical Start DateTime (0018,1078).
>Radiopharmaceutical Administration Event UID	(0008,3012)	3	Unique identification of the administration of the radiopharmaceutical to the patient. Note The UID is the same Radiopharmaceutical Administration Event UID that is in the Radiopharmaceutical Radiation Dose Report.

Attribute Name	Tag	Type	Attribute Description
>Radionuclide Half Life	(0018,1075)	1	The radionuclide half life, in seconds, that was used in the correction of this image.
>Radionuclide Positron Fraction	(0018,1076)	1	The radionuclide positron fraction (fraction of decays that are by positron emission) that was used in the correction of this image.
>Radiopharmaceutical Specific Activity	(0018,1077)	3	The activity per unit mass of the radiopharmaceutical, in Bq/micromole, at the Radiopharmaceutical Start DateTime (0018,1078).
>Radiopharmaceutical Code Sequence	(0054,0304)	1	Sequence that identifies the radiopharmaceutical. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 4021 “PET Radiopharmaceutical”.*

C.8.22.5 Enhanced PET Image Functional Group Macros

The following sections contain Functional Group Macros specific to the Enhanced PET Image IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".

C.8.22.5.1 PET Frame Type Macro

Table C.8.22-10 specifies the Attributes of the PET Frame Type Functional Group Macro.

Table C.8.22-10. PET Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Frame Type Sequence	(0018,9751)	1	A Sequence that describes general characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008) Attribute, except that the value MIXED is not allowed unless the SOP Class UID is "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted). See Section C.8.16.1 and Section C.8.22.3.1.
>Include Table C.8-131 “Common CT/MR Image Description Macro Attributes”			

C.8.22.5.2 PET Frame Acquisition Macro

Table C.8.22-11 specifies the Attributes of the PET Frame Acquisition Functional Group Macro.

Table C.8.22-11. PET Frame Acquisition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Frame Acquisition Sequence	(0018,9732)	1	Contains the Attributes defining the PET acquisition mode. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Table Height	(0018,1130)	1	The distance in mm from the top of the patient table to the data collection center. The distance is positive when the table is below the data collection center.
>Gantry/Detector Tilt	(0018,1120)	1	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations. Zero degrees means the gantry is not tilted, negative degrees are when the top of the gantry is tilted away from where the table enters the gantry.
>Gantry/Detector Slew	(0018,1121)	1	Nominal angle of slew in degrees of the gantry. Not intended for mathematical computations. Zero degrees means the gantry is no slewed. Positive slew is moving the gantry on the patient's left toward the patient's superior, when the patient is supine.
>Data Collection Diameter	(0018,0090)	1	The diameter in mm of the region over which data were collected. See Section C.8.22.5.4.1.

C.8.22.5.3 PET Detector Motion Details Macro

Table C.8.22-12 specifies the Attributes of the PET Detector Motion Details Functional Group Macro.

Table C.8.22-12. PET Detector Motion Details Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Detector Motion Details Sequence	(0018,9733)	1	Contains the Attributes defining the details of the motion of the Detector. Only a single Item shall be included in this Sequence.
>Rotation Direction	(0018,1140)	1	Direction of rotation of the detector about the gantry, as viewed while facing the gantry where the table enters the gantry. Enumerated Values: **CW** clockwise **CC** counter clockwise
>Revolution Time	(0018,9305)	1	The time in seconds of a complete revolution of the detector around the gantry orbit.

C.8.22.5.4 PET Position Macro

Table C.8.22-14 specifies the Attributes of the PET Position Functional Group Macro.

Table C.8.22-14. PET Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Position Sequence	(0018,9735)	1	Contains the Attributes defining the PET geometry. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Table Position	(0018,9327)	1C	Relative longitudinal position of acquisition location of this frame in mm from an implementation specific reference point. Shall be relative to the same reference point for all frames in this SOP Instance, but may be different from the reference point in other SOP Instances. Positions as the table moves into the gantry viewed from the front are more negative. Note 1. For contiguous slices reconstructed from multiple detectors one would expect different values for adjacent slices. 2. Lateral positioning or tilting or swiveling are not described. Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Data Collection Center (Patient)	(0018,9313)	1C	The x, y, and z coordinates (in the Patient-Based Coordinate System) in mm of the center of the region in which data were collected. See Section C.8.22.5.4.1. Required if Frame Type (0008,9007) Value 1 equals ORIGINAL. May be present otherwise.
>Reconstruction Target Center (Patient)	(0018,9318)	1C	The x, y, and z coordinates (in the Patient-Based Coordinate System) of the reconstruction center target point as used for reconstruction in mm. See Section C.8.22.5.4.1. Note If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (0018,9313) Attribute. Required if Frame Type (0008,9007) Value 1 equals ORIGINAL. May be present otherwise.

C.8.22.5.4.1 Relationships Between PET Geometric Attributes (Informative)

In Figure C.8.22-1 the relationship of the Geometric Attributes within the PET Geometry and PET Reconstruction Functional Groups is shown. In this example, the Pixel Data is shown encoding the entire reconstructed region with no outside padding or clipping, and the reconstructed region is illustrated as being square, i.e., the value of Reconstruction Diameter would be the same as both values of Reconstruction Field of View, whichever Attribute is present. Figure C.8.22-1, viewed from the front of the gantry (where the table enters the gantry), is informative only and is not meant to represent a standardization of an equipment-based Frame of Reference.

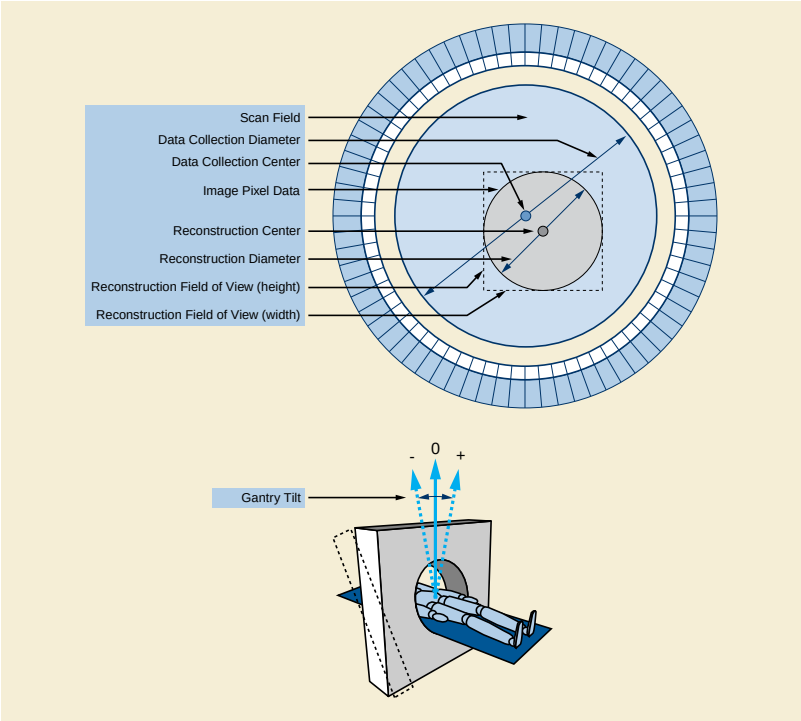


Figure C.8.22-1. Geometry of PET Acquisition System

C.8.22.5.5 PET Frame Correction Factors Macro

Table C.8.22-15 specifies the Attributes of the PET Frame Correction Factors Functional Group Macro.

Table C.8.22-15. PET Frame Correction Factors Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Frame Correction Factors Sequence	(0018,9736)	1	Contains the Attributes that describe the correction factors applied to this frame. Only a single Item shall be included in this Sequence.
>Primary (Prompts) Counts Accumulated	(0054,1310)	1C	The sum of events that occur in the primary event channel. The counts include Trues +Scatter+ Randoms if Corrected Image (0028,0051) includes RAN; otherwise the counts are Trues +Scatter. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Slice Sensitivity Factor	(0054,1320)	1C	The slice-to-slice sensitivity correction factor that was used to correct this frame. The value shall be one if no slice sensitivity correction was applied. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Decay Factor	(0054,1321)	1C	The decay factor that was used to scale this frame. Required if Decay Corrected (0018,9758) equals YES.

Attribute Name	Tag	Type	Attribute Description
>Scatter Fraction Factor	(0054,1323)	1C	An estimate of the fraction of acquired counts that were due to scatter and that were corrected in this frame. The value shall be zero if no scatter correction was applied. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.
>Dead Time Factor	(0054,1324)	1C	The average dead time correction factor that was applied to this frame. The value shall be one if no dead time correction was applied. Required if Frame Type (0008,9007) Value 1 is ORIGINAL. May be present otherwise.

C.8.22.5.6 PET Reconstruction Macro

Table C.8.22-17 specifies the Attributes of the PET Reconstruction Functional Group Macro, which describe the method used to reconstruct this image.

Table C.8.22-17. PET Reconstruction Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Reconstruction Sequence	(0018,9749)	1	Contains the Attributes describing the reconstruction process for this frame. Only a single Item shall be included in this Sequence.
>Reconstruction Type	(0018,9756)	1C	Description of the type of algorithm used when reconstructing the image from the data acquired during the acquisition process. Defined Terms: **2D** **3D** **3D_REBINNED** Required if Frame Type (0008,9007) Value 1 equals ORIGINAL. May be present otherwise.
>Reconstruction Algorithm	(0018,9315)	1C	Description of the algorithm used when reconstructing the image from the data acquired during the acquisition process. Defined Terms: **FILTER_BACK_PROJ** **REPROJECTION** **RAMLA** **MLEM** Required if Frame Type (0008,9007) Value 1 of this frame is ORIGINAL. May be present otherwise.
>Iterative Reconstruction Method	(0018,9769)	1	Iterative Reconstruction Method used. Enumerated Values: **YES** **NO**
>Number of Iterations	(0018,9739)	1C	Number of iterations. Required if Frame Type (0008,9007) Value 1 equals ORIGINAL and Iterative Reconstruction Method (0018,9769) equals YES. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Number of Subsets	(0018,9740)	1C	Number of subsets. Required if Frame Type (0008,9007) Value 1 equals ORIGINAL and Iterative Reconstruction Method (0018,9769) equals YES. May be present otherwise.
>Reconstruction Diameter	(0018,1100)	1C	The diameter in mm of the region from which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. See Section C.8.22.5.4.1. The diameter defines a circular region that is entirely contained within the encoded Pixel Data (7FE0,0010), unless the encoded image has been cropped after reconstruction. Note If not cropped or padded, for square images with square pixels, both values of Pixel Spacing (0028,0030) will be equal and equal to Reconstruction Diameter (0018,1100) / Rows (0028,0010) and Reconstruction Diameter (0018,1100) / Columns (0028,0011). Required if Frame Type (0008,9007) Value 1 equals ORIGINAL and Reconstruction Field of View (0018,9317) is not present. Otherwise may be present if Frame Type (0008,9007) Value 1 equals DERIVED and Reconstruction Field of View (0018,9317) is not present.
>Reconstruction Field of View	(0018,9317)	1C	The field of view width followed by height as used for reconstruction in mm. Note If not cropped or padded, for both Pixel Spacing (0028,0030) and Reconstruction Pixel Spacing (0018,9322): • The first value (adjacent row spacing) will be equal to the second value of Reconstruction Field of View (0018,9317) / Rows (0028,0010). • The second value (adjacent column spacing) will be equal to the first value of Reconstruction Field of View (0018,9317) / Columns (0028,0011). Required if Image Type (0008,9007) Value 1 equals ORIGINAL and Reconstruction Diameter (0018,1100) is not present. Otherwise may be present if Frame Type (0008,9007) Value 1 equals DERIVED and Reconstruction Diameter (0018,1100) is not present.

C.8.22.5.7 PET Table Dynamics Macro

Table C.8.22-18 specifies the Attributes of the PET Table Dynamics Functional Group Macro, which describes the table motion during acquisition of the data.

Table C.8.22-18. PET Table Dynamics Macro Attributes

Attribute Name	Tag	Type	Attribute Description
PET Table Dynamics Sequence	(0018,9734)	1	Contains the Attributes describing the movement of the PET Table. Only a single Item shall be included in this Sequence.
>Table Speed	(0018,9309)	1	The distance in mm that the Table moves in one second during the gathering of data that resulted in this frame.

C.8.22.6 Enhanced PET Corrections Module

Table C.8.22-19 specifies the Attributes of the Enhanced PET Corrections Module.

Table C.8.22-19. Enhanced PET Corrections Module Attributes

Attribute Name	Tag	Type	Attribute Description
Counts Source	(0054,1002)	1	The primary source of counts. Enumerated Values: **EMISSION** **TRANSMISSION**
Decay Corrected	(0018,9758)	1	Decay (DECY) correction has been applied to image. Enumerated Values: **YES** **NO**
Attenuation Corrected	(0018,9759)	1	Attenuation (ATTN) correction has been applied to image. Enumerated Values: **YES** **NO**
Scatter Corrected	(0018,9760)	1	Scatter (SCAT) correction has been applied to image. Enumerated Values: **YES** **NO**
Dead Time Corrected	(0018,9761)	1	Dead time (DTIM) correction has been applied to image. Enumerated Values: **YES** **NO**
Gantry Motion Corrected	(0018,9762)	1	Gantry motion (MOTN) correction has been applied to image. Enumerated Values: **YES** **NO**
Patient Motion Corrected	(0018,9763)	1	Patient motion (PMOT) correction has been applied to image. Enumerated Values: **YES** **NO**
Count Loss Normalization Corrected	(0018,9764)	1	Count loss (CLN) normalization correction has been applied to image. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Randoms Corrected	(0018,9765)	1	Randoms (RAN) correction has been applied to image. Enumerated Values: **YES** **NO**
Non-uniform Radial Sampling Corrected	(0018,9766)	1	Non-uniform radial sampling (RADL) correction has been applied to image. Enumerated Values: **YES** **NO**
Sensitivity Calibrated	(0018,9767)	1	Image is sensitivity calibrated using a dose calibrator (DCAL). Enumerated Values: **YES** **NO**
Detector Normalization Correction	(0018,9768)	1	Detector normalization (NORM) correction has been applied to image. Enumerated Values: **YES** **NO**
Randoms Correction Method	(0054,1100)	1C	Type of randoms correction processing. Defined Terms: **DLYD** delayed event subtraction **SING** singles estimation **PDDL** Processed Delays, which is a correction based on a processed (filtered) version of the data acquired from the delayed coincidence channel. Required if Randoms Corrected (0018,9765) equals YES.
Attenuation Correction Source	(0018,9738)	1C	Contains the source of the attenuation map information used for attenuation correction. See Section C.8.22.3.1.2 Required if Attenuation Corrected (0018,9759) equals YES.
Attenuation Correction Temporal Relationship	(0018,9770)	1C	Contains the temporal relationship between the attenuation correction source image and the PET image data. See Section C.8.22.3.1.3 Required if Attenuation Corrected (0018,9759) equals YES.
Scatter Correction Method	(0054,1105)	1C	A textual description of the scatter correction processing. e.g., convolution-subtraction, dual energy window, model-based, use of attenuation data. Required if Scatter Corrected (0018,9760) equals YES.
Decay Correction DateTime	(0018,9701)	1C	The date and time to which all frames in this Image were decay corrected. Required if Decay Corrected (0018,9758) equals YES.

C.8.23 Surface Segmentation

This section describes the specific Modules for the Surface Segmentation IOD.

C.8.23.1 Surface Segmentation Module

Table C.8.23-1 defines the general Attributes of the Surface Segmentation Module.

Table C.8.23-1. Surface Segmentation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-12 “Content Identification Macro Attributes”			
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Segment Sequence	(0062,0002)	1	Describes the segments that are contained within the data. One or more Items shall be included in this Sequence.
>Include Table C.8.20-4 “Segment Description Macro Attributes”			
>Surface Count	(0066,002A)	1	The number of surfaces that comprise this segment. Shall be greater than zero.
>Referenced Surface Sequence	(0066,002B)	1	Sequence referencing the surfaces composed to construct this segment. One or more Items shall be included in this Sequence. The number of Items shall equal the value of Surface Count (0066,002A).
>>Referenced Surface Number	(0066,002C)	1	Identifies the Surface Number (0066,0003) within the Surface Sequence (0066,0002) to which this reference applies.
>>Segment Surface Generation Algorithm Identification Sequence	(0066,002D)	1	A description of how this segment surface was derived. Only a single Item shall be included in this Sequence.
>>>Include Table 10-19 “Algorithm Identification Macro Attributes”			*For Algorithm Family Code Sequence (0066,002F) BCID 7162 “Surface Processing Algorithm Families”.*
>>Segment Surface Source Instance Sequence	(0066,002E)	2	A Sequence that identifies the set of Instances by their SOP Class/Instance pair that were used to derive this segment surface. Zero or more Items shall be included in this Sequence.
>>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			

C.8.24 Enhanced US Volume Modules and Functional Group Macros

C.8.24.1 Enhanced US Series Module

Table C.8.24.1-1 specifies Attributes for the Enhanced US Series Module, including specialization of Attributes in the General Series Module for use in the Enhanced US Series Module.

Table C.8.24.1-1. Enhanced US Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **US** **IVUS** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Performed Protocol Code Sequence	(0040,0260)	1C	Sequence describing a Protocol being followed for this Procedure Step. Only a single Item shall be included in this Sequence. Required if a Protocol is controlling the creation of this Series. May be present otherwise.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 12001 "Ultrasound Protocol Types".*
>Protocol Context Sequence	(0040,0440)	3	Sequence that specifies the context for the Performed Protocol Code Sequence (0040,0260) Item. One or more Items are permitted in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes Description"			*No Baseline TID is defined.*
>>Content Item Modifier Sequence	(0040,0441)	3	Sequence that specifies modifiers for a Protocol Context Content Item. One or more Items are permitted in this Sequence. See Section C.4.10.1.
>>>Include Table 10-2 "Content Item Macro Attributes Description"			*No Baseline TID is defined.*
Performed Protocol Type	(0040,0261)	1C	Type of protocol performed. Enumerated Values: **STAGED** **NON_STAGED** Required if Performed Protocol Code Sequence (0040,0260) is present.

C.8.24.2 Ultrasound Frame of Reference Module

Table C.8.24.2-1 specifies the Attributes of the Ultrasound Frame Of Reference Module. See Section C.8.24.2.1.

Table C.8.24.2-1. Ultrasound Frame of Reference Module Attributes

Attribute Name	Tag	Type	Attribute Description
Volume Frame of Reference UID	(0020,9312)	1	Uniquely identifies this Volume Frame of Reference.
Ultrasound Acquisition Geometry	(0020,9307)	1	Characteristic of the ultrasound acquisition geometry. Defined Terms: **APEX** there exists an apex of the scan lines from which the volume data was acquired. **PATIENT** the ultrasound acquisition geometry is patient relative Note When the value is PATIENT, the Plane Position (Patient) and Plane Orientation (Patient) Functional Group Macros will be present, and may or may not contain Attributes with identical values to the corresponding Attributes in the Plane Position (Volume) and Plane Orientation (Volume) Functional Group Macros; see Section A.59.4.1.2.
Apex Position	(0020,9308)	1C	Position of the apex (or phase center) of the acquisition geometry, encoded as x_A, y_A, and z_A in mm units in the Volume Frame of Reference. The apex (x_A, y_A, z_A) may be located in the volume or exterior to it. Required if value of Ultrasound Acquisition Geometry (0020,9307) is APEX.
Volume to Transducer Relationship	(0020,930B)	1C	Relationship between the transducer and the acquired volume. Enumerated Values: **FIXED** The transducer position and orientation relative to the volume is constant and specified by Volume to Transducer Mapping Matrix (0020,9309). **POSITION_VAR** The transducer position relative to the volume varies during acquisition and the position specified by Volume to Transducer Mapping Matrix (0020,9309) is a nominal value. The transducer orientation relative to the volume is constant and specified by Volume to Transducer Mapping Matrix (0020,9309). **ORIENTATION_VAR** The transducer orientation relative to the volume varies during acquisition and the orientation specified by Volume to Transducer Mapping Matrix (0020,9309) is a nominal value. The transducer position relative to the volume is constant and specified by Volume to Transducer Mapping Matrix (0020,9309). **VARIABLE** The transducer position and orientation relative to the volume varies during acquisition and the position and orientation specified by Volume to Transducer Mapping Matrix (0020,9309) are nominal. Required if the transducer position and/or orientation relative to the volume is not constant. May be present otherwise.
Volume to Transducer Mapping Matrix	(0020,9309)	1	A 4x4 rigid transformation matrix that maps the Volume Frame of Reference homogeneous coordinate system (X_V, Y_V, Z_V) to the Transducer Frame of Reference homogeneous coordinate system (X_X,Y_X, Z_X). Matrix elements shall be listed in row-major order. See Section C.8.24.2.1 for details.

Attribute Name	Tag	Type	Attribute Description
Patient Frame of Reference Source	(0020,930C)	1C	Indicates how the supplied Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) values are obtained. Enumerated Values: **TABLE** A positioning device, such as a gantry, was used to generate these values. **ESTIMATED** Estimated patient position / orientation (e.g., estimated by the user), or if reliable information is not available. **REGISTRATION** Acquisition has been spatially registered to a prior image set. Required if either Image Position (Patient) (0020,0032) or Image Orientation (Patient) (0020,0037) is present.
Table Frame of Reference UID	(0020,9313)	1C	Uniquely identifies this Table Frame of Reference. Required if Patient Frame of Reference Source (0020,930C) is TABLE.
Volume to Table Mapping Matrix	(0020,930A)	1C	A 4x4 rigid transformation matrix that maps the Volume Frame of Reference homogeneous coordinate system (X_V,Y_V, Z_V) to the Table Frame of Reference homogeneous coordinate system (X_T,Y_T, Z_T). Matrix elements shall be listed in row-major order. See Section C.8.24.2.2 for details. Required if Patient Frame of Reference Source (0020,930C) is TABLE.

C.8.24.2.1 Ultrasound Frame of Reference Module Overview

The Ultrasound Frame of Reference Module is used to relate the image planes to a Frame of Reference appropriate for the ultrasound modality, most notably a volume-based Frame of Reference. There are many different transducer scan acquisition geometries used in 3D ultrasound imaging. Regardless of the acquisition geometry, after acquisition of the initial scan images comprising the volume, the ultrasound (US) scanner will assemble (reformat) the data into a proper Cartesian volume with the assumption that the data are related through a Right-Hand Coordinate System (RHCS). x-positions are defined in mm with positive values increasing towards the right. y-positions are defined in mm with positive values in the direction of increasing image depth. z-positions are defined in mm with positive values in the direction as defined in a right-hand coordinate system.

A Cartesian volume will consist of a series of 1 to n parallel planes. The image planes comprising the Cartesian volume are typically oriented during creation of the volume so that the best image quality is in the XY plane. Table C.8.24.2-1 specifies the Attributes of the Ultrasound Frame of Reference Module. There are three levels of detail for the Ultrasound Frame of Reference: Volume, Transducer and Table.

C.8.24.2.1.1 Volume Frame of Reference

The Volume Frame of Reference is a Right-hand Coordinate System consisting of a Volume Origin at the location (0,0,0) and mutually orthogonal X_V, Y_V, and Z_V axes in a Right-Hand Coordinate System. The particular IOD using the Volume Frame of Reference may constrain the alignment of frames with respect to the axes of the Volume Frame of Reference. For example, Figure C.8.24.2-1 illustrates the use of the Volume Frame of Reference with frames whose rows are parallel to the X_V axis and columns are parallel to the Y_V axis and whose origins lie on the Z_V axis.

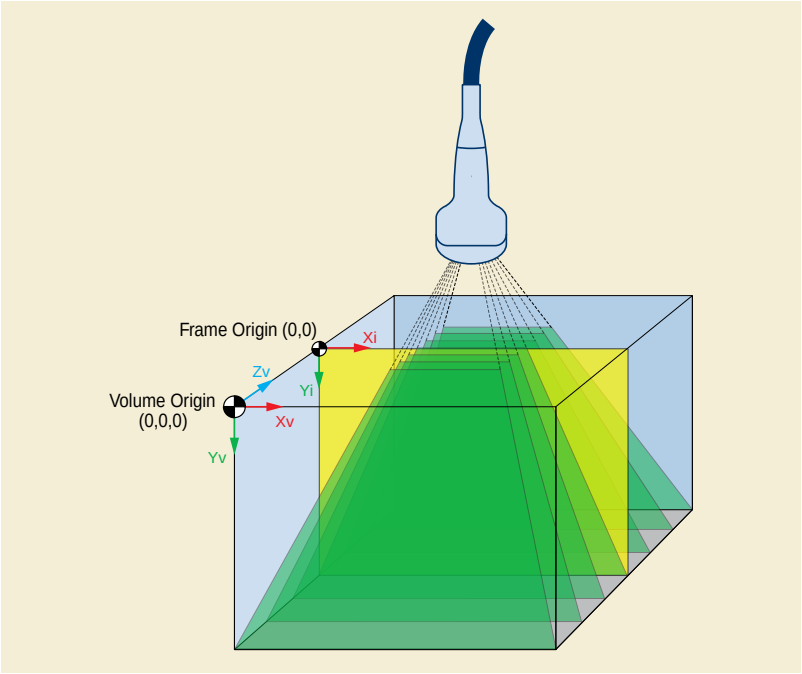


Figure C.8.24.2-1. Volume Frame of Reference

C.8.24.2.1.2 Transducer Frame of Reference

The Transducer Frame of Reference is a Right-hand Coordinate System consisting X_X, Y_X, and Z_X axes originating at a reference "Transducer Origin" defined as the geometric center of the transducer face.

The orientation of the Transducer Frame of Reference relative to the Volume Origin is such that the Y_X axis is normal to the transducer face and the "direction reference" (i.e., transducer tactile marker or zero reference) is aligned with the positive X_X axis. A transformation is specified between the Volume Frame of Reference and the Transducer Frame of Reference to define the position of the transducer relative to the volume. This transformation is specified by the Volume to Transducer Mapping Matrix (0020,9309).

The Transducer Frame of Reference recognizes two types of scan geometry: 1) a scan geometry with a real apex such as would be the case for a pyramid, toroid or rotational volume acquisition, or 2) a scan geometry for which there is no specific apex. The point (x_A, y_A, z_A) is the apex (or phase center) of the acquisition volume geometry in the Volume Frame of Reference. The apex (x_A, y_A, z_A) may be located in the volume or exterior to it.

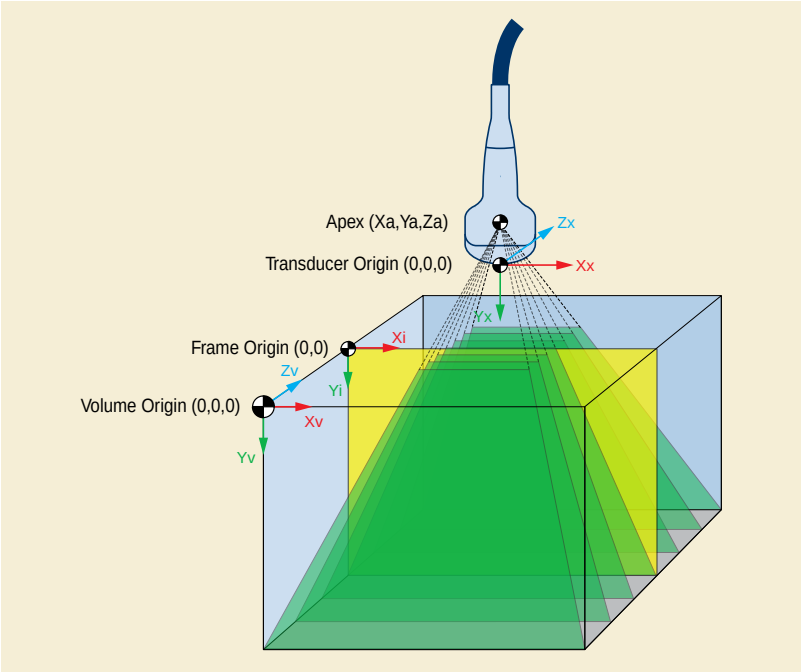


Figure C.8.24.2-2. Transducer Frame of Reference

In some acquisition modalities, the transducer position and/or orientation changes during acquisition and a single transducer mapping matrix is insufficient to describe the relationship between transducer and volume. In this case, Volume to Transducer Relationship (0020,930B) is required and specifies the nature of the relationship Transducer Frame of Reference and the Volume Frame of Reference.

C.8.24.2.1.3 Table Frame of Reference

There also may exist a fixed equipment reference called the Table Frame of Reference, a Right-hand Coordinate System consisting of X_T, Y_T, and Z_T axes originating at a reference "Table Origin". See Figure C.8.24.2-3.

Note

In this context the Table Frame of Reference refers to a fixed coordinate system in space that may be provided by a variety of source devices such as coordinates from a magnetic position sensor, LED sensor array, a physical scanner gantry, or similar device.

A transformation may be specified between the Volume Frame of Reference and the Table Frame of Reference to define the position and orientation of the volume relative to this external Frame of Reference. This transformation is specified by the Volume to Table Mapping Matrix (0020,930A).

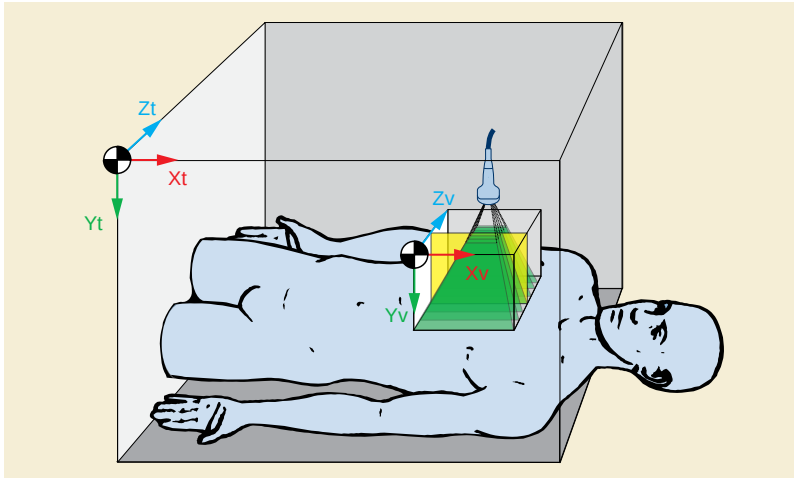


Figure C.8.24.2-3. Table Frame of Reference

C.8.24.2.2 Ultrasound Frame of Reference Module Attributes

C.8.24.2.2.1 Volume to Transducer Mapping Matrix

The Volume to Transducer Mapping Matrix (0020,9309) is used to describe the relationship between the Transducer Frame of Reference coordinate system and the Volume Frame of Reference coordinate system.

The Volume to Transducer Mapping Matrix ($[M_{TV}]$ = [P]*[Q]) describes how to transform a point (X_V, Y_V, Z_V) in the Volume coordinate system into (X_X,Y_X, Z_X) in the Transducer coordinate system according to the equation below.

Where:

$X_VY_VZ_V$ The voxel location (in mm) in the Volume Frame of Reference

$X_XY_XZ_X$ The voxel location (in mm) in the Transducer Frame of Reference

Pij,Pij,Pij A 3x3 matrix of direction cosine values as measured to the Transducer origin from the volume origin.

Qx,Qy,Qz The translation values (in mm) describe the location in mm of the Transducer Frame of Reference (X_X,Y_X, Z_X) origin from the Volume Reference Origin (X_V,Y_V, Z_V) measured in millimeters along the Volume axes i.e., to the transducer origin from the volume origin.

C.8.24.2.2.2 Volume to Table Mapping Matrix

The Volume to Table Mapping Matrix (0020,930A) is used to describe the relationship between the Volume Frame of Reference coordinate system and a modality specific equipment coordinate system. This mapping can be used only with systems that have a well-defined equipment coordinate system.

The Volume to Table Mapping Matrix($[M_{VG}]$ = [R]*[S]) describes how to transform a point ($X_VY_VZ_V$) in the Volume coordinate system into (X_T, Y_T, Z_T) in the Table coordinate system according to the equation below.

$$\begin{bmatrix} X_T \\ Y_T \\ Z_T \\ 1 \end{bmatrix} = \begin{bmatrix} R_{XX} & R_{YX} & R_{ZX} & S_X \\ R_{XY} & R_{YY} & R_{ZY} & S_Y \\ R_{XZ} & R_{YZ} & R_{ZZ} & S_Z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_V \\ Y_V \\ Z_V \\ 1 \end{bmatrix} \quad \text{(C.8.24-1)}$$

Where:

$X_VY_VZ_V$ The voxel location (in mm) in the Volume Frame of Reference

$X_TY_TZ_T$ The voxel location (in mm) in the Table Frame of Reference

Rij,Rij,Rij A 3x3 matrix of direction cosine values as measured to the gantry origin from the volume origin.

Sx,Sy,Sz The translation values (in mm) describe the location in mm of the Table Frame of Reference (X_T, Y_T, Z_T) origin from the Volume Reference Origin (X_V,Y_V, Z_V) measured in millimeters along the table axes i.e., to the table origin from the volume origin.

Note

The Mapping Matrices are rigid transformations that involve only translations and rotations. Mathematically, the matrix is orthonormal and describes six degrees of freedom: three translations, and three rotations.

C.8.24.3 Enhanced US Image Module

Table C.8.24.3-1 specifies the Attributes that describe the Enhanced US Image Module. As described in Section A.1.2.6, the Attributes in this Module apply to the first frame of a multi-frame image; any or all of this information may be overridden by Attributes in Per-frame Functional Groups.

Table C.8.24.3-1. Enhanced US Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.24.3.2 for specialization.
Samples Per Pixel	(0028,0002)	1	Number of samples per pixel in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Shall be equal to Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. The constrained Enumerated Value implies the VR of all Palette Color Lookup Table Descriptors be US (and not SS). Enumerated Values: **0000H** unsigned integer See Section C.8.24.3.1 for specialization.
Dimension Organization Type	(0020,9311)	1	Dimension organization of the Instance. Enumerated Values: **3D** **3D_TEMPORAL** See Section C.8.24.3.3 for details.

Attribute Name	Tag	Type	Attribute Description
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started.
Acquisition Duration	(0018,9073)	1	Duration of the image acquisition in seconds.
Position Measuring Device Used	(0018,980C)	1C	Describes the type of position measuring device used in the acquisition of the image, if any. This gives an indication of the degree of precision of Pixel Spacing (0028,0030) and the spacing between adjacent planes. Enumerated Values: **RIGID** The image was acquired with a position measuring device. **FREEHAND** The image was acquired without a position measuring device. Required if Volumetric Properties (0008,9206) is VOLUME and Volume Based Calculation Technique (0008,9207) is NONE. May be present otherwise.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values.
Rescale Intercept	(0028,1052)	1	The value b in relationship between stored values (SV) and the output units. Output units = m*SV + b. Enumerated Values: **0**

Attribute Name	Tag	Type	Attribute Description
Rescale Slope	(0028,1053)	1	m in the equation specified by Rescale Intercept (0028,1052). Enumerated Values: **1**
Source Image Sequence	(0008,2112)	1C	A Sequence that identifies the set of Image SOP Class/Instance pairs of the Images that were used to derive this Image. One or more Items shall be included in this Sequence. See Section C.12.4.1.2 for further explanation. Required if Image Type (0008,0008) Value 1 is DERIVED.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7202 "Source Image Purposes of Reference".*
Referenced Image Sequence	(0008,1140)	3	A Sequence that references other images significantly related to this image. (e.g., an image containing spatially related frames) One or more Items are permitted in this Sequence.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7201 "Referenced Image Purposes of Reference".*
Referenced Raw Data Sequence	(0008,9121)	3	A Sequence that identifies the set of Raw Data SOP Class/Instance pairs of the raw data that were used to derive this Image. One or more Items are permitted in this Sequence.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Referenced Instance Sequence	(0008,114A)	1C	A Sequence that provides reference to a set of non-image SOP Class/Instance pairs significantly related to this Image, including waveforms that may or may not be temporally synchronized with this image. One or more Items shall be included in this Sequence. Required if waveforms are acquired in conjunction with image acquisition. May be present otherwise.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the Instance(s). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7004 "Waveform Purposes of Reference" for referenced waveforms.*

Attribute Name	Tag	Type	Attribute Description
Number of Stages	(0008,2124)	1C	Number of stages in this protocol. Required if Performed Protocol Type (0040,0261) is present with value STAGED.
Stage Number	(0008,2122)	1C	A number that identifies the Stage. Stage Number starts at one. Required if Performed Protocol Type (0040,0261) is present with value STAGED.
Stage Code Sequence	(0040,000A)	1C	Sequence describing the performed Ultrasound Protocol Stage. Only a single Item shall be included in this Sequence. Required if Performed Protocol Type (0040,0261) is present with value STAGED.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 12002 "Ultrasound Protocol Stage Types".*
Include Table 10-24 "Mandatory View and Slice Progression Direction Macro Attributes"			*See Section C.8.5.6.1.19 for CIDs.*
Event Timer Sequence	(0008,2133)	3	Sequence of time intervals of significance to this image. Each Item describes one time interval either beginning or ending at Acquisition DateTime (0008,002A). One or more Items are permitted in this Sequence.
>Event Time Offset	(0008,2134)	1	Signed value of the time between Acquisition DateTime (0008,002A) and the event, in milliseconds. Positive values indicate the event occurs after Acquisition DateTime (0008,002A).
>Event Code Sequence	(0008,2135)	1	Type of event. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 12031 "Protocol Interval Events".*
>Event Timer Name(s)	(0008,2132)	3	Name that identifies the event timer. May be used in addition to Event Time Code Sequence to offer site-specific user-readable event time names. Only a single value shall be included.
Include Table 10-5 "General Anatomy Mandatory Macro Attributes"			No Context IDs are specified.
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the image may or may not contain recognizable visual features.

Attribute Name	Tag	Type	Attribute Description
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*
Transducer Data	(0018,5010)	3	Manufacturer defined code or description
Transducer Identification Sequence	(0018,5011)	3	Identification of the ultrasound transducer used. Only a single Item is permitted in this Sequence.
Include Table 10.36-1 "Device Identification Macro Attributes"			Device Type Code Sequence (3010,002E) BCID 12035 "Ultrasound Transducer Application".
Transducer Scan Pattern Code Sequence	(0018,9809)	1	The scan pattern the transducer is capable of. Only a single Item shall be included in this Sequence. See Section C.8.24.3.4 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 12032 "Transducer Scan Pattern".*
Transducer Geometry Code Sequence	(0018,980D)	1	Geometric structure of the transducer. Only a single Item shall be included in this Sequence. See Section C.8.24.3.4 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 12033 "Ultrasound Transducer Geometry".*
Transducer Beam Steering Code Sequence	(0018,980E)	1	Technique used by the transducer for beam steering. One or more Items shall be included in this Sequence. If more than one Item is present, the order is significant from plane-forming technique to volume-forming technique. See Section C.8.24.3.4 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 12034 "Ultrasound Transducer Beam Steering".*
Transducer Application Code Sequence	(0018,980F)	1	The primary clinical application of the transducer. Only a single Item shall be included in this Sequence. See Section C.8.24.3.4 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 12035 "Ultrasound Transducer Application".*
Processing Function	(0018,5020)	3	Manufacturer defined description of processing of echo information. Data may include code or description of gain (initial, overall, TGC, dynamic range, etc.), pre-processing, post-processing, Doppler processing parameters, e.g., cutoff filters, etc., as used in generating a given image.
Mechanical Index	(0018,5022)	1	See Section C.8.5.6.1.8 for Description.
Bone Thermal Index	(0018,5024)	1	See Section C.8.5.6.1.8 for Description.
Cranial Thermal Index	(0018,5026)	1	See Section C.8.5.6.1.8 for Description.
Soft Tissue Thermal Index	(0018,5027)	1	See Section C.8.5.6.1.8 for Description.
Depth(s) of Focus	(0018,9801)	1	The depth or depths from the transducer face, of the manufacturer defined beam focus points used for the image, in mm.
Depth of Scan Field	(0018,5050)	1	The depth, in mm, from the transducer face to the deepest point included in the image- the field of view.

C.8.24.3.1 Pixel Representation

Pixel Representation (0028,0103) is specified to be Type 1 with the constraint that VR for all the pixel data will always be unsigned (US) and not signed (SS).

Enumerated Values:

0000H unsigned integer

Note

The real-world values that are inherently signed (e.g., Flow Velocity, Tissue Velocity, Variance) are represented as unsigned, unitless pixel values and may be mapped to signed real-world quantities via the Real World Value Mapping Macro.

C.8.24.3.2 Image Type

C.8.24.3.2.1 Pixel Data Characteristics

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Enumerated Values.

C.8.24.3.2.2 Patient Examination Characteristics

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Enumerated Values.

C.8.24.3.2.3 Image Flavor

Value 3 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.3. No additional requirements or Defined Terms.

C.8.24.3.2.4 Derived Pixel Contrast

Value 4 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.4. No additional requirements or Defined Terms.

C.8.24.3.3 Dimension Organization Type

Dimension Organization Type (0020,9311) specifies the general structure of the image. The concept of "multi-frame dimensions" as specified by the Dimension Index Sequence (0020,9222) and per-frame Dimension Index Values (0020,9157) shall be used to specify the relationships of frames within that general structure.

If Dimension Organization Type (0020,9311) has values of 3D or 3D_TEMPORAL, then the Dimension Index Sequence (0020,9222) shall have exactly three Items, with the dimension values described in Table C.8.24.3.3-1.

Table C.8.24.3.3-1. Dimension Definition for US Acquisition 3D Images

Item	Attribute	Tag	Value
Dimension Index Sequence		(0020,9222)	
1st	>Dimension Index Pointer	(0020,9165)	Tag of Attribute specifying temporal position of frames
	>Functional Group Pointer	(0020,9167)	Tag of Sequence containing above Attribute
	…		
2nd	>Dimension Index Pointer	(0020,9165)	(0020,9301) Image Position (Volume)
	>Functional Group Pointer	(0020,9167)	(0020,930E) Plane Position (Volume) Sequence
	…		
3rd	>Dimension Index Pointer	(0020,9165)	(0018,9808) Data Type
	>Functional Group Pointer	(0020,9167)	(0018,9807) Image Data Type Sequence

Item	Attribute	Tag	Value
	…		

The Dimension Index Values (0020,9157) corresponding to these dimension variables positively associate frames with different Data Type values at the same spatial and temporal position. Figure C.8.24.3.3-1 illustrates the use of Dimensions to associate frames with temporal, spatial, and Data Type dimensions.

These Dimension values shall be used even if there is only one possible value for a Dimension.

Note

For example, if Dimension Organization Type (0020,9311) has the value 3D, the temporal position dimension is present and the dimension index of the temporal Attribute is the same in every frame of the image. Similarly, if the Data Type Attribute is in the Shared Functional Group and all frames in the object are of Data Type TISSUE_INTENSITY, the Data Type dimension is present and the dimension index of the Data Type dimension is the same in every frame of the image.

Each plane in the volume consists of one or more frames each with a distinct value of Data Type (0018,9808). Adjacent planes in the volume shall be equally spaced in the Z direction.

Each frame comprising a volume shall have the same value of the temporal dimension Attribute. Any appropriate physiological event temporal Attribute may be used to specify the temporal position. If there is no specific physiological event to which the temporal position of frames is referenced, then Temporal Position Time Offset (0020,930D) in the Temporal Position Sequence (0020,9310) may be used as the temporal dimension Attribute. If all frames are at the same temporal position, any temporal Attribute may be referenced.

Note

For example, the Attribute specifying temporal position of frames may be any appropriate temporal Attribute, such as Nominal Cardiac Trigger Delay Time (0020,9153) or Nominal Percentage of Cardiac Phase (0020,9241) in the Cardiac Synchronization Sequence (0018,9118) if the temporal position of frames is referenced to the cardiac R-wave, or Nominal Respiratory Trigger Delay Time (0020,9255) or Nominal Percentage of Respiratory Phase (0020,9245) in the Respiratory Synchronization Sequence (0020,9253) if the temporal position of frames is referenced to the latest inspiration maximum.

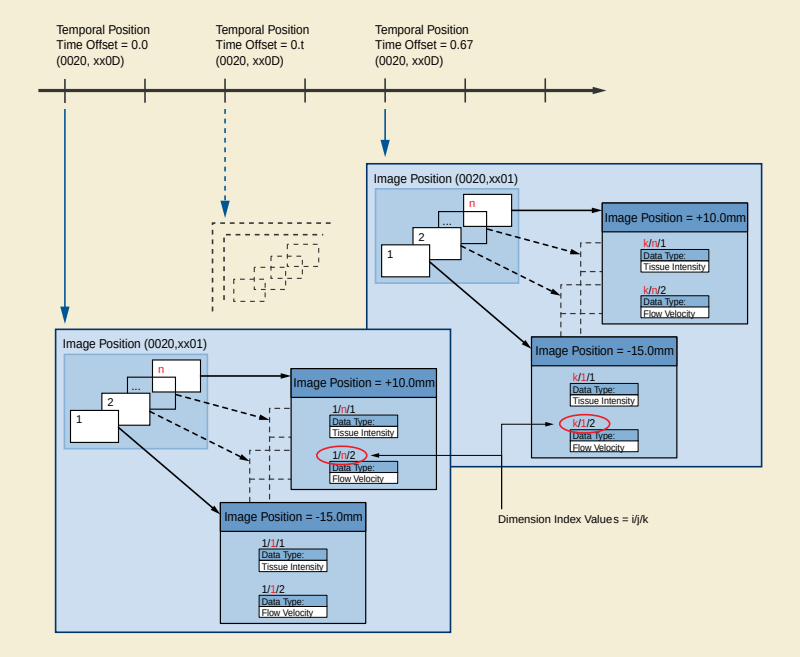


Figure C.8.24.3.3-1. Dimension Organization Type Frame Relationships

C.8.24.3.4 Transducer Description

The following elements together describe the type of transducer used to acquire the image. These are characteristics of the transducer itself rather than its specific use in the acquisition of this image. In other words, these Attribute values are determined from the construction and design of the transducer and a given transducer generally has the same values of these Attributes in every image it is used to create.

- Transducer Scan Pattern Code Sequence (0018,9809)

The shape of the acoustic scan field the transducer is capable of.

- Transducer Geometry Code Sequence (0018,980D)

The physical scan aperture from which acoustic pulses are emitted and received.

- Transducer Beam Steering Code Sequence (0018,980E)

The method used to steer acoustic beam.

- Transducer Application Code Sequence (0018,980F)

The placement on the subject for which the transducer is designed.

Each probe model has a unique set of values of these Attributes. For example, these sample probes have the following characteristics, which are encoded in the Attributes above:

Table C.8.24.3.4-1. Sample Transducer Characteristics

Model	Scan Pattern	Geometry	Beam Steering	Application
Pedoff CW	Line	NonImaging	Fixed direction	External
Phased array sector probe	Plane	Sector	Phased	External
Steerable TEE	Plane	Sector	Phased, Mechanical	Transesophogeal
Curved Linear Abdominal	Plane	Curved Linear	Phased	External
Endovaginal	Plane	Curved Linear	Phased	Endovaginal
Mechanical 3D	Volume	Sector	Phased, Mechanical	External
Phased 3D	Volume	Sector	Phased	External
Endovaginal 3D	Volume	Curved Linear	Phased, Mechanical	Endovaginal

C.8.24.4 IVUS Image Module

Table C.8.24.4-1 specifies the Attributes of an IVUS Module.

Table C.8.24.4-1. IVUS Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
IVUS Acquisition	(0018,3100)	1	Defined Terms: **MOTOR_PULLBACK** **MANUAL_PULLBACK** **SELECTIVE** **GATED_PULLBACK** See Section C.8.5.6.1.21
IVUS Pullback Rate	(0018,3101)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK. Specified in units of mm/sec. See Section C.8.5.6.1.22

Attribute Name	Tag	Type	Attribute Description
IVUS Gated Rate	(0018,3102)	1C	Required if IVUS Acquisition (0018,3100) value is GATED_PULLBACK. Specified in units of mm/beat. See Section C.8.5.6.1.23
IVUS Pullback Start Frame Number	(0018,3103)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See Section C.8.5.6.1.24
IVUS Pullback Stop Frame Number	(0018,3104)	1C	Required if IVUS Acquisition (0018,3100) value is MOTOR_PULLBACK or GATED_PULLBACK. See Section C.8.5.6.1.25

C.8.24.5 Excluded Intervals Module

The Excluded Intervals Module indicates those periods within Acquisition Duration (0018,9073) during which no volume acquisition takes place. It provides information not available at the frame level or image level, since individual frames of the volume may have been built-up over a time period within which some intervals were excluded from acquisition. Further, it provides information that is not specific to associated waveform objects since the fact that volume acquisition was excluded during these intervals is a characteristic of the volume, not the associated waveform(s), see Figure C.8.24.5-1. Table C.8.24.5-1 specifies the Attributes of the Excluded Intervals Module.

Note

For example, if the imaging device performing a gated volume acquisition excludes volume data acquired during an ectopic beat, the Excluded Intervals Attributes would be used to mark this interval in an associated physio waveform display.

Table C.8.24.5-1. Excluded Intervals Module Attributes

Attribute Name	Tag	Type	Attribute Description
Excluded Intervals Sequence	(0018,9803)	1C	List of excluded intervals. One or more Items shall be included in this Sequence. Required if one or more intervals was excluded.
>Exclusion Start DateTime	(0018,9804)	1	Time-point of the exclusion start in the same Synchronization Frame of Reference as Acquisition DateTime (0008,002A).
>Exclusion Duration	(0018,9805)	1	Duration of the exclusion in ms.

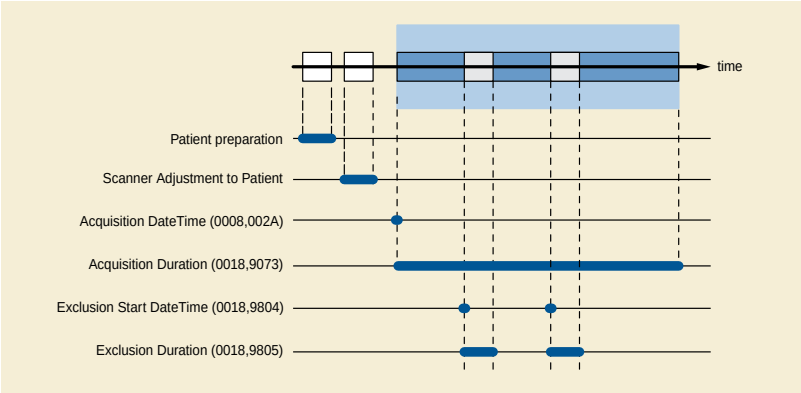


Figure C.8.24.5-1. Relationship of Timing Related Attributes

C.8.24.6 Enhanced US Volume Functional Group Macros

The following sections contain Functional Group Macros specific to the Enhanced US Volume IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean " for all frames".

C.8.24.6.1 US Image Description Macro

Table C.8.24.6.1-1 specifies the Attributes of the US Image Description Functional Group Macro.

Table C.8.24.6.1-1. US Image Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
US Image Description Sequence	(0018,9806)	1	A Sequence that describes a general description of this image or frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed. See Section C.8.24.3.2.
>Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See Section C.8.16.2.1.2 for a description and Enumerated Values.
>Volume Based Calculation Technique	(0008,9207)	1	Method used for volume calculations with frames in the SOP Instance. See Section C.8.16.2.1.3 for a description and Defined Terms.

If Volumetric Properties (0008,9206) is VOLUME and Volume Based Calculation Technique (0008,9207) is NONE, all frames in the frame set shall be spaced the same Z-distance from adjacent frames (i.e., spacing between slices is constant).

C.8.25 Ophthalmic Refractive Measurements Modules

C.8.25.1 Lensometry Measurements Series Module

The Lensometry Measurements IODs use the General Series Module, specialized by the Lensometry Measurements Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

Table C.8.25.1-1 specifies the Attributes that identify and describe general information about the Lensometry Measurements Series.

Table C.8.25.1-1. Lensometry Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **LEN** See Section C.7.3.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.25.2 Autorefraction Measurements Series Module

The Autorefraction Measurements IODs use the General Series Module, specialized by the Autorefraction Measurements Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

Table C.8.25.2-1 specifies the Attributes that identify and describe general information about the Autorefraction Measurements Series.

Table C.8.25.2-1. Autorefraction Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **AR** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.25.3 Keratometry Measurements Series Module

The Keratometry Measurements IODs use the General Series Module, specialized by the Keratometry Measurements Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

Table C.8.25.3-1 specifies the Attributes that identify and describe general information about the Keratometry Measurements Series.

Table C.8.25.3-1. Keratometry Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **KER** See Section C.7.3.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.25.4 Subjective Refraction Measurements Series Module

The Subjective Refraction Measurements IODs use the General Series Module, specialized by the Subjective Refraction Measurements Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

Table C.8.25.4-1 specifies the Attributes that identify and describe general information about the Subjective Refraction Measurements Series.

Table C.8.25.4-1. Subjective Refraction Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **SRF** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.25.5 Visual Acuity Measurements Series Module

The Visual Acuity Measurements IODs use the General Series Module, specialized by the Visual Acuity Measurements Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of Ophthalmic device.

Table C.8.25.5-1 specifies the Attributes that identify and describe general information about the Visual Acuity Measurements Series.

Table C.8.25.5-1. Visual Acuity Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **VA** See Section C.7.3.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.25.6 General Ophthalmic Refractive Macros

C.8.25.6.1 Cylinder Sequence Macro

Table C.8.25.6.1-1 describes the Attributes for the Cylinder Sequence Macro

Table C.8.25.6.1-1. Cylinder Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Cylinder Sequence	(0046,0018)	1C	A Sequence that specifies lens measurements to correct for astigmatism or measurements of an eye that has astigmatism. Required if astigmatic correction or astigmatism is measured. Only a single Item shall be included in this Sequence. Note When astigmatism is present the power is NOT the same in all meridians, but has its minimum and maximum power in meridians separated by 90 degrees.
>Cylinder Power	(0046,0147)	1	The power that is present at the power meridian (90 degrees from the axis), in diopters.
>Cylinder Axis	(0022,0009)	1	The meridian, defined in degrees, that is 90 degrees from the power meridian.

C.8.25.6.2 Prism Sequence Macro

Table C.8.25.6.2-1 describes the Attributes for the Prism Sequence Macro

Table C.8.25.6.2-1. Prism Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Prism Sequence	(0046,0028)	1C	A Sequence that specifies prism that is measured in a lens, or that is required to correct for a patient's ocular misalignment. Required if prism is measured in the lens or if this part of a refraction is done for a patient. Only a single Item shall be included in this Sequence. Note A prism is a wedge shaped lens that deviates light toward the base and shifts the apparent image toward its apex.
>Horizontal Prism Power	(0046,0030)	1	The power of a prism to bend light in the horizontal direction, in prism diopters.

Attribute Name	Tag	Type	Attribute Description
>Horizontal Prism Base	(0046,0032)	1	Direction of the base of the measured prism -- either in (toward the nose), or out (away from the nose) Enumerated Values: **IN** **OUT**
>Vertical Prism Power	(0046,0034)	1	The power of a prism to bend light in the vertical direction, in prism diopters.
>Vertical Prism Base	(0046,0036)	1	Direction of the base of the measured prism -- either up, or down. Enumerated Values: **UP** **DOWN**

C.8.25.7 General Ophthalmic Refractive Measurements Module

Table C.8.25.7-1 defines the General Ophthalmic Refractive Measurements Module Attributes.

Table C.8.25.7-1. General Ophthalmic Refractive Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies these measurements.
Content Date	(0008,0023)	1	The date the measurements data creation started.
Content Time	(0008,0033)	1	The time the measurements data creation started.
Measurement Laterality	(0024,0113)	3	Laterality of refractive measurement performed. Enumerated Values: **R** right **L** left **B** both left and right together Note 1. Laterality (0020,0060) is a Series level Attribute and must be the same for all Measurements in the Series, hence it must be absent if multiple instances from different eyes or lenses are encoded. 2. Needs to be consistent with any other laterality information contained at the Measurement level.
Image Comments	(0020,4000)	3	User-defined comments about this SOP Instance.
Referenced Refractive Measurements Sequence	(0046,0145)	2C	A Sequence that specifies Ophthalmic Refractive Measurements SOP Instances that are relevant to the interpretation of this SOP Instance. Zero or more Items shall be included in this Sequence. See Section C.8.25.7.1.1 for further explanation. Required if Visual Acuity Type Code Sequence (0046,0121) is present. May be present otherwise.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.25.7.1 General Ophthalmic Refractive Measurements Module Attributes

C.8.25.7.1.1 Referenced Refractive Measurements Sequence

Whenever visual acuity is measured it is necessary to know the conditions under which it was measured. If the vision was measured with the patient's habitual correction in place, this Attribute is used to reference a lensometry measurements SOP Instance for the current glasses. If the measurements are of the patient's best-corrected vision, this Attribute may reference the SOP Instance that describes the correction that resulted in that vision, which may for example be the subjective refraction, or the autorefraction.

This Attribute enables a receiver of this SOP Instance to identify the results of measurements from a lensometer, autorefractor, or automated phoropter (subjective refraction) that are relevant to interpretation.

C.8.25.8 Lensometry Measurements Module

Table C.8.25.8-1 defines the Attributes used to capture the refractive measurements by a lensometer for spectacles. This is typically for a pair of lenses, but sometimes for just one. Sometimes a single lens is measured with an unknown laterality.

Table C.8.25.8-1. Lensometry Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Lens Description	(0046,0012)	2	A free text description of the lens and lens general comments. Note A common example is to identify the specific spectacles measured
Right Lens Sequence	(0046,0014)	1C	A Sequence that specifies measurements of a patient's right lens. Required if the right lens is measured. Only a single Item shall be included in this Sequence. Note If Right Lens Sequence (0046,0014) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.8-2 “Lensometry Measurements Macro Attributes”			
Left Lens Sequence	(0046,0015)	1C	A Sequence that specifies measurements of a patient's left lens. Required if the left lens is measured. Only a single Item shall be included in this Sequence. Note If Left Lens Sequence (0046,0015) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Include Table C.8.25.8-2 “Lensometry Measurements Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Unspecified Laterality Lens Sequence	(0046,0016)	1C	A Sequence that specifies measurements of one lens of unknown laterality. Only a single Item shall be included in this Sequence. Shall not be included if Attribute Right Lens Sequence (0046,0014) or Left Lens Sequence (0046,0015) is present. Required if a single lens of unknown laterality is measured.
>Include Table C.8.25.8-2 “Lensometry Measurements Macro Attributes”			

Table C.8.25.8-2 describes the Attributes for the Lensometry Measurements Macro.

Table C.8.25.8-2. Lensometry Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Sphere Power	(0046,0146)	1	Refractive power of the lens that is the same in all meridians, measured at distance (optical infinity), in diopters.
Include Table C.8.25.6.1-1 “Cylinder Sequence Macro Attributes”			
Add Near Sequence	(0046,0100)	1C	A Sequence that specifies refractive measurements of the lens to correct for inability to focus at near while wearing the distance prescription. Only a single Item shall be included in this Sequence. Required if Add Near is measured in the lens.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this Sequence.
Add Intermediate Sequence	(0046,0101)	1C	A Sequence that specifies refractive measurements of the lens to correct for inability to focus at intermediate distance while wearing the distance prescription. Only a single Item shall be included in this Sequence. Required if Add intermediate is measured in the lens.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this Sequence Item.
Include Table C.8.25.6.2-1 “Prism Sequence Macro Attributes”			
Lens Segment Type	(0046,0038)	3	The type of segment of a lens containing the "add" power, as described above Enumerated Values: **PROGRESSIVE** **NONPROGRESSIVE**
Optical Transmittance	(0046,0040)	3	The fraction of light that passes through the measured lens optical media, in percent.

Attribute Name	Tag	Type	Attribute Description
Channel Width	(0046,0042)	3	In a progressive lens, the width in mm of that portion of the lens where there is gradual or progressive increase in "add" power. Note See Attributes, Add Near Sequence (0046,0100) and Add Intermediate Sequence (0046,0101) for description of "add".

C.8.25.9 Autorefraction Measurements Module

Table C.8.25.9-1 defines the Attributes used to represent the refractive measurements by an autorefractor of a patient's eyes. Usually both eyes are measured, but sometimes just one.

Table C.8.25.9-1. Autorefraction Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Autorefraction Right Eye Sequence	(0046,0050)	1C	A Sequence that specifies refractive measurements of a patient's right eye. Only a single Item shall be included in this Sequence. Required if the right eye is measured. Note If Autorefraction Right Eye Sequence (0046,0050) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
>Include Table C.8.25.6.1-1 “Cylinder Sequence Macro Attributes”			
>Pupil Size	(0046,0044)	3	The horizontal diameter measurement of the pupil, in mm.
>Corneal Size	(0046,0046)	3	The horizontal diameter measurement of the cornea, in mm.
Autorefraction Left Eye Sequence	(0046,0052)	1C	A Sequence that specifies refractive measurements of a patient's left eye. Only a single Item shall be included in this Sequence. Required if the left eye is measured. Note If Autorefraction Left Eye Sequence (0046,0052) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
>Include Table C.8.25.6.1-1 “Cylinder Sequence Macro Attributes”			
>Pupil Size	(0046,0044)	3	The horizontal diameter measurement of the pupil, in mm.
>Corneal Size	(0046,0046)	3	The horizontal diameter measurement of the cornea, in mm.
Distance Pupillary Distance	(0046,0060)	3	Distance in mm between the pupils when the patient's object of regard is in the distance, as measured by an autorefractor.
Near Pupillary Distance	(0046,0062)	3	Distance in mm between the pupils when the patient's object of regard is at near, as measured by an autorefractor.

C.8.25.10 Keratometry Measurements Module

Table C.8.25.10-1 defines the Attributes used to represent the keratometric measurements by a keratometer of a patient's eyes. Usually both eyes are measured, but sometimes just one.

Table C.8.25.10-1. Keratometry Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Keratometry Right Eye Sequence	(0046,0070)	1C	A Sequence that specifies keratometric measurements of a patient's right eye, defining principal meridians wherein the steepest meridian is separated by 90 degrees from the flattest. Only a single Item shall be included in this Sequence. Required if the right eye is measured. Note 1. Consideration for steep, flat, and spherical meridians is made. For instances where spherical keratometric measurements are obtained, values specified in the steep and flat Attributes are equivalent. 2. If Keratometry Right Eye Sequence (0046,0070) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.10-2 “Keratometric Measurements Macro Attributes”			
Keratometry Left Eye Sequence	(0046,0071)	1C	A Sequence that specifies keratometric measurements of a patient's left eye, defining principal meridians wherein the steepest meridian is separated by 90 degrees from the flattest. Only a single Item shall be included in this Sequence. Required if the left eye is measured. Note 1. Consideration for steep, flat, and spherical meridians is made. For instances where spherical keratometric measurements are obtained, values specified in the steep and flat Attributes are equivalent. 2. If Keratometry Left Eye Sequence (0046,0071) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Include Table C.8.25.10-2 “Keratometric Measurements Macro Attributes”			

Table C.8.25.10-2 describes the Attributes for the Keratometric Measurements Macro.

Table C.8.25.10-2. Keratometric Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Steep Keratometric Axis Sequence	(0046,0074)	1	A Sequence that specifies the steepest meridian as defined by the greatest power of curvature and shortest radius of curvature. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Flat Keratometric Axis Sequence	(0046,0080)	1	A Sequence that specifies the flattest meridian as defined by the least power of curvature and longest radius of curvature. Only a single Item shall be included in this Sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric radius of curvature or power is measured, in degrees.

C.8.25.11 Subjective Refraction Measurements Module

Table C.8.25.11-1 defines the Attributes used to represent the subjective refractive measurements of a patient's eyes. Usually both eyes are measured, but sometimes just one.

Table C.8.25.11-1. Subjective Refraction Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Subjective Refraction Right Eye Sequence	(0046,0097)	1C	A Sequence that specifies the subjective refractive measurements of a patient's right eye. Only a single Item shall be included in this Sequence. Required if the right eye is measured. Note If Subjective Refraction Right Eye Sequence (0046,0097) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.11-2 “Subjective Refraction Measurements Macro Attributes”			
Subjective Refraction Left Eye Sequence	(0046,0098)	1C	A Sequence that specifies the subjective refractive measurements of a patient's left eye. Only a single Item shall be included in this Sequence. Required if the left eye is measured. Note If Subjective Refraction Left Eye Sequence (0046,0098) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Include Table C.8.25.11-2 “Subjective Refraction Measurements Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Distance Pupillary Distance	(0046,0060)	3	Distance in mm between the pupils when the patient's object of regard is in the distance, as measured by a phoropter.
Near Pupillary Distance	(0046,0062)	3	Distance in mm between the pupils when the patient's object of regard is at near, as measured by a phoropter.
Intermediate Pupillary Distance	(0046,0063)	3	Distance in mm between the pupils when the patient's object of regard is at an intermediate distance, as measured by a phoropter.
Other Pupillary Distance	(0046,0064)	3	Distance in mm between the pupils when the patient's object of regard is at the distance specified in the Attribute Add Other Sequence (0046,0102), as measured by a phoropter.

Table C.8.25.11-2 describes the Attributes used for the Subjective Refraction Measurements Macro.

Table C.8.25.11-2. Subjective Refraction Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Sphere Power	(0046,0146)	1	Refractive power of the eye that is the same in all meridians, measured at distance (optical infinity), in diopters.
Include Table C.8.25.6.1-1 “Cylinder Sequence Macro Attributes”			
Include Table C.8.25.6.2-1 “Prism Sequence Macro Attributes”			
Add Near Sequence	(0046,0100)	1C	A Sequence that specifies refractive measurements of the eye to correct for inability to focus at near while wearing the distance prescription. Only a single Item shall be included in this Sequence. Required if near point refraction is done.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this Sequence.
Add Intermediate Sequence	(0046,0101)	1C	A Sequence that specifies refractive measurements of the eye to correct for inability to focus at intermediate distance while wearing the distance prescription. Only a single Item shall be included in this Sequence. Required if intermediate point refraction is done.
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity using the value of Add Power (0046,0104) in this Sequence Item.
Add Other Sequence	(0046,0102)	1C	A Sequence that specifies refractive measurements of the eye to correct for inability to focus at the below specified distance while wearing the distance prescription. Only a single Item shall be included in this Sequence. Required if refraction is done at less than distance (optical infinity), but at a distance other than "near" or "intermediate".

Attribute Name	Tag	Type	Attribute Description
>Add Power	(0046,0104)	1	Additional power relative to the distance correction, expressed in diopters, that allows best corrected visual acuity at the defined viewing distance.
>Viewing Distance	(0046,0106)	3	The distance, in cm, for testing visual acuity corresponding to the value of Add Power (0046,0104) in this Sequence Item.

C.8.25.12 Visual Acuity Measurements Module

Table C.8.25.12-1 defines the Attributes used to represent the subjective measurements of a patient's visual acuity. Usually each eye is measured individually, but sometimes only one eye is measured; sometimes the visual acuity of both eyes working together is measured. The visual acuity may be measured uncorrected, or with various refractive corrections, such as best corrected distance, pinhole, habitual near, etc

Table C.8.25.12-1. Visual Acuity Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Viewing Distance Type	(0046,0125)	1	The viewing distance conditions under which a patient's vision was measured. Enumerated Values: **DISTANCE** **NEAR** **INTERMEDIATE** **OTHER**
Visual Acuity Type Code Sequence	(0046,0121)	1	A Sequence that specifies the conditions under which a patient's vision was measured. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”. DCID 4216 “Ophthalmic Visual Acuity Type”.			
Background Color	(0046,0092)	1	The color of the background upon which optotypes are displayed for measurements of visual acuity. Defined Terms: **RED** **GREEN** **WHITE** **REDGREENSPLIT**
Optotype	(0046,0094)	1	The standardized test type (standard object of regard) used in measurements of visual acuity. Defined Terms: **LETTERS** **NUMBERS** **PICTURES** **TUMBLING E** **LANDOLT C**

Attribute Name	Tag	Type	Attribute Description
Optotype Detailed Definition	(0046,0139)	1C	Required if the Optotype (0046,0094) Attribute value is LETTERS or NUMBERS or PICTURES. Provides additional information to define what optotype was used. Note Letters, numbers, and pictures are commonly used but poorly standardized. The tumbling E and Landolt C are well defined.
Optotype Presentation	(0046,0095)	1	Specifies whether single or multiple optotypes were presented. Enumerated Values: **SINGLE** **MULTIPLE**
Visual Acuity Right Eye Sequence	(0046,0122)	1C	A Sequence that specifies the subjective measurement of a patient's visual acuity for the right eye. Only a single Item shall be included in this Sequence. Required if the right eye is measured. Note If Visual Acuity Right Eye Sequence (0046,0122) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.12-2 "Visual Acuity Measurements Macro Attributes"			
Visual Acuity Left Eye Sequence	(0046,0123)	1C	A Sequence that specifies the subjective measurements of a patient's visual acuity for the left eye. Only a single Item shall be included in this Sequence. Required if the left eye is measured. Note If Visual Acuity Left Eye Sequence (0046,0123) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Include Table C.8.25.12-2 "Visual Acuity Measurements Macro Attributes"			
Visual Acuity Both Eyes Open Sequence	(0046,0124)	3	A Sequence that specifies a patient's subjective visual acuity measurements with both eyes open. Only a single Item is permitted in this Sequence. Note If Visual Acuity Both Eyes Open Sequence (0046,0124) is present, Measurement Laterality (0024,0113), if present, will have a value of B.
>Include Table C.8.25.12-2 "Visual Acuity Measurements Macro Attributes"			

Table C.8.25.12-2 describes the Attributes for the Visual Acuity Measurements Macro.

Table C.8.25.12-2. Visual Acuity Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Decimal Visual Acuity	(0046,0137)	1	A patient's visual acuity specified in decimal. The value is derived from two values in a fraction where the numerator of the fraction is the nominal distance to the chart that the patient is reading. The denominator represents the line of smallest optotypes of which the patient can see more than half. Note 1. Typical examples: reference standard is 1, severe vision loss is 0.1 2. See Annex RR “Ophthalmic Refractive Reports Use Cases (Informative)” in PS3.17 for guidance in converting Decimal Visual Acuity to other customarily used display notation such as 20/20 in the US and 6/6 in Britain.
Visual Acuity Modifiers	(0046,0135)	3	The first value is a positive or negative integer numeric value such as +1, +2, +3, 0, -1, -2, or -3 used to indicate that the patient missed letters on the line referenced, or saw additional letters on the next smaller line. The second value is a positive or negative integer numeric value such as +1, +2, +3, 0, -1, -2, or -3, which in combination with the first value indicates that the patient both saw additional letters on the next smaller line and missed letters on the line referenced. Note 1. When the modifier values are zero, the values are not typically displayed to the user. 2. See Annex RR “Ophthalmic Refractive Reports Use Cases (Informative)” in PS3.17 for guidance regarding significance of modifiers.

C.8.25.13 Ophthalmic Axial Measurements Series Module

Table C.8.25.13-1 specifies the Attributes that identify and describe general information about the Ophthalmic Axial Measurements Series.

Table C.8.25.13-1. Ophthalmic Axial Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the measurements in this Series. Enumerated Values: **OAM** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.25.14 Ophthalmic Axial Measurements Module

Table C.8.25.14-1 defines the Attributes used to encode axial measurements of the eye made by an axial measurements device. This is typically done for both eyes, but may be for just one.

Table C.8.25.14-1. Ophthalmic Axial Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Measurements Device Type	(0022,1009)	1	Describes the type of ophthalmic axial measurement acquisition device. Defined Terms: **ULTRASOUND** **OPTICAL**
Ophthalmic Ultrasound Method Code Sequence	(0022,1044)	1C	The method used for obtaining axial measurements of the eye. Only a single Item shall be included in this Sequence. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4230 "Ophthalmic Ultrasound Axial Measurements Type"*
Anterior Chamber Depth Definition Code Sequence	(0022,1125)	3	The definition of anterior chamber depth for this instrument. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4239 "Anterior Chamber Depth Definition"*
Ophthalmic Axial Measurements Right Eye Sequence	(0022,1007)	1C	Axial measurements of a patient's right eye. Only a single Item shall be included in this Sequence. Required if the right eye is measured. Note If Ophthalmic Axial Measurements Right Eye Sequence (0022,1007) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.14-2 "Ophthalmic Axial Measurements Macro Attributes"			
>Include Table C.8.25.14-5 "Ophthalmic Axial Measurements Selected Macro Attributes"			
Ophthalmic Axial Measurements Left Eye Sequence	(0022,1008)	1C	Axial measurements of a patient's left eye. Only a single Item shall be included in this Sequence. Required if the left eye is measured. Note If Ophthalmic Axial Measurements Left Eye Sequence (0022,1008) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.8.25.14-2 “Ophthalmic Axial Measurements Macro Attributes”			
>Include Table C.8.25.14-5 “Ophthalmic Axial Measurements Selected Macro Attributes”			

C.8.25.14.1 Ophthalmic Axial Measurements Macro

Table C.8.25.14-2 describes the Attributes for the Ophthalmic Axial Measurements Macro.

Table C.8.25.14-2. Ophthalmic Axial Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Lens Status Code Sequence	(0022,1024)	1	Lens status of the eye. See Section C.8.25.14.1.1.1 for further explanation. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4231 “Lens Status”*
Lens Status Description	(0022,1065)	3	A free form text description of Lens Status (0022,1024).
Vitreous Status Code Sequence	(0022,1025)	1	Status of the vitreous cavity. See Section C.8.25.14.1.1.2 for further explanation. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4232 “Vitreous Status”*
Vitreous Status Description	(0022,1066)	3	A free form text description of Vitreous Status (0022,1025).
Pupil Dilated	(0022,000D)	2	Whether or not the patient's pupils were pharmacologically dilated for this acquisition Enumerated Values: **YES** **NO** If this Attribute is empty, no information is available.
Degree of Dilation	(0022,000E)	2C	The degree of the dilation in mm. Required if the value of Pupil Dilated (0022,000D) is YES.
Mydriatic Agent Sequence	(0022,0058)	2C	Information about the agent administered. Zero or more Items shall be included in this Sequence. Note An empty Sequence indicates that an agent was used for dilation, but the name was not entered. Required if the value of Pupil Dilated (0022,000D) is YES.
>Mydriatic Agent Code Sequence	(0022,001C)	1	The actual agent administered to dilate the pupil. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*BCID 4208 “Mydriatic Agent”.*
>Mydriatic Agent Concentration	(0022,004E)	3	The concentration of the agent.

Attribute Name	Tag	Type	Attribute Description
>Mydriatic Agent Concentration Units Sequence	(0022,0042)	1C	Units of measure for the Mydriatic Agent Concentration. Only a single Item shall be included in this Sequence. Required if Mydriatic Agent Concentration (0022,004E) is present.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4244 "Ophthalmic Agent Concentration Units"*
Ophthalmic Axial Length Measurements Sequence	(0022,1050)	1	Measurements of the axial length of a patient's eye. One or more Items shall be included in this Sequence.
>Ophthalmic Axial Length Measurements Type	(0022,1010)	1	Identifies whether measuring the total axial length of the patient's eye or a segment of the eye for which a discrete measurement was obtained. Enumerated Values: **TOTAL LENGTH** the total axial length was taken with one measurement **LENGTH SUMMATION** the total axial length is a summation of segmental lengths **SEGMENTAL LENGTH** the length of a segment of the axis
>Ophthalmic Axial Length Measurements Total Length Sequence	(0022,1210)	1C	The axial length of a patient's eye, in mm. One or more Items shall be included in this Sequence. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is TOTAL LENGTH. See Section C.8.25.14.1.1.4 for further explanation.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement acquired, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
>>Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: **YES** **NO**
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be included in this Sequence. See Section C.8.25.14.1.1.6 for further explanation.
>>>Include Table C.8.25.16-6 "Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes"			
>>Include Table C.8.25.14-4 "Ophthalmic Axial Measurements Related Information Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Ophthalmic Axial Length Measurements Length Summation Sequence	(0022,1212)	1C	Axial length of a patient's eye, in mm, when it is calculated by summation of multiple segmental axial length measurements. One or more Items shall be included in this Sequence. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is LENGTH SUMMATION. See Section C.8.25.14.1.1.4 for further explanation.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement acquired, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
>>Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: **YES** **NO**
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be included in this Sequence. See Section C.8.25.14.1.1.6 for further explanation.
>>>Include Table C.8.25.16-6 “Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes”			
>>Ophthalmic Axial Length Measurements Segmental Length Sequence	(0022,1211)	1	Segmental axial length measurements of a patient's eye that contribute to an aggregate axial length measurement. One or more Items shall be included in this Sequence. See Section C.8.25.14.1.1.4 for further explanation.
>>>Include Table C.8.25.14-3 “Ophthalmic Axial Length Segmental Measurements Macro Attributes”			
>Ophthalmic Axial Length Measurements Segmental Length Sequence	(0022,1211)	1C	Segmental axial length measurement of a patient's eye. One or more Items shall be included in this Sequence. Required if Ophthalmic Axial Length Measurements Type (0022,1010) is SEGMENTAL LENGTH. See Section C.8.25.14.1.1.4 for further explanation.
>>Include Table C.8.25.14-3 “Ophthalmic Axial Length Segmental Measurements Macro Attributes”			

C.8.25.14.1.1 Ophthalmic Axial Measurements Macro Attribute Descriptions

C.8.25.14.1.1.1 Lens Status Code Sequence

Lens Status Code Sequence (0022,1024) refers to either the natural lens of the eye (phakic), or various types of lens implants inserted in cataract surgery, or lack of a lens in the eye (aphakic).

C.8.25.14.1.1.2 Vitreous Status Code Sequence

Vitreous Status Code Sequence (0022,1025) refers to either the natural status of the vitreous cavity (vitreous only) or to various possible states after vitreous surgery.

C.8.25.14.1.1.3 Ophthalmic Axial Length

If Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND, the Ophthalmic Axial Length (0022,1019) measurement is taken from the anterior vertex of the cornea to the anterior surface of the retina (internal limiting membrane).

If Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL, the Ophthalmic Axial Length (0022,1019) measurement is taken from the anterior vertex of the cornea to the level of the photoreceptors in the retina and compensated to adjust for the thickness of the retina to mimic the ultrasound technique.

This difference is an inherent property of the measurement method. Since optical devices measure to retinal pigment epithelium and ultrasound devices measure to internal limiting membrane, the difference must be subtracted to obtain comparable results for use in intraocular lens calculation formulas. The difference is the thickness of the retina, which has been determined empirically and varies with the axial length of the eye.

The intent is to measure along the patient's visual axis.

C.8.25.14.1.1.4 Ophthalmic Axial Length Measurements Segment Name Code Sequence

When the acquisition device type is ultrasound, the Ophthalmic Axial Length (0022,1019) may represent distance calculated using a single time value and an average presumed velocity for the entire eye. Alternatively it may represent the sum of multiple segmental axial length measurements with each distance value calculated using a different time value and a presumed velocity specific to that segment of the eye.

When the acquisition device type is optical, the whole length can be measured instead of measuring and summing up different segments of the eye. Nevertheless, optical axial measurement devices can also measure segments of the eye independently (e.g., the Anterior Chamber depth).

Each segment of the eye that is measured shall be identified by the Ophthalmic Axial Length Measurements Segment Name Code Sequence (0022,1101).

C.8.25.14.1.1.5 Observer Type

For Attribute Observer Type (0040,A084), Ultrasound axial length measurement devices take many measurements in rapid sequence. The machine can be set to select a good quality measurement automatically, or it can be set so that the user presses a footswitch when he/she sees a quality measurement based on the graphical display.

C.8.25.14.1.1.6 Referenced Ophthalmic Axial Length Measurement QC Image Sequence

The Attribute Referenced Ophthalmic Axial Length Measurement QC Image Sequence (0022,1330) references a quality control image that is a secondary capture of the presentation of a one dimensional waveform produced when performing ophthalmic axial measurements. It is acquired by the modality creating the ophthalmic axial measurements. The purpose of these images is to judge the quality of an axial length measurement for use in calculating the power of intraocular lens to place in a patient's eye in cataract surgery. The image is used for quality control and not for diagnostic purposes. See PS3.17.

The SOP Instance for the quality control image will meet the following requirements:

- Frame Increment Pointer (0028,0009) is set to 00182002 = sequencing by Frame Label Vector (0018,2002).

  Note

  The frame number is the recommended value for the label.

- The Attribute Referenced Instance Sequence (0008,114A) is conveyed and only a single Item is used. The Item in Referenced Instance Sequence (0008,114A) contains the value "1.2.840.10008.5.1.4.1.1.78.7" = (this SOP Class) for Attribute Referenced SOP Class UID (0008,1150) and Attribute Referenced SOP Instance UID (0008,1155) will reference this measurement SOP Instance.
- Burned In Annotation (0028,0301) is set to NO.

  The Attribute Burned In Annotation (0028,0301) defines whether patient demographics have been burned into the image. This Attribute does not prohibit non-demographic burned in annotation, such as position of gates, for image or waveform annotations that are very important to a user. Such annotations are expected to be conveyed and displayed.
- Quality Control Image (0028,0300) is set to YES.

C.8.25.14.2 Ophthalmic Axial Length Segmental Measurements Macro

Table C.8.25.14-3 describes the Attributes for the Ophthalmic Axial Length Segmental Measurements Macro.

Table C.8.25.14-3. Ophthalmic Axial Length Segmental Measurements Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
Ophthalmic Axial Length Measurement Modified	(0022,1140)	1	Whether or not the clinician intervened to modify the output of the device. For example by forcing it to select a different peak in the display. Enumerated Values: **YES** **NO**
Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	The name of the segment measured. See Section C.8.25.14.1.1.4 for further explanation. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4233 “Ophthalmic Axial Length Measurements Segment Names”*
Include Table C.8.25.14-4 “Ophthalmic Axial Measurements Related Information Macro Attributes”			

C.8.25.14.3 Ophthalmic Axial Measurements Related Information Macro

Table C.8.25.14-4 describes the Attributes for the Ophthalmic Axial Measurements Related Information Macro.

Table C.8.25.14-4. Ophthalmic Axial Measurements Related Information Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Ultrasound Ophthalmic Axial Length Measurements Sequence	(0022,1220)	1C	Related information about an axial length measurement being performed on an ultrasound device. Only a single Item shall be included in this Sequence. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND.

Attribute Name	Tag	Type	Attribute Description
>Ophthalmic Axial Length Velocity	(0022,1059)	1	The sound velocity used in calculating the Ophthalmic Axial Length Measurement Value (0022,1019), in m/sec.
>Observer Type	(0040,A084)	1	Method used to select which acquired axial length measurement values are kept. Enumerated Values: **PSN** Person; manually selected **DEV** Device; automatically selected See Section C.8.25.14.1.1.5 for further explanation.
>Ophthalmic Axial Length Data Source Code Sequence	(0022,1150)	1	Source of the value recorded in Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4240 "Ophthalmic Measurement or Calculation Data Source"*
>Ophthalmic Axial Length Data Source Description	(0022,1159)	3	A free text description of the axial length measurement data source.
Optical Ophthalmic Axial Length Measurements Sequence	(0022,1225)	1C	Related information about an axial length measurement being performed on an optical device. Only a single Item shall be included in this Sequence. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL.
>Signal to Noise Ratio	(0022,1155)	3	The ratio of signal power to the background noise power (P_{signal} / P_{noise}).
>Ophthalmic Axial Length Data Source Code Sequence	(0022,1150)	1	The source of the value in Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4240 "Ophthalmic Measurement or Calculation Data Source"*
>Ophthalmic Axial Length Data Source Description	(0022,1159)	3	A free text description of the axial length measurement data source.

C.8.25.14.4 Ophthalmic Axial Measurements Selected Macro

Table C.8.25.14-5 describes the Attributes for the Ophthalmic Axial Measurements Selected Macro. These are the Attributes of the Ophthalmic Axial Length (0022,1019) selected for use in IOL calculations.

Table C.8.25.14-5. Ophthalmic Axial Measurements Selected Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Ultrasound Selected Ophthalmic Axial Length Sequence	(0022,1230)	1C	Information related to the selected axial length measurement of the patient's eye when acquired on an ultrasound device. Only a single Item shall be included in this Sequence. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND.

Attribute Name	Tag	Type	Attribute Description
>Ophthalmic Axial Length Measurements Type	(0022,1010)	3	Identifies whether measuring the total axial length of the patient's eye or a segment of the eye for which a discrete measurement was obtained. Enumerated Values: **TOTAL LENGTH** the total axial length was taken with one measurement **LENGTH SUMMATION** the total axial length is a summation of segmental lengths
>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.4 for further explanation.
>Ophthalmic Axial Length Selection Method Code Sequence	(0022,1250)	1	Method used to derive the value recorded in Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.
~~>>*Include* Table 8.8-1 "Code Sequence Macro Attributes".~~			~~*D*CID 4241 "Ophthalmic Axial Length Selection Method".~~
>>*Include* Table 8.8-1 "Code Sequence Macro Attributes".			*D*CID 4241 "Ophthalmic Axial Length Selection Method".
>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	References to the quality control image associated with this measurement. Only a single Item shall be included in this Sequence. See Section C.8.25.14.1.1.6 for further explanation.
>>Include Table C.8.25.16-6 "Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes"			
>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	1	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.
>>Include Table C.8.25.14-6 "Ophthalmic Axial Length Quality Metric Macro Attributes"			
>Selected Segmental Ophthalmic Axial Length Sequence	(0022,1257)	1C	Segmental axial length measurements of a patient's eye that are summed to derive a total axial length for the eye. One or more Items shall be included in this Sequence. Required if the value of Ophthalmic Axial Length Measurements Type (0022,1010) is present and is LENGTH SUMMATION. May be present otherwise.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
>>Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	Name of the segment measured. See Section C.8.25.14.1.1.4 for further explanation. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4233 "Ophthalmic Axial Length Measurements Segment Names"*
Optical Selected Ophthalmic Axial Length Sequence	(0022,1255)	1C	Information related to the selected axial length measurement(s) of the patient's eye when acquired on an optical device. One or more Items shall be included in this Sequence. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is OPTICAL.
>Ophthalmic Axial Length Measurements Type	(0022,1010)	3	Identifies whether measuring the total axial length of the patient's eye or a segment of the eye for which a discrete measurement was obtained. Enumerated Values: **TOTAL LENGTH** the total axial length was taken with one measurement **LENGTH SUMMATION** the total axial length is a summation of segmental lengths **SEGMENTAL LENGTH** the length of a segment of the axis
>Selected Total Ophthalmic Axial Length Sequence	(0022,1260)	1C	Total axial length measurement selected for the patient's eye. Only a single Item shall be included in this Sequence. Required if the value of Ophthalmic Axial Length Measurements Type (0022,1010) is present and is either TOTAL LENGTH or LENGTH SUMMATION. May be present otherwise Note In case of Ophthalmic Axial Length Measurements Type (0022,1010) has the value LENGTH SUMMATION both the Selected Total Ophthalmic Axial Length Sequence (0022,1260) and Selected Segmental Ophthalmic Axial Length Sequence (0022,1257) are used.
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	1	Reference to the quality control image associated with this measurement. Only a single Item shall be included in this Sequence. See Section C.8.25.14.1.1.6 for further explanation.
>>>Include Table C.8.25.16-6 "Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes"			
>>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	1	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>>Include Table C.8.25.14-6 "Ophthalmic Axial Length Quality Metric Macro Attributes"			
>Selected Segmental Ophthalmic Axial Length Sequence	(0022,1257)	1C	Segmental axial length measurement(s) selected for the patient's eye. One or more Items shall be included in this Sequence. Required if the value of Ophthalmic Axial Length Measurements Type (0022,1010) is present and is either SEGMENTAL LENGTH or LENGTH SUMMATION. May be present otherwise. Note In case of Ophthalmic Axial Length Measurements Type (0022,1010) has the value LENGTH SUMMATION both the Selected Total Ophthalmic Axial Length Sequence (0022,1260) and Selected Segmental Ophthalmic Axial Length Sequence (0022,1257) are used.
>>Ophthalmic Axial Length Measurements Segment Name Code Sequence	(0022,1101)	1	Name of the segment measured. See Section C.8.25.14.1.1.4 for further explanation. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4233 "Ophthalmic Axial Length Measurements Segment Names"*
>>Ophthalmic Axial Length	(0022,1019)	1	The axial length measurement, in mm. The type of measurement is specified in the Ophthalmic Axial Length Measurements Type (0022,1010). See Section C.8.25.14.1.1.3 and Section C.8.25.14.1.1.4 for further explanation.
>>Referenced Ophthalmic Axial Length Measurement QC Image Sequence	(0022,1330)	3	Reference to the quality control image associated with this measurement. Only a single Item is permitted in this Sequence. See Section C.8.25.14.1.1.6 for further explanation.
>>>Include Table C.8.25.16-6 "Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes"			
>>Ophthalmic Axial Length Quality Metric Sequence	(0022,1262)	3	Information about the quality metric applied to Ophthalmic Axial Length (0022,1019). Only a single Item is permitted in this Sequence.
>>>Include Table C.8.25.14-6 "Ophthalmic Axial Length Quality Metric Macro Attributes"			

C.8.25.14.5 Ophthalmic Axial Measurements Quality Metric Macro

Table C.8.25.14-6 describes the Attributes for the Ophthalmic Axial Length Quality Metric Macro.

Table C.8.25.14-6. Ophthalmic Axial Length Quality Metric Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Concept Name Code Sequence	(0040,A043)	1	Type of metric used to evaluate the quality of the ophthalmic axial length. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4243 "Ophthalmic Quality Metric Type"*
Numeric Value	(0040,A30A)	1	Value for quality metric applied to axial length values.
Measurement Units Code Sequence	(0040,08EA)	1	Units of Numeric Value (0040,A30A). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 82 "Units of Measurement".*

C.8.25.15 Intraocular Lens Calculations Series Module

Table C.8.25.15-1 specifies the Attributes that identify and describe general information about the Intraocular Lens Calculations Series.

Table C.8.25.15-1. Intraocular Lens Calculations Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Specific equipment on which the software that performed the calculations in this Series resides. Enumerated Values: **IOL** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.25.16 Intraocular Lens Calculations Module

Table C.8.25.16-1 defines the Attributes used to calculate the power of an intraocular lens to be placed in a patient's eye. This is typically done for both eyes for comparison, but may be for just one eye. Values used may be measurements acquired using the axial length measurements device, manually entered, or derived from a referenced SOP class or other data source.

Table C.8.25.16-1. Intraocular Lens Calculations Module Attributes

Attribute Name	Tag	Type	Attribute Description
Intraocular Lens Calculations Right Eye Sequence	(0022,1300)	1C	Calculations of intraocular lens power for a patient's right eye. One or more Items shall be included in this Sequence. Required if the device calculated intraocular lens power for the right eye. Note If Intraocular Lens Calculations Right Eye Sequence (0022,1300) is present, Measurement Laterality (0024,0113), if present, will have a value of R or B as appropriate.
>Include Table C.8.25.16-2 "Intraocular Lens Calculations Macro Attributes"			
Intraocular Lens Calculations Left Eye Sequence	(0022,1310)	1C	Calculations of intraocular lens power for a patient's left eye. One or more Items shall be included in this Sequence. Required if the device calculated intraocular lens power for the left eye. Note If Intraocular Lens Calculations Left Eye Sequence (0022,1310) is present, Measurement Laterality (0024,0113), if present, will have a value of L or B as appropriate.
>Include Table C.8.25.16-2 "Intraocular Lens Calculations Macro Attributes"			

C.8.25.16.1 Intraocular Lens Calculations Module Attributes

C.8.25.16.1.1 Referenced SOP Sequence

Data in an IOL Calculations SOP Instance will frequently be gathered from other SOP Instances, such as ophthalmic axial measurements SOP Instances or refractive measurements SOP Instances. If this occurs, a reference to the SOP Instances is desired in Attribute Referenced SOP Sequence (0008,1199).

C.8.25.16.2 Intraocular Lens Calculations Macro

Table C.8.25.16-2 describes the Attributes for the Intraocular Lens Calculations Macro.

Table C.8.25.16-2. Intraocular Lens Calculations Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Target Refraction	(0022,1037)	1	The desired postoperative refractive error, in diopters.
Refractive Procedure Occurred	(0022,1039)	2	Whether or not a patient has had refractive surgery. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Refractive Surgery Type Code Sequence	(0022,1040)	2C	Type of refractive surgery a patient has had. Zero or more Items shall be included in this Sequence. Required if the value of Refractive Procedure Occurred (0022,1039) is YES.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4234 “Refractive Surgery Types”*
Refractive Error Before Refractive Surgery Code Sequence	(0022,1103)	2C	The patient's refractive error before any of the refractive surgeries listed in Refractive Surgery Type Code Sequence (0022,1040) were performed. Zero or one Item shall be included in this Sequence. Required if the value of Refractive Procedure Occurred (0022,1039) is YES.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4238 “Refractive Error Types”*
Corneal Size Sequence	(0046,0047)	3	Corneal Size value and source. Only a single Item is permitted in this Sequence.
>Corneal Size	(0046,0046)	1	The horizontal diameter measurement of the cornea, in mm.
>Source of Corneal Size Data Code Sequence	(0022,1036)	1	Source of the value of Corneal Size (0046,0046). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Corneal Size Data Code Sequence (0022,1036) contains an Item with the value (111784, DCM, "Autorefraction Measurements SOP Instance").
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Lens Thickness Sequence	(0022,1127)	3	Lens thickness value and source. Only a single Item is permitted in this Sequence.
>Lens Thickness	(0022,1130)	1	The value for axial length of the lens in a patient's eye, in mm.
>Source of Lens Thickness Data Code Sequence	(0022,1132)	1	Source of the value of Lens Thickness (0022,1130). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*

Attribute Name	Tag	Type	Attribute Description
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Lens Thickness Data Code Sequence (0022,1132) contains an Item with the value (111782, DCM, "Axial Measurements SOP Instance").
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Anterior Chamber Depth Sequence	(0022,1128)	3	Anterior chamber depth value and source. Only a single Item is permitted in this Sequence.
>Anterior Chamber Depth	(0022,1131)	1	The value for axial length of the anterior chamber, in mm.
>Source of Anterior Chamber Depth Data Code Sequence	(0022,1133)	1	Source of the value of Anterior Chamber Depth (0022,1131). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Anterior Chamber Depth Data Code Sequence (0022,1133) contains an Item with the value (111782, DCM, "Axial Measurements SOP Instance").
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Refractive State Sequence	(0022,001B)	2	Refractive state of the imaged eye at the time of acquisition. Zero or one Item shall be included in this Sequence.
>Spherical Lens Power	(0022,0007)	1	Sphere value in diopters.
>Cylinder Lens Power	(0022,0008)	1	Cylinder value in diopters.
>Cylinder Axis	(0022,0009)	1	Axis value in degrees.
>Source of Refractive Measurements Sequence	(0022,1134)	1	Refractive measurements source. Only a single Item shall be included in this Sequence.
>>Source of Refractive Measurements Code Sequence	(0022,1135)	1	Source of values in Refractive State Sequence (0022,101B). Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*

Attribute Name	Tag	Type	Attribute Description
>>Referenced SOP Sequence	(0008,1199)	1C	SOP Instances that are relevant to the interpretation of this SOP Instance. One or more Items shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Refractive Measurements Code Sequence (0022,1135) contains an Item with the value (111783, DCM, "Refractive Measurements SOP Instance").
>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Include Table C.8.25.16-3 “Keratometry Macro Attributes”			
Cornea Measurements Sequence	(0046,0110)	3	Cornea measurement values and source. One or more Items are permitted in this Sequence.
>Include Table C.8.25.16-8 “Cornea Measurement Macro Attributes”			
>Source of Cornea Measurement Data Code Sequence	(0046,0111)	1	Source of the values of Steep Corneal Axis Sequence (0046,0112) and Flat Corneal Axis Sequence (0046,0113). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instance that is relevant to the interpretation of this SOP Instance. Only a single Item shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Cornea Measurement Data Code Sequence (0046,0111) contains an Item with the value (111757, DCM, "Keratometry Measurements SOP Instance").
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
IOL Formula Code Sequence	(0022,1028)	1	Formula used to calculate IOL power. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4236 “IOL Calculation Formula”*
IOL Formula Detail	(0022,1029)	3	A free form text description of the of the IOL Formula Code Sequence (0022,1028) (e.g., a reference to the mathematical equation).
Include Table C.8.25.16-4 “IOL Ophthalmic Axial Length Macro Attributes”			
Surgically Induced Astigmatism Sequence	(0022,1045)	3	The astigmatism that is expected to be induced by corneal incisions during cataract surgery. Only a single Item is permitted in this Sequence.
>Cylinder Power	(0046,0147)	1	The cylinder power, in diopters.
>Cylinder Axis	(0022,0009)	1	The cylinder axis, in degrees.
Include Table C.8.25.16-5 “Calculated IOL Macro Attributes”			

C.8.25.16.3 Keratometry Macro

Table C.8.25.16-3 describes the Attributes for the Keratometry Macro.

Table C.8.25.16-3. Keratometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Steep Keratometric Axis Sequence	(0046,0074)	1	Steepest meridian as defined by the greatest power of curvature and shortest radius of curvature. Only a single Item shall be included in this Sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	2	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Flat Keratometric Axis Sequence	(0046,0080)	1	Flattest meridian as defined by the least power of curvature and longest radius of curvature. Only a single Item shall be included in this Sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Keratometric Axis	(0046,0077)	2	The meridian where the keratometric radius of curvature or power is measured, in degrees.
Keratometry Measurement Type Code Sequence	(0022,1096)	2	Descriptors relevant to keratometry data. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4235 “Keratometry Descriptors”*
Keratometer Index	(0022,1033)	2	The translation factor specific to each keratometer that derives a number for power from the measured radius of curvature of the cornea.

C.8.25.16.4 IOL Ophthalmic Axial Length Macro

Table C.8.25.16-4 describes the Attributes for the IOL Ophthalmic Axial Length Macro.

Table C.8.25.16-4. IOL Ophthalmic Axial Length Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Axial Length Sequence	(0022,1012)	1	Axial length value and source that was used in calculation of IOL power. Only a single Item shall be included in this Sequence.
>Ophthalmic Axial Length	(0022,1019)	1	The axial length of a patient's eye, in mm, that was used in calculation of IOL power.
>Ophthalmic Axial Length Selection Method Code Sequence	(0022,1250)	1	Method used to select the value recorded in Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4241 “Ophthalmic Axial Length Selection Method”*
>Source of Ophthalmic Axial Length Code Sequence	(0022,1035)	1	Source of the value of Ophthalmic Axial Length (0022,1019). Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4240 “Ophthalmic Measurement or Calculation Data Source”*
>Referenced SOP Sequence	(0008,1199)	1C	SOP Instances that are relevant to the interpretation of this SOP Instance. One or more Items shall be included in this Sequence. See Section C.8.25.16.1.1 for further explanation. Required if Source of Ophthalmic Axial Length Code Sequence (0022,1035) contains an Item with the value (111782, DCM, "Axial Measurements SOP Instance").
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Ophthalmic Ultrasound Method Code Sequence	(0022,1044)	1C	Method used for obtaining axial measurements of the eye. Required if Ophthalmic Axial Measurements Device Type (0022,1009) is ULTRASOUND. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4230 “Ophthalmic Ultrasound Axial Measurements Type”*

C.8.25.16.5 Calculated IOL Macro

Table C.8.25.16-5 describes the Attributes for the Calculated IOL Macro.

Table C.8.25.16-5. Calculated IOL Macro Attributes

Attribute Name	Tag	Type	Attribute Description
IOL Manufacturer	(0022,1093)	1	Name of the manufacturer that produced the lens.
Implant Name	(0022,1095)	1	The (product) name of the lens.
Type of Optical Correction	(0022,1046)	3	Type of the optical correction achieved by the IOL. Enumerated Values: **SPHERICAL** **TORIC**
Lens Constant Sequence	(0022,1092)	1	Constants used in calculation of intraocular lens power. These constants are a characteristic of the model of intraocular lens being considered for use in cataract surgery. One or more Items shall be included in this Sequence.
>Concept Name Code Sequence	(0040,A043)	1	Constant type used in calculation of intraocular lens power. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4237 “Lens Constant Type”*
>Numeric Value	(0040,A30A)	1	The value of the constant used.
IOL Power Sequence	(0022,1090)	1	Information needed to select the intraocular lens power for cataract surgery. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>IOL Power	(0022,1053)	1	The intraocular lens power, in diopters. If Type of Optical Correction (0022,1046) is TORIC, this value represents the spherical equivalent of the toric intraocular lens power.
>Toric IOL Power Sequence	(0022,1047)	1C	The toric intraocular lens power. Only a single Item shall be included in this Sequence. Required if Type of Optical Correction (0022,1046) is TORIC.
>>Include Table C.8.25.16-7 "Calculated Toric Power Macro Attributes"			
>Predicted Refractive Error	(0022,1054)	1	The predicted postoperative refractive error (i.e., amount of near or far sightedness), in diopters.
>Predicted Toric Error Sequence	(0022,1048)	1C	The predicted postoperative toric error. Only a single Item shall be included in this Sequence. Required if Type of Optical Correction (0022,1046) is TORIC.
>>Include Table C.8.25.16-7 "Calculated Toric Power Macro Attributes"			
>Implant Part Number	(0022,1097)	2	The (product) identifier of the lens.
>Pre-Selected for Implantation	(0022,1049)	3	Indicates whether the intraocular lens specified by this Sequence Item has been pre-selected for implantation or not. Enumerated Values: **YES** **NO** Only one Item in IOL Power Sequence (0022,1090) shall contain the value YES.
IOL Power for Exact Emmetropia	(0022,1121)	2	The IOL power that would be required to achieve exact emmetropia, or no need for glasses at distance after surgery, in diopters. If Type of Optical Correction (0022,1046) is TORIC, this value represents the spherical equivalent of the toric intraocular lens power for exact emmetropia.
Toric IOL Power for Exact Emmetropia Sequence	(0022,104A)	2C	The toric IOL power that would be required to achieve exact emmetropia. Zero or one Item shall be included in this Sequence. Required if Type of Optical Correction (0022,1046) is TORIC.
>Include Table C.8.25.16-7 "Calculated Toric Power Macro Attributes"			
IOL Power for Exact Target Refraction	(0022,1122)	2	The IOL power that would be required to exactly achieve Target Refraction (0022,1037), in diopters. If Type of Optical Correction (0022,1046) is TORIC, this value represents the spherical equivalent of the toric intraocular lens power for exact target refraction.

Attribute Name	Tag	Type	Attribute Description
Toric IOL Power for Exact Target Refraction Sequence	(0022,104B)	2C	The toric IOL power that would be required to exactly achieve Target Refraction (0022,1037). Zero or one Item shall be included in this Sequence. Required if Type of Optical Correction (0022,1046) is TORIC.
>Include Table C.8.25.16-7 "Calculated Toric Power Macro Attributes"			
Calculation Comment Sequence	(0022,112A)	3	Comment, hints or warnings related to the intraocular lens calculation(s). One or more Items are permitted in this Sequence. See Section C.8.25.16.5.1.
>Calculation Comment Type	(0022,112B)	1	The type of the Calculation Comment (0022,112C). Defined Terms: **INFORMATIVE** **WARNING**
>Calculation Comment	(0022,112C)	1	Comment related to the intraocular lens calculation(s).

C.8.25.16.5.1 Calculated IOL Macro Attributes ~~Attributes~~

C.8.25.16.5.1 Calculation Comment Sequence

Specific behaviors associated with Calculation Comment Type (0022,112B) are left to implementations to define. For example, the user might be expected to be notified about a comment with a type of WARNING whereas they might have to seek out comments with a type of INFORMATIVE. However, since this is an optional Attribute, and one that was added to this Module after its original definition, and there are no SOP Class specific constraints on display behavior, the sender cannot be guaranteed that a receiving system or user will not ignore or discard the comments.

C.8.25.16.6 Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro

Table C.8.25.16-6 describes the Attributes for the Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro

Table C.8.25.16-6. Ophthalmic Axial Measurements Quality Image SOP Instance Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class. Enumerated Values: **1.2.840.10008.5.1.4.1.1.7.2** Multi-frame Grayscale Byte Secondary Capture Image Storage **1.2.840.10008.5.1.4.1.1.7.4** Multi-frame True Color Secondary Capture Image Storage
Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.

Attribute Name	Tag	Type	Attribute Description
Referenced Frame Number	(0008,1160)	1	Identifies the frame number within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Only a single value shall exist. Note This Attribute is a multi-value field but for this Macro it can only contain one value.

C.8.25.16.7 Calculated Toric Power Macro

Table C.8.25.16-7 specifies and describes the attributes that identify the toric amount of calculated refractive power used in IOL calculation.

Table C.8.25.16-7. Calculated Toric Power Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Sphere Power	(0046,0146)	3	The calculated spherical power, in diopters.
Cylinder Power	(0046,0147)	1	The calculated cylinder power, in diopters.
Cylinder Axis	(0022,0009)	1	The calculated cylinder axis, in degrees.

C.8.25.16.8 Cornea Measurement Macro

Table C.8.25.16-8 specifies and describes the attributes for the Cornea Measurement Macro used in IOL calculation.

Table C.8.25.16-8. Cornea Measurement Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Steep Corneal Axis Sequence	(0046,0112)	1	Steepest meridian as defined by the greatest power of curvature and shortest radius of curvature. Only a single Item shall be included in this Sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Corneal Power	(0046,0114)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Corneal Axis	(0046,0115)	2	The meridian where the radius of curvature or corneal power is measured, in degrees.
Flat Corneal Axis Sequence	(0046,0113)	1	Flattest meridian as defined by the least power of curvature and longest radius of curvature. Only a single Item shall be included in this Sequence.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridians of the cornea, measured in mm.
>Corneal Power	(0046,0114)	2	The refractive power of the cornea at the principal meridians, measured in diopters.
>Corneal Axis	(0046,0115)	2	The meridian where the radius of curvature or corneal power is measured, in degrees.
Cornea Measurement Method Code Sequence	(0046,0116)	1	Method of the cornea measurement. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4242 “Cornea Measurement Method Descriptors”*
Keratometer Index	(0022,1033)	2	The translation factor specific to each keratometer that derives a number for power from the measured radius of curvature of the cornea.
Refractive Index of Cornea	(0046,0117)	1C	The refractive translation factor specific for the cornea when deriving a number of power from the measured radius of curvature of the posterior surface of cornea. Required if Cornea Measurement Type Code Sequence (0046,0116) contains an item with the value (DCM, 111759, "Posterior Cornea Surface Measurement").
Refractive Index of Aqueous Humor	(0046,0118)	1C	The refractive translation factor specific for the aqueous humor when deriving a number of power from the measured radius of curvature of the posterior surface of cornea. Required if Cornea Measurement Type Code Sequence (0046,0116) contains an item with the value (DCM, 111759, "Posterior Cornea Surface Measurement").

C.8.26 Visual Field Static Perimetry Measurements Modules

C.8.26.1 Visual Field Static Perimetry Measurements Series Module

Table C.8.26.1-1 specifies the Attributes that identify and describe general information about the Visual Field Static Perimetry Measurements Series.

Table C.8.26.1-1. Visual Field Static Perimetry Measurements Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the measurements in this Series. Enumerated Values: **OPV** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-9 “Request Attributes Macro Attributes”			*In this Module Reason for Requested Procedure Code Sequence (0040,100A) has the DCID 4256 “Visual Field Procedure Modifier”.* Note Reason for Requested Procedure Code Sequence (0040,100A) may be used to provide whether the test in the Series was taken for screening or diagnostic (quantitative) purposes. *In this Module Scheduled Protocol Code Sequence (0040,0008) has the Defined CIDs 4250 and 4251.* Note Scheduled Protocol Code Sequence (0040,0008) may be used to provide test pattern and test strategy. *No Baseline CIDs are defined for other Attributes.*
Include Table 10-16 “Performed Procedure Step Summary Macro Attributes”			*In this Module Attribute Performed Protocol Code Sequence (0040,0260) is Type 1 and the DCID 4250 “Visual Field Static Perimetry Test Patterns” and CID 4251 “Visual Field Static Perimetry Test Strategies”.* Note Performed Protocol Code Sequence (0040,0260) is used to provide test pattern and test strategy. *In this Module Attribute Protocol Context Sequence (0040,0440) is Type 1 and the DCID 4256 “Visual Field Procedure Modifier”.* Note Protocol Context Sequence (0040,0440) is used to provide whether the test in the Series were taken for screening or diagnostic purposes. *No Baseline CIDs are defined for other Attributes.*

C.8.26.2 Visual Field Static Perimetry Test Parameters Module

Table C.8.26.2-1 defines the Attributes used to represent the parameters used during a patient's visual field test.

Table C.8.26.2-1. Visual Field Static Perimetry Test Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Visual Field Horizontal Extent	(0024,0010)	1	The maximum horizontal angular subtend (diameter or width) of the tested visual field, in degrees.
Visual Field Vertical Extent	(0024,0011)	1	The maximum vertical angular subtend (diameter or height) of the tested visual field, in degrees.
Visual Field Shape	(0024,0012)	1	The shape of the visual field tested. Defined Terms: **RECTANGLE** **CIRCLE** **ELLIPSE**

Attribute Name	Tag	Type	Attribute Description
Screening Test Mode Code Sequence	(0024,0016)	1C	Mode used to determine how the starting luminance values and expected thresholds are chosen. Only a single Item shall be included in this Sequence. Required if Content Item Modifier Sequence (0040,0441) within Performed Protocol Code Sequence (0040,0260) contains an Item with the value (360156006, SCT, "Screening"). May be present otherwise.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4252 “Visual Field Static Perimetry Screening Test Modes”*
Maximum Stimulus Luminance	(0024,0018)	1	Maximum luminance of stimulus, in candelas per square meter (cd/m²).
Background Luminance	(0024,0020)	1	Background luminance of the device, in candelas per square meter (cd/m²). Note This value is easily convertible to apostilb, which is used only in perimetry and is not a standardized unit.
Stimulus Color Code Sequence	(0024,0021)	1	Color of light stimulus presented to the patient. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4255 “Visual Field Illumination Color”*
Background Illumination Color Code Sequence	(0024,0024)	1	Color of the background illumination of the visual field device. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4255 “Visual Field Illumination Color”*
Stimulus Area	(0024,0025)	1	Area of light stimulus presented to the patient, in degrees squared.
Stimulus Presentation Time	(0024,0028)	1	The duration of time that a light stimulus is presented to a patient per each individual test point, in milliseconds. Note This time is the same for each stimulus presentation.

C.8.26.3 Visual Field Static Perimetry Test Reliability Module

Table C.8.26.3-1 defines the Attributes used to represent the test reliability parameters determined during a patient's visual field test.

Table C.8.26.3-1. Visual Field Static Perimetry Test Reliability Module Attributes

Attribute Name	Tag	Type	Attribute Description
Fixation Sequence	(0024,0032)	1	The patient's gaze stability information during the visual field test. Only a single Item shall be included in this Sequence.
>Fixation Monitoring Code Sequence	(0024,0033)	1	The device strategy used to monitor the patient's fixation. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4253 “Visual Field Static Perimetry Fixation Strategy”.*

Attribute Name	Tag	Type	Attribute Description
>Fixation Checked Quantity	(0024,0035)	1C	The number of times that the patient's gaze fixation is checked. Required if Fixation Monitoring Code Sequence (0024,0033) contains an Item with the value (111844, DCM, "Blind Spot Monitoring") or (111845, DCM, "Macular Fixation Testing"). May be present otherwise.
>Patient Not Properly Fixated Quantity	(0024,0036)	1C	The number of times the patient's gaze is not properly fixated. Required if Fixation Monitoring Code Sequence (0024,0033) contains an Item with the value (111844, DCM, "Blind Spot Monitoring") or (111845, DCM, "Macular Fixation Testing"). May be present otherwise.
>Excessive Fixation Losses Data Flag	(0024,0039)	1	Whether the device was able to determine excessive fixation losses. Enumerated Values: **YES** **NO**
>Excessive Fixation Losses	(0024,0040)	1C	The number of fixation losses is outside of implementation-specific limits. Enumerated Values: **YES** **NO** Required if Excessive Fixation Losses Data Flag (0024,0039) is YES.
Visual Field Catch Trial Sequence	(0024,0034)	1	The reliability of the patient's responses to the visual field test. Only a single Item shall be included in this Sequence.
>Catch Trials Data Flag	(0024,0055)	1	Whether catch trials data were performed. Enumerated Values: **YES** **NO**
>Negative Catch Trials Quantity	(0024,0048)	1C	Total number of times the patient's visual attention was tested using stimuli brighter than previously seen luminance (negative catch trials). Required if Catch Trials Data Flag (0024,0055) is YES.
>False Negatives Quantity	(0024,0050)	1C	Total number of stimuli that were not seen by the patient but were previously seen at a lower luminance earlier in the visual field test (false negatives). Required if Catch Trials Data Flag (0024,0055) is YES.
>False Negatives Estimate Flag	(0024,0045)	1	Whether the device was able to estimates false negatives. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
>False Negatives Estimate	(0024,0046)	1C	Estimated percentage of all stimuli that were not seen by the patient but were previously seen at a lower luminance earlier in the visual field test (false negative responses), as percent. Required if False Negatives Estimate Flag (0024,0045) is YES.
>Excessive False Negatives Data Flag	(0024,0051)	1	Whether the device was able to determine excessive false negatives. Enumerated Values: **YES** **NO**
>Excessive False Negatives	(0024,0052)	1C	The false negative estimate is outside of implementation-specific limits. Enumerated Values: **YES** **NO** Required if Excessive False Negatives Data Flag (0024,0051) is YES.
>Positive Catch Trials Quantity	(0024,0056)	1C	The total number of times the device behaved as if it was going to present a visual stimulus but did not actually present the stimulus (positive catch trials). Required if Catch Trials Data Flag (0024,0055) is YES.
>False Positives Quantity	(0024,0060)	1C	The total number of patient responses that occurred at a time when no visual stimulus was present (false positive responses). Required if Catch Trials Data Flag (0024,0055) is YES.
>False Positives Estimate Flag	(0024,0053)	1	Whether the device was able to estimate false positives. Enumerated Values: **YES** **NO**
>False Positives Estimate	(0024,0054)	1C	Estimated percentage of all patient responses that occurred at a time when no visual stimulus was present (false positive responses), as percent. Required if False Positives Estimate Flag (0024,0053) is YES.
>Excessive False Positives Data Flag	(0024,0061)	1	Whether the device was able to determine excessive false positives. Enumerated Values: **YES** **NO**
>Excessive False Positives	(0024,0062)	1C	The false positive estimate is outside of implementation-specific limit. Enumerated Values: **YES** **NO** Required if Excessive False Positives Data Flag (0024,0061) is YES.

Attribute Name	Tag	Type	Attribute Description
Stimuli Retesting Quantity	(0024,0042)	3	Total number of times in the course of a visual field exam that any location had to be retested at the same magnitude. Note An example is that the patient received 20 stimuli and blinked twice, therefore need to present the stimuli two additional times in which case the value is 2.
Patient Reliability Indicator	(0024,0069)	3	Vendor implementation specific text to provide an analysis and/or summary of patient reliability indicator/indices.
Comments on Patient's Performance of Visual Field	(0024,0044)	3	Operator's (test administrator) subjective comment on patient's performance.
Visual Field Test Reliability Global Index Sequence	(0024,0317)	3	Information about various visual field indices related to test reliability. One or more Items are permitted in this Sequence.
>Include Table C.8.26.3-2 "Ophthalmic Visual Field Global Index Macro Attributes"			

C.8.26.3.1 Ophthalmic Visual Field Global Index Macro

Table C.8.26.3-2 describes the Attributes for the Ophthalmic Visual Field Global Index Macro.

Table C.8.26.3-2. Ophthalmic Visual Field Global Index Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Data Observation Sequence	(0024,0325)	1	Information about various visual field global indexes. Only a single Item shall be included in this Sequence.
>Include Table 10-2 "Content Item Macro Attributes Description"			*Value Type (0040,A040) shall be NUMERIC or CODE.* *Concept Name Code Sequence (0040,A043) DCID 4257 "Visual Field Global Index Name".* *Concept Code Sequence (0040,A168) DCID 4254 "Visual Field Static Perimetry Test Analysis Results".*
Index Normals Flag	(0024,0338)	1	Whether normative data exists for this index. Enumerated Values: **YES** **NO**
Index Probability Sequence	(0024,0344)	1C	Probability value and software algorithm used to provide the index. Only a single Item shall be included in this Sequence. Required if Index Normals Flag (0024,0338) is YES.
>Index Probability	(0024,0341)	1	Probability for the index value within the normal population, in percent.
>Include Table 10-19 "Algorithm Identification Macro Attributes"			

C.8.26.4 Visual Field Static Perimetry Test Measurements Module

Table C.8.26.4-1 defines the Attributes used to represent the test measurement values determined during a patient's visual field test.

Table C.8.26.4-1. Visual Field Static Perimetry Test Measurements Module Attributes

Attribute Name	Tag	Type	Attribute Description
Measurement Laterality	(0024,0113)	1	Laterality of body part (eye) examined. See Section C.8.26.4.1.1 for further explanation. Enumerated Values: **R** right **L** left **B** both left and right together Note This Attribute is mandatory, in order to ensure that measurements may be positioned correctly relative to one another for display. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Measurements in the Series, hence it must be absent if multiple instances from different eyes are encoded.
Presented Visual Stimuli Data Flag	(0024,0037)	1	Whether the device was able to determine presented visual stimuli. Enumerated Values: **YES** **NO**
Number of Visual Stimuli	(0024,0038)	1C	The total number of visual stimuli presented to the patient. This includes the number of stimuli repetitions. Required if Presented Visual Stimuli Data Flag (0024,0037) is YES.
Visual Field Test Duration	(0024,0088)	1	Total time the visual field machine was actively presenting visual stimuli to patient, in seconds.
Foveal Sensitivity Measured	(0024,0086)	1	Whether foveal sensitivity was measured. Enumerated Values: **YES** **NO**
Foveal Sensitivity	(0024,0087)	1C	Foveal Sensitivity is the reciprocal of foveal threshold (1/foveal threshold), in dB. Foveal Threshold is the minimum amount of luminance increment on a uniform background that can be detected by the patient at coordinates 0,0 (relative to the center of the patient's fixation). See Section C.8.26.4.1.2 for further explanation. Required if the value for Foveal Sensitivity Measured (0024,0086) is YES.
Foveal Point Normative Data Flag	(0024,0117)	1	Existence of normative data base for the foveal point sensitivity. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Foveal Point Probability Value	(0024,0118)	1C	The percentile of the foveal point sensitivity within an age corrected normal visual field, in percent. Required if the value for Foveal Sensitivity Measured (0024,0086) is YES and Foveal Point Normative Data Flag (0024,0117) is YES.
Screening Baseline Measured	(0024,0120)	1	Whether visual field screening baseline was measured. Enumerated Values: **YES** **NO**
Screening Baseline Measured Sequence	(0024,0122)	1C	Information about the starting luminance screening values. One or more Items shall be included in this Sequence. Required if the value for Screening Baseline Measured (0024,0120) is YES.
>Screening Baseline Type	(0024,0124)	1	Method used to determine starting luminance screening values. Enumerated Values: **CENTRAL** **PERIPHERAL**
>Screening Baseline Value	(0024,0126)	1	Visual Field screening baseline value, in dB.
Blind Spot Localized	(0024,0106)	1	Whether the blind spot was measured. Enumerated Values: **YES** **NO**
Blind Spot X-Coordinate	(0024,0107)	1C	The horizontal coordinate of the patient's blind spot relative to the center of the patient's fixation, in degrees, such that toward the right is positive. Required if the value for Blind Spot Localized (0024,0106) is YES. See Section C.8.26.4.1.3 for further explanation.
Blind Spot Y-Coordinate	(0024,0108)	1C	The vertical coordinate of the patient's blind spot relative to the center of the patient fixation, in degrees, such that up is positive. Required if the value for Blind Spot Localized (0024,0106) is YES. See Section C.8.26.4.1.3 for further explanation.
Minimum Sensitivity Value	(0024,0105)	1	The minimum sensitivity value generated by the equipment used for this visual field test, in dB.
Test Point Normals Data Flag	(0024,0057)	1	Existence of normative data base for at least one of the test points in this set of test points. Enumerated Values: **YES** **NO**
Test Point Normals Sequence	(0024,0058)	1C	Normative data base used for this test sequence. Only a single Item shall be included in this Sequence. Required if Test Point Normals Data Flag (0024,0057) is YES.

Attribute Name	Tag	Type	Attribute Description
>Include Table 10-22 “Externally-Sourced Data Set Identification Macro Attributes”			
Age Corrected Sensitivity Deviation Algorithm Sequence	(0024,0065)	1C	Software algorithm used to provide the probability that the age corrected sensitivity deviation values at each test point belong to a normal visual field. Only a single Item shall be included in this Sequence. Required if Test Point Normals Data Flag (0024,0057) is YES.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			
Generalized Defect Sensitivity Deviation Algorithm Sequence	(0024,0067)	1C	Software algorithm used to provide the probability that the sensitivity deviation values at each test point belong to a normal visual field. Only a single Item shall be included in this Sequence. Required if Test Point Normals Data Flag (0024,0057) is YES.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			
Visual Field Test Point Sequence	(0024,0089)	1	Information for each test point in the visual field. One or more Items shall be included in this Sequence.
>Visual Field Test Point X-Coordinate	(0024,0090)	1	The horizontal coordinate of a single test point relative to the center of the patient fixation, in degrees, such that toward the right is positive.
>Visual Field Test Point Y-Coordinate	(0024,0091)	1	The vertical coordinate of a single test point relative to the center of the patient fixation, in degrees, such that up is positive.
>Stimulus Results	(0024,0093)	1	Whether the patient saw a stimulus presented at a luminance other than maximum, a presentation at maximum luminance, or did not see any presented stimulus. Enumerated Values: **SEEN** stimulus seen at a luminance value less than maximum **NOT SEEN** stimulus not seen **SEEN AT MAX** stimulus seen at the maximum luminance possible for the instrument Note SEEN AT MAX is a value only relevant to Screening tests.
>Sensitivity Value	(0024,0094)	1C	If Stimulus Results (0024,0093) is SEEN then this value is the sensitivity, in dB. Required if Content Item Modifier Sequence (0040,0441) within Performed Protocol Code Sequence (0040,0260) contains an Item with the value (261004008, SCT, "Diagnostic"). May be present otherwise. Note If this is not present, refer to the Attribute Minimum Sensitivity Value (0024,0105).
>Retest Stimulus Seen	(0024,0095)	3	Whether the retested stimulus presented was seen by the patient. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
>Retest Sensitivity Value	(0024,0096)	3	If the Retest Stimulus Seen (0024,0095) is YES, then this value is the sensitivity, in dB. Note If this is not present, refer to the Attribute Minimum Sensitivity Value (0024,0105).
>Quantified Defect	(0024,0098)	3	Difference between the expected and the determined sensitivity, each in dB. Note This field is only useful when the sensitivity is quantified. Some examples include Test Strategy Code Sequence (0024,0015) with Items providing values such as Quantity-Defects, 2LT-Dynamic, 2LT-Normal.
>Visual Field Test Point Normals Sequence	(0024,0097)	2C	Information about normal values for each visual field test point. Zero or more Items shall be included in this Sequence. May be empty if there is no normative data for this test point. Required if Test Point Normals Data Flag (0024,0057) is YES.
>>Age Corrected Sensitivity Deviation Value	(0024,0092)	1	Difference between the patient's local sensitivity and the age corrected normal sensitivity, in dB.
>>Age Corrected Sensitivity Deviation Probability Value	(0024,0100)	1	The percentile of the age corrected sensitivity deviation within the normal population of visual field, in percent.
>> Generalized Defect Corrected Sensitivity Deviation Flag	(0024,0102)	1	Whether generalized defect corrected data are available for this point. Enumerated Values: **YES** **NO**
>>Generalized Defect Corrected Sensitivity Deviation Value	(0024,0103)	1C	The age corrected sensitivity deviation after correction for the Generalized Defect, in dB. Generalized defect is proportional to the loss in sensitivity shared by all points in the visual field. Required if Generalized Defect Corrected Sensitivity Deviation Flag (0024,0102) is YES.
>>Generalized Defect Corrected Sensitivity Deviation Probability Value	(0024,0104)	1C	The percentile of the generalized defect corrected sensitivity deviation within the normal population of visual field, in percent. Required if Generalized Defect Corrected Sensitivity Deviation Flag (0024,0102) is YES.

C.8.26.4.1 Visual Field Static Perimetry Test Measurement Attribute Descriptions

C.8.26.4.1.1 Measurement Laterality

When B (both left and right together) eyes are provided for Measurement Laterality (0024,0113) it shall mean that both eyes are open during the test (binocular). It shall not be used to provide two monocular tests (i.e., one for the left eye and one for the right). Two monocular tests require two SOP Instances and two monocular tests with one binocular test require three SOP Instances.

C.8.26.4.1.2 Foveal Sensitivity

For Foveal Sensitivity (0024,0087), the terminology commonly used for perimetric measurements is employed, with reference to visual thresholds designated by a decibel (dB) scale. The decibel scale for conventional perimetry is based on the maximum stimulus luminance that can be superimposed on a uniform background, and it is given a value of 0 dB of sensitivity. Sensitivity is the inverse

of threshold (sensitivity = 1/threshold) and vice versa. In other disciplines, visual threshold is usually defined by the probability of seeing a difference in luminance, brightness, hue or saturation, or a difference in some other attribute exhibited by a given set of stimuli. As such, a threshold is usually described in terms of the minimum amount of luminance, contrast, hue or other attribute that can be minimally detected. However, many sources that refer to perimetry have described threshold in terms of decibel (dB) values rather than attributing the dB measures to sensitivity. It would be advisable to check each individual device to determine how dB is defined.

C.8.26.4.1.3 Blind Spot X and Y Coordinates

For Blind Spot X-Coordinate (0024,0107) and Blind Spot Y-Coordinate (0024,0108), the convention described below for the Cartesian coordinate system specifies that to the right is positive on the x axis and up is positive on the Y axis. Figure C.8.26.4.1-1 illustrates how visual fields are displayed in standard format with the temporal visual field from the right eye displayed to the right and the nasal visual field from the right eye to the left.

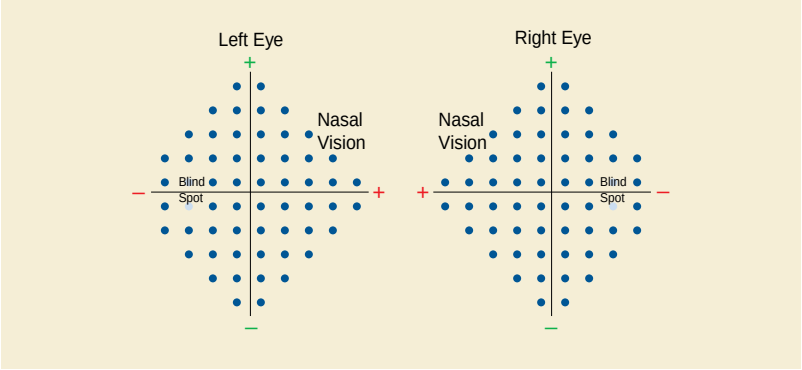


Figure C.8.26.4.1-1. Convention of coordinate system used in visual field representation.

C.8.26.5 Visual Field Static Perimetry Test Results Module

Table C.8.26.5-1 defines the Attributes used to interpret the test results of a patient's visual field test.

Table C.8.26.5-1. Visual Field Static Perimetry Test Results Module Attributes

Attribute Name	Tag	Type	Attribute Description
Visual Field Mean Sensitivity	(0024,0070)	1C	Average sensitivity of the test points of the visual field, in dB. Required if Content Item Modifier Sequence (0040,0441) within the Performed Protocol Code Sequence (0040,0260) contains an Item with the value (261004008, SCT, "Diagnostic"). May be present otherwise.
Visual Field Test Normals Flag	(0024,0063)	1	Whether normals exist for this patient's results. Enumerated Values: **YES** **NO**
Results Normals Sequence	(0024,0064)	1C	Information that represents the statistically normal results for patients from a referenced data base. Only a single Item shall be included in this Sequence. Required if Visual Field Test Normals Flag (0024,0063) is YES.
>Include Table 10-22 “Externally-Sourced Data Set Identification Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Global Deviation from Normal	(0024,0066)	1	Weighted average deviation from the age corrected normal field, in dB.
>Global Deviation Probability Normals Flag	(0024,0059)	1	Whether normals exist for the global deviation probability. Enumerated Values: **YES** **NO**
>Global Deviation Probability Sequence	(0024,0083)	1C	Probability value and software algorithm used to provide the normality for the global deviation. Only a single Item shall be included in this Sequence. Required if Global Deviation Probability Normals Flag (0024,0059) is YES.
>>Global Deviation Probability	(0024,0071)	1	The percentile of the Global Deviation from Normal (0024,0066) value within the normal population, in percent.0024
>>Include Table 10-19 “Algorithm Identification Macro Attributes”			
>Localized Deviation From Normal	(0024,0068)	1	Weighted square root of loss variance, in dB.
>Local Deviation Probability Normals Flag	(0024,0072)	1	Whether normals exist for the local deviation probability. Enumerated Values: **YES** **NO**
>Localized Deviation Probability Sequence	(0024,0085)	1C	Probability value and software algorithm used to provide the normality for the local deviation. Only a single Item shall be included in this Sequence. Required if Local Deviation Probability Normals Flag (0024,0072) is YES.
>>Localized Deviation Probability	(0024,0073)	1	The percentile of the Localized Deviation From Normal (0024,0068) value within the normal population, in percent.
>>Include Table 10-19 “Algorithm Identification Macro Attributes”			
Short Term Fluctuation Calculated	(0024,0074)	1	Whether the short term fluctuation was calculated. Enumerated Values: **YES** **NO**
Short Term Fluctuation	(0024,0075)	1C	Average deviation of sensitivity for the repeated test locations, in dB. This is used to determine the consistency of the patient's responses. Required if Short Term Fluctuation Calculated (0024,0074) is YES.
Short Term Fluctuation Probability Calculated	(0024,0076)	1	Whether the short term fluctuation probability was calculated. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
Short Term Fluctuation Probability	(0024,0077)	1C	The percentile of the Short Term Fluctuation (0024,0075) value within the normal population, in percent. Required if Short Term Fluctuation Probability Calculated (0024,0076) is YES.
Corrected Localized Deviation From Normal Calculated	(0024,0078)	1	Whether the corrected localized deviation from normal was calculated. Enumerated Values: **YES** **NO**
Corrected Localized Deviation From Normal	(0024,0079)	1C	Weighted square root of loss variance corrected for short term fluctuation, in dB. Required if Corrected Localized Deviation From Normal Calculated (0024,0078) is YES.
Corrected Localized Deviation From Normal Probability Calculated	(0024,0080)	1	Whether the corrected localized deviation from Normal probability was calculated. Enumerated Values: **YES** **NO**
Corrected Localized Deviation From Normal Probability	(0024,0081)	1C	The percentile of the Corrected Localized Deviation From Normal (0024,0079) value within the normal population, in percent. Required if Corrected Localized Deviation From Normal Probability Calculated (0024,0080) is YES.
Visual Field Global Results Index Sequence	(0024,0320)	3	Information about various visual field indexes related to test results. One or more Items are permitted in this Sequence.
>Include Table C.8.26.3-2 “Ophthalmic Visual Field Global Index Macro Attributes”			

C.8.26.6 Ophthalmic Patient Clinical Information and Test Lens Parameters Module

Table C.8.26.6-1 defines the Attributes used to represent a patient's clinical parameters during an ophthalmic test.

Table C.8.26.6-1. Ophthalmic Patient Clinical Information and Test Lens Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Patient Clinical Information Left Eye Sequence	(0024,0114)	1C	Information used to represent a patient's clinical parameters during an ophthalmic test. Only a single Item shall be included in this Sequence. Required if Measurement Laterality (0024,0113) is L or B.
>Include Table C.8.26.6-2 “Ophthalmic Patient Clinical Information and Test Lens Parameters Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Patient Clinical Information Right Eye Sequence	(0024,0115)	1C	Information used to represent a patient's clinical parameters during an ophthalmic test. Only a single Item shall be included in this Sequence. Required if Measurement Laterality (0024,0113) is R or B.
>Include Table C.8.26.6-2 “Ophthalmic Patient Clinical Information and Test Lens Parameters Macro Attributes”			

C.8.26.6.1 Ophthalmic Patient Clinical Information and Test Lens Parameters Macro

Table C.8.26.6-2 describes the Attributes for the Ophthalmic Patient Clinical and Test Lens Parameters Macro.

Table C.8.26.6-2. Ophthalmic Patient Clinical Information and Test Lens Parameters Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Refractive Parameters Used on Patient Sequence	(0024,0112)	2	Refractive parameters used when performing visual field test. Zero or one Item shall be included in this Sequence.
>Spherical Lens Power	(0022,0007)	1	Sphere value in diopters.
>Cylinder Lens Power	(0022,0008)	1	Cylinder value in diopters.
>Cylinder Axis	(0022,0009)	1	Axis value in degrees.
Pupil Size	(0046,0044)	2	The horizontal diameter measurement of the pupil, in mm.
Pupil Dilated	(0022,000D)	2	The patient's pupils were pharmacologically dilated for this acquisition. Enumerated Values: **YES** **NO** If this Attribute is empty, no information is available.
Intra Ocular Pressure	(0022,000B)	3	Value of intraocular pressure in mmHg.
Visual Acuity Measurement Sequence	(0024,0110)	3	Measurements of a patient's visual acuity. Only a single Item is permitted in this Sequence.
>Include Table C.8.25.12-2 “Visual Acuity Measurements Macro Attributes”			

C.8.27 Intravascular Optical Coherence Tomography Modules

C.8.27.1 Intravascular OCT Series Module

Table C.8.27.1-1 specifies the Attributes that identify and describe general information about the Intravascular Optical Coherence Tomography Series.

Table C.8.27.1-1. Intravascular OCT Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **IVOCT** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Referenced SOP Class UID	(0008,1150)	1	Uniquely identifies the referenced SOP Class.
>Referenced SOP Instance UID	(0008,1155)	1	Uniquely identifies the referenced SOP Instance.
Presentation Intent Type	(0008,0068)	1	Identifies the intent of the images that are contained within this Series. Enumerated Values: **FOR PRESENTATION** **FOR PROCESSING**

C.8.27.1.1 Intravascular OCT Series Attribute Descriptions

C.8.27.1.1.1 Presentation Intent Type

Presentation Intent Type (0008,0068) identifies the intent for the purposes of display or other presentation of all Images within this Series.

Note

1. Since this is a Series level Attribute, all Images within a Series have the same value for this Attribute.
2. The intent of this restriction is to ensure that FOR PRESENTATION and FOR PROCESSING images are placed in separate Series, so that no confusion can arise as to which images are suitable for diagnostic reading as determined by local policy.

A Series of Images intended for viewing by an observer shall have an Enumerated Value of FOR PRESENTATION. The value shall not be set to FOR PRESENTATION unless Z Offset correction, refractive index correction and polar to rectangular conversion have been applied

Images or individual frames of a FOR PRESENTATION image shall reference their associated source FOR PROCESSING frames, if any exist, using the Derivation Image Functional Group Macro, with the Derivation Code (113093, DCM, "Polar to Rectangular Scan Conversion") and the Purpose of Reference Code (121358, DCM, "For Processing Image").

Note

1. FOR PRESENTATION images are still be of Image Type (0008,0008) and Frame Type (0008,9007) ORIGINAL rather than DERIVED despite having undergone processing, such as corrections for Z Offset, Refractive index and Polar to Rectangular conversion. In this case a DERIVED image would have undergone yet further processing to make it substantially different from the original. See Figure C.8.27-1. The Derivation Image Functional Group Macro may be used even if Image Type (0008,0008) and Frame Type (0008,9007) is ORIGINAL.

2. FOR PRESENTATION images may still be subjected to processing or further processing, if appropriate, depending on the application.

3. FOR PRESENTATION images are intended for display on a device, without (further) processing, since that device may not be capable of image processing. The quality of the displayed image or its suitability for any purpose is beyond the scope of the DICOM Standard.

4. If all of the frames of a FOR PRESENTATION image are created by processing all of the frames of a FOR PROCESSING image, then a reference to the FOR PROCESSING SOP Instance only, without reference to specific frame numbers, in the Shared Functional Group Sequence avoids the need for a frame-by-frame reference in each Per-Frame Functional Group, though there is no requirement that the order of the frames or the number of frames in the FOR PROCESSING and FOR PRESENTATION SOP Instances correspond.

FOR PROCESSING images may have Z Offset correction applied to the A-line data and/or Refractive Index applied to A-line Pixel Spacing (0052,0014). However, due to irreversible loss of information, images that have had Polar to Rectangular scan conversion applied shall not be stored as FOR PROCESSING images.

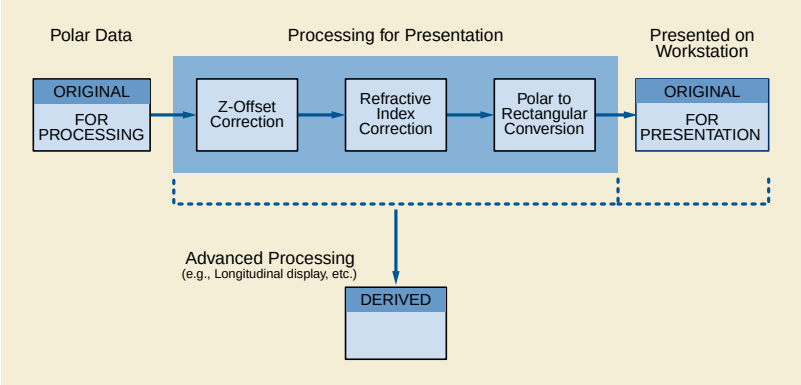


Figure C.8.27-1. Explanation of Presentation Intent Type

C.8.27.2 Intravascular OCT Image Module

Table C.8.27.2-1 specifies the Attributes that describe an Image produced by Intravascular OCT imaging modalities.

Table C.8.27.2-1. Intravascular OCT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.27.2.1 for specialization.
Volumetric Properties	(0008,9206)	1	Indication if geometric manipulations are possible with frames in the SOP Instance. See Section C.8.27.2.2.
Pixel Presentation	(0008,9205)	1	Indication of the presence or absence of color information that may be used during rendering. See Section C.8.27.2.3 for a description and Enumerated Values.
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**

Attribute Name	Tag	Type	Attribute Description
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data started. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800).
Acquisition Duration	(0018,9073)	1C	The scan time in seconds used to create all frames of an Intravascular Optical Coherence Tomography image. Required if Image Type (0008,0008) Value 1 is ORIGINAL. May be present otherwise.
Acquisition Number	(0020,0012)	1	A number identifying the single continuous gathering of data over a period of time that resulted in this image.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. See Section C.8.27.2.4 for specialization.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. See Section C.8.27.2.4 for specialization.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).
Presentation LUT Shape	(2050,0020)	1C	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Enumerated Values: **IDENTITY** output is in P-Values. Required if Presentation Intent Type (0008,0068) equals FOR PRESENTATION.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01". Note For historical reasons, the lossy compression method may also be described in Derivation Description (0008,2111).
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **NO**
Referenced Instance Sequence	(0008,114A)	3	A Sequence that provides reference to a set of non-image SOP Class/Instance pairs significantly related to this Image, including waveforms that may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the SOP Instances. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7004 “Waveform Purposes of Reference” for referenced waveforms.*
Image Comments	(0020,4000)	3	User-defined comments about the image.
Recommended Display Frame Rate	(0008,2144)	3	Recommended rate at which the frames of an Intravascular OCT image should be displayed in frames/second.
Interpolation Type	(0052,0039)	1C	The type of interpolation used for the Polar to Cartesian scan-conversion. Defined Terms: **REPLICATE** **BILINEAR** **CUBIC** Required if Presentation Intent Type (0008,0068) equals FOR PRESENTATION.

Attribute Name	Tag	Type	Attribute Description
Referenced Color Palette Instance UID	(0028,0304)	1C	The identifier of a color palette (i.e., an Instance of the Color Palette Storage SOP Class "1.2.840.10008.5.1.4.39.1") that may be used during rendering. See PS3.4 Color Palette Storage Service Class and PS3.6 Well-Known Color Palettes. Required if Pixel Presentation (0008,9205) is COLOR_REF.

C.8.27.2.1 Image Type and Frame Type

In addition to the requirements specified in Section C.8.16.1 Image Type, the following additional requirements and Defined Terms are specified.

Value 1 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.1. No additional requirements or Defined Terms.

Value 2 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.2. No additional requirements or Defined Terms.

Value 3 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.3.

Table C.8.27.2-2 specifies the Defined Terms for IVOCT for Value 3 for Image Type (0008,0008) and Frame Type (0008,9007).

Table C.8.27.2-2. IVOCT Image Type and Frame Type Value 3

Defined Term Name	Defined Term Description
AXIAL	An image that has an orientation that is perpendicular to the long axis of the vessel. (i.e., cross-sectional).
LONGITUDINAL	An image that has an orientation that is parallel to the long axis of the vessel.

Value 4 of Image Type (0008,0008) and Frame Type (0008,9007) is discussed in Section C.8.16.1.4. No additional requirements or Defined Terms.

C.8.27.2.2 Volumetric Properties

The value of Volumetric Properties (0008,9206) Attribute allows applications doing geometric manipulations to determine if the image is an appropriate candidate for an operation without having to know all the details of the generating application.

Table C.8.27.2-3 specifies the Enumerated Values for Volumetric Properties (0008,9206).

Table C.8.27.2-3. Volumetric Properties Attribute Values

Enumerated Value Name	Enumerated Value Description
DISTORTED	Frames do not represent the true geometry of the vessel.

C.8.27.2.3 Pixel Presentation

Pixel Presentation (0008,9205) is used to indicate whether a color tint is intended to be applied to the IVOCT image. See Table C.8.27.2-4.

Table C.8.27.2-4. Pixel Presentation Attribute Values

Enumerated Value Name	Enumerated Value Description
COLOR	Image is intended to be displayed in color using Supplemental Palette Color LUTs, but can be displayed in grayscale if current display does not support color or with a user selected LUT. See Section C.8.16.2.1.1.1.

Enumerated Value Name	Enumerated Value Description
COLOR_REF	Image is intended to be displayed in color using an externally defined Palette Color LUTs, but can be displayed in grayscale if current display does not support color, or with a user selected LUT. I.e., the encoded pixel values are still continuous grayscale values (and not arbitrarily order indices into a lookup table).
MONOCHROME	Image is intended to be displayed in grayscale only.

C.8.27.2.4 Bits Allocated, Bits Stored and Samples Per Pixel

For IVOCT images, Bits Allocated (0028,0100), Bits Stored (0028,0101) Samples Per Pixel (0028,0002) are specified to use the following values for Presentation Intent Type (0008,0068) Attribute:

Table C.8.27.2-5. Bits Allocated/Stored

Presentation Intent Type	Bits Allocated / Bits Stored	Samples Per Pixel
FOR PRESENTATION	8/8, 16/12 or 16/16	1
FOR PROCESSING	8/8, 16/12 or 16/16	1

C.8.27.3 Intravascular OCT Acquisition Parameters Module

Table C.8.27.3-1 describes the parameters used to acquire an Intravascular Optical Coherence Tomography image.

Table C.8.27.3-1. Intravascular OCT Acquisition Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
OCT Focal Distance	(0052,0002)	2	Distance from focal point to center of catheter, in mm (measured in air).
Beam Spot Size	(0052,0003)	2	The full width at half maximum (FWHM) of the point spread function (PSF) or line spread function (LSF), in µm (measured in air). Also known as Transverse Resolution.
Effective Refractive Index	(0052,0004)	2C	Index of refraction of the tissue and flush medias used during the Intravascular OCT acquisition. Required if Presentation Intent Type (0008,0068) is FOR PROCESSING. May be present otherwise.
OCT Acquisition Domain	(0052,0006)	1	The type of OCT acquisition domain. Defined Terms: **TIME** **FREQUENCY** **SPECTRAL**
OCT Optical Center Wavelength	(0052,0007)	2	Center optical wavelength of the OCT light source, in µm.
Axial Resolution	(0052,0008)	2	The full width at half maximum (FWHM) of the axial plane response function, in µm (measured in air)
Ranging Depth	(0052,0009)	1	Maximum detectable sample-to-reference path displacement, in mm (measured in air). This is the radius of the FOR PRESENTATION image in air. Note Ranging Depth is distinct from Penetration Depth, which is the depth to which one can obtain an OCT signal in tissue.
A-line Rate	(0052,0011)	1	The number of IVOCT A-lines acquired per second in Hz.

Attribute Name	Tag	Type	Attribute Description
A-lines Per Frame	(0052,0012)	1	Number of A-lines acquired in an IVOCT frame, including unused (padded) A-lines. Note Will be the same as Rows (0028,0010) for a FOR PROCESSING image.

C.8.27.4 Intravascular OCT Processing Parameters Module

Table C.8.27.4-1 describes the parameters used for processing an Intravascular Optical Coherence Tomography polar data image.

Table C.8.27.4-1. Intravascular OCT Processing Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
OCT Z Offset Applied	(0052,0026)	1	Indicates whether or not Z offset correction was applied to the OCT image frames. Enumerated Values: **YES** **NO**
Refractive Index Applied	(0052,003A)	1	Indicates whether or not Refractive Index correction was applied. Enumerated Values: **YES** **NO** See Section C.8.27.4.1 for further explanation.
A-line Pixel Spacing	(0052,0014)	1	Spacing of pixels in the A-line (X-axis), in mm.
Pixel Intensity Relationship	(0028,1040)	1	The relationship between the pixel sample values and the IVOCT A-line intensity. See Section C.8.27.4.2.
First A-line Location	(0052,0034)	1	Orientation in degrees at which the 1st A-line in the frame should be displayed. Value shall be between 0 and 360, with zero representing vertical.

C.8.27.4.1 Refractive Index Applied

For Refractive Index Applied (0052,003A) a value of YES indicates that Effective Refractive Index (0052,0004) correction has been applied to the reported A-line Pixel Spacing (0052,0014) Attribute. A value of NO indicates that Effective Refractive Index (0052,0004) correction has not been applied (i.e., A-line Pixel Spacing corresponds to the pixel spacing in air).

C.8.27.4.2 Pixel Intensity Relationship

Pixel Intensity Relationship (0028,1040) shall identify the relationship of the pixel values to the IVOCT A-line intensity.

Defined Terms:

LIN Approximately proportional to A-line intensity.

LOG Non-linear "Log Function"; A Pixel Intensity Relationship LUT shall be included with the image to allow it to be scaled back to its proportional A-line intensity value.

C.8.27.5 Intravascular Image Acquisition Parameters Module

Table C.8.27.5-1 describes the parameters and characteristics of an intravascular image acquisition. These parameters are common to both IVUS and IVOCT.

Table C.8.27.5-1. Intravascular Image Acquisition Parameters Module Attributes

Attribute Name	Tag	Type	Attribute Description
IVUS Acquisition	(0018,3100)	1	Type of Intravascular Image Acquisition. Enumerated Values: **MOTORIZED** **MANUAL** **SELECTIVE** **MEASURED** See Section C.8.27.5.1.
IVUS Pullback Rate	(0018,3101)	1C	Intravascular imaging catheter pullback rate. Specified in units of mm/sec. Required if IVUS Acquisition (0018,3100) value is MOTORIZED. See Section C.8.27.5.2.
IVUS Pullback Start Frame Number	(0018,3103)	1C	Frame number at which the motorized portion of the acquisition begins. Required if IVUS Acquisition (0018,3100) value is MOTORIZED. See Section C.8.27.5.1.
IVUS Pullback Stop Frame Number	(0018,3104)	1C	Frame number at which the motorized portion of the acquisition is complete. Required if IVUS Acquisition (0018,3100) value is MOTORIZED. See Section C.8.27.5.1.
Catheter Direction of Rotation	(0052,0031)	1C	Direction of rotation of the Intravascular rotating catheter during acquisition, from the perspective of the motor, proximal to distal. Enumerated Values: **CW** clockwise **CC** counter-clockwise Required if rotational catheter is used.
Catheter Rotational Rate	(0052,0013)	1C	Rate of rotation of the Intravascular rotating catheter during acquisition, in Hz. Required if rotational catheter is used.
Mode of Percutaneous Access Sequence	(0052,0016)	2	Mode of access of the Intravascular Imaging Catheter. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 3746 “Percutaneous Entry Site”.*

C.8.27.5.1 IVUS Acquisition

The Attribute IVUS Acquisition (0018,3100) denotes the method used to acquire the Intravascular Images.

MOTORIZED: The Intravascular imaging catheter is positioned in the blood vessel proximal or distal to the anatomical structures to be examined. The catheter is attached to a motorized mechanism capable of either pushing forward or pulling back the catheter through the vessel at a constant velocity, as specified by the IVUS Pullback Rate (0018,3101). The motorized acquisition takes place during the time between acquisition of the IVUS Pullback Start Frame Number (0018,3103), and acquisition of the IVUS Pullback Stop Frame Number (0018,3104).

MANUAL: The Intravascular imaging catheter is positioned in the blood vessel proximal or distal to the anatomical structures to be examined. The catheter is then manually pulled back or pushed forward through the vessel segment of interest.

SELECTIVE: The Intravascular imaging catheter is positioned in the blood vessel. The catheter is then manually pushed forward and/or pulled back to examine the anatomical structures in the vessel.

MEASURED: The Intravascular imaging catheter is positioned in the blood vessel near the anatomical structures to be examined. The catheter is then pulled back or pushed forward through the vessel segment of interest. The longitudinal movement between each acquired frame is measured and recorded. See Section C.8.27.6.2 for more information.

C.8.27.5.2 IVUS Pullback Rate

The Attribute IVUS Pullback Rate (0018,3101) specifies the constant velocity of longitudinal movement of the Intravascular imaging catheter. Positive values indicate movement from Distal to Proximal (pulling back). Negative values indicate movement from Proximal to Distal (pushing forward).

C.8.27.6 Intravascular OCT Functional Group Macros

The following sections contain Functional Group Macros specific to the Intravascular OCT IOD.

C.8.27.6.1 Intravascular OCT Frame Type Macro

Table C.8.27.6.1-1 specifies the Attributes of the Intravascular OCT Frame Type Functional Group.

Table C.8.27.6.1-1. Intravascular OCT Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Intravascular OCT Frame Type Sequence	(0052,0025)	1	Identifies characteristics of this frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed. See Section C.8.27.2.1.

C.8.27.6.2 Intravascular Frame Content Macro

Table C.8.27.6.2-1 specifies the Attributes of the Intravascular Frame Content Functional Group.

Table C.8.27.6.2-1. Intravascular Frame Content Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Intravascular Frame Content Sequence	(0052,0027)	1	A Sequence that describes a general description of this image or frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Intravascular Longitudinal Distance	(0052,0028)	1C	Longitudinal distance in millimeters between this frame and the previous acquired frame. Positive values indicate movement is from Distal to Proximal (pull back). Negative values indicate movement is from Proximal to Distal (push forward). Required if Intravascular Acquisition (0018,3100) equals MEASURED.
>Seam Line Location	(0052,0033)	2C	Clockwise rotational orientation (in degrees) at which the seam line in the frame is displayed, relative to vertical (zero degrees). Required if Presentation Intent Type (0008,0068) equals FOR PRESENTATION.

C.8.27.6.3 Intravascular OCT Frame Content Macro

Table C.8.27.6.3-1 specifies the Attributes of the Intravascular OCT Frame Content Functional Group.

Table C.8.27.6.3-1. Intravascular OCT Frame Content Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Intravascular OCT Frame Content Sequence	(0052,0029)	1	A Sequence that describes a general description of this image or frame. Only a single Item shall be included in this Sequence.
>OCT Z Offset Correction	(0052,0030)	1	The amount to shift the frame along the axial direction, in pixels, to correct for interferometer path-length mismatch. See Section C.8.27.6.3.1 for further explanation.
>Seam Line Index	(0052,0036)	1	The A-line number (zero index) that coincides with the seam line as indicated with the First A-line Location (0052,0034) Attribute.
>Number of Padded A-lines	(0052,0038)	1C	The number of padded A-lines contained in the FOR PROCESSING image frame. Required if the FOR PROCESSING image contains padded A-lines. See Section C.8.27.6.3.2 for further explanation.

C.8.27.6.3.1 OCT Z Offset Correction

OCT Z Offset Correction (0052,0030) specifies the number of pixels to shift the A-lines of the frame to correct for the path length difference between the OCT Sample arm and Reference arm (in air). A positive value of Z Offset correction means pixels are shifted further away from the catheter optics. A negative value of Z Offset correction means pixels are shifted closer to the catheter optics. See Figure C.8.27-2

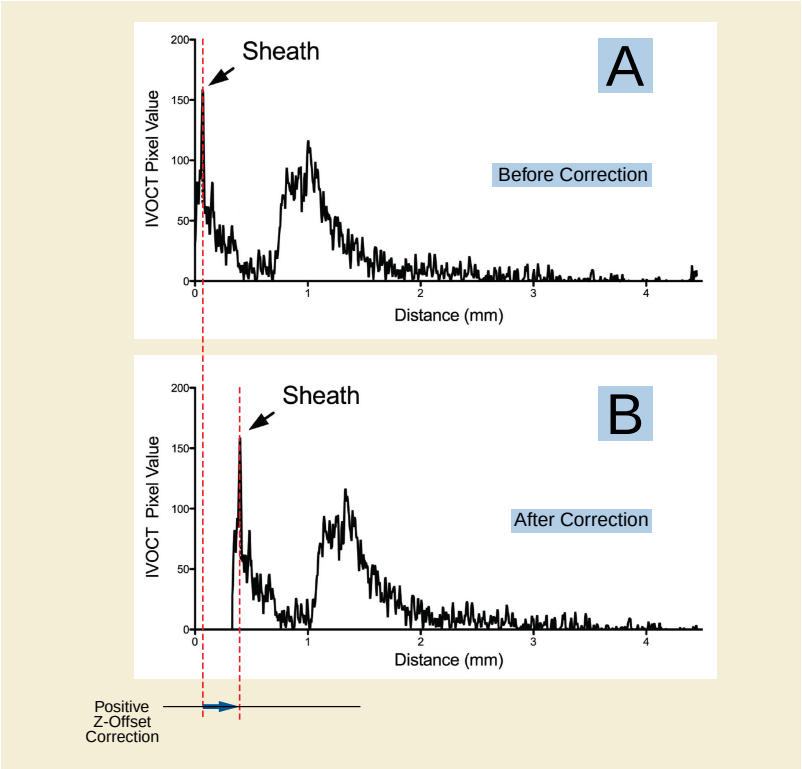


Figure C.8.27-2. OCT Z Offset Correction Example

C.8.27.6.3.2 A-line Padding

Padded A-lines shall not be used in FOR PRESENTATION frames. Padded A-lines shall only be encoded in the high order rows of the FOR PROCESSING frame and shall be contiguous. Padded A-lines may contain arbitrary pixel values.

C.8.28 Ophthalmic Thickness Map Modules

C.8.28.1 Ophthalmic Thickness Map Series Module

Table C.8.28.1-1 specifies the Attributes that identify and describe general information about the Ophthalmic Thickness Map Series.

Table C.8.28.1-1. Ophthalmic Thickness Map Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that created the maps in this Series. Enumerated Values: **OPM** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.28.2 Ophthalmic Thickness Map Module

Table C.8.28.2-1 specifies the Attributes that describe an Image produced by ophthalmic thickness mapping devices.

Table C.8.28.2-1. Ophthalmic Thickness Map Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Mapping Device Type	(0022,1415)	1	Describes the type of ophthalmic mapping acquisition device. See Section C.8.28.2.1.3 for further explanation. Defined Terms **OCT** Optical coherence tomography **POLARIMETRY** Scanning laser polarimetry **SLO_TOMO** Scanning Laser Ophthalmoscopy Tomography
Acquisition Method Code Sequence	(0022,1420)	1	The acquisition method used for obtaining ophthalmic thickness mapping. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4261 “Ophthalmic Mapping Acquisition Method”*
Acquisition Method Algorithm Sequence	(0022,1423)	1C	Software algorithm used to provide acquisition method. Required if Acquisition Method Code Sequence (0022,1420) contains an Item with the value of (111923, DCM, "Corneal birefringence compensation") May be present otherwise. Only a single Item shall be included in this Sequence.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			
Instance Number	(0020,0013)	1	A number that identifies this Instance.
Content Date	(0008,0023)	1	The date the data creation was started.
Content Time	(0008,0033)	1	The time the data creation was started.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.28.2.1.1 for specialization.
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation. Enumerated Values: **1**

Attribute Name	Tag	Type	Attribute Description
Photometric Interpretation	(0028,0004)	1	Specified the intended interpretation of the pixel data. See Section C.7.6.3.1.2 for further explanation. Enumerated Values: **MONOCHROME2**
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0000H** unsigned integer
Pixel Spacing	(0028,0030)	1	Physical distance in the patient between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. Note Since a patient's retina is curved, there can be a small error in using Pixel Spacing (0028,0030) for distance measurements in the periphery of the image. See Section 10.7.1.3 for further explanation.
Pixel Aspect Ratio	(0028,0034)	1	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS3.5 for further explanation. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Shall be equal to Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).
Pixel Presentation	(0008,9205)	1	The source of the color information for use during rendering. Enumerated Values: **COLOR** Use Supplemental Palette Color Lookup Table Module Attributes **COLOR_REF** Use Referenced Color Palette Instance UID (0028,0304)
Referenced Color Palette Instance UID	(0028,0304)	1C	The identifier of the color palette (i.e., an Instance of the Color Palette Storage SOP Class "1.2.840.10008.5.1.4.39.1") for use during rendering. Required if Pixel Presentation (0008,9205) is COLOR_REF.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Burned In Annotation	(0028,0301)	1	Indicates that the image does not contain burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **NO**
Image Laterality	(0020,0062)	1	Laterality of object imaged (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right eye **L** left eye Note This Attribute is mandatory, in order to ensure that images may be positioned correctly relative to one another for display. Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent.

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Thickness Map Type Code Sequence	(0022,1436)	1	The type of ophthalmic thickness map encoded in this SOP Instance. It specifies the meaning of the pixel values. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 4263 "Ophthalmic Thickness Map Value Type"
~~*Include* Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"~~			~~*Include if Ophthalmic Thickness Map Type Code Sequence (0022,1436) contains an Item with the value* (111930, DCM, "Absolute ophthalmic thickness") *or* (111932, DCM, "Thickness deviation from normative data").~~ ~~*May be present otherwise.*~~ ~~*D*CID 4260 "Ophthalmic Mapping Units for Real World Value Mapping"~~
Include Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"			*Include if Ophthalmic Thickness Map Type Code Sequence (0022,1436) contains an Item with the value* (111930, DCM, "Absolute ophthalmic thickness") *or* (111932, DCM, "Thickness deviation from normative data"). *May be present otherwise.* *D*CID 4260 "Ophthalmic Mapping Units for Real World Value Mapping"
Pixel Value Mapping to Coded Concept Sequence	(0022,1450)	1C	Provides a pixel value and the mapping of that pixel value to an associated Coded Concept. Required if Ophthalmic Thickness Map Type Code Sequence (0022,1436) contains an Item with the value (111931, DCM, "Thickness deviation category from normative data"). May be present otherwise. One or more Items shall be present.
>Mapped Pixel Value	(0022,1452)	1	Pixel value to be mapped.
>Pixel Value Mapping Code Sequence	(0040,9098)	1	The mapping from Mapped Pixel Value (0022,1452) to an associated Coded Concept. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4265 "Ophthalmic Thickness Deviation Categories".*
>Pixel Value Mapping Explanation	(0022,1454)	3	Free form text explanation of the Coded Concept.
Ophthalmic Thickness Mapping Normals Sequence	(0022,1443)	1C	Identifies the Externally Sourced Data Set used for mapping values from a normative data base. Required if Ophthalmic Thickness Map Type Code Sequence (0022,1436) contains an Item with the value or (111931, DCM, "Thickness deviation category from normative data") or (111932, DCM, "Thickness deviation from normative data"). May be present otherwise. Only a single Item shall be included in this Sequence.
>Include Table 10-22 "Externally-Sourced Data Set Identification Macro Attributes"			
Relevant OPT Attributes Sequence	(0022,1472)	1C	Attributes from the OPT image that provide critical context for the interpretation of this ophthalmic map SOP Instance. Required if Ophthalmic Mapping Device Type (0022,1415) is OCT. Only a single Item shall be included in this Sequence

Attribute Name	Tag	Type	Attribute Description
>Depth Spatial Resolution	(0022,0035)	1	The inherent limiting resolution in microns for depth of the acquisition equipment for high contrast objects for the data gathering and reconstruction technique chosen. If variable, the value at the center of the scanning volume.
>Maximum Depth Distortion	(0022,0036)	1	Maximum distortion in depth direction in % of Depth Spatial Resolution.
Source Image Sequence	(0008,2112)	1C	The Image SOP Class/Instance pair of the Image that was used to generate this Image. Required if Ophthalmic Mapping Device Type (0022,1415) is OCT. May be present otherwise. Only a single Item shall be included in this Sequence
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made, (i.e., the role the source image or frame(s) played in the generation of this image). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7202 "Source Image Purposes of Reference".*
Referenced Instance Sequence	(0008,114A)	1C	A Sequence that provides reference to a set of SOP Class/Instance pairs identifying images or other composite SOP Instances to plan the acquisition or significant related information. Required if Ophthalmic Photography Reference Image available. May be present otherwise. See Section C.7.6.16.2.5.1 for further explanation. Zero or more Items may be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the Instance(s). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4264 "Ophthalmic Map Purposes of Reference".*
Registration to Localizer Sequence	(0022,1465)	3	Registration of current Instance to a localizer SOP Instance referenced in Attribute Referenced Instance Sequence (0008,114A). See Section C.8.28.2.1.2 for an example.
>Registered Localizer Units	(0022,1466)	1	Units of measure for the axes of the registered localizer image. Enumerated Values: **PIXEL** See Bounding Box Annotation Units (0070,0003) for definition.
>Registered Localizer Top Left Hand Corner	(0022,1467)	1	Location of the Top Left Hand Corner (TLHC) of the registered localizer in Registered Localizer Units (0022,1466), given as column\row. Column is the horizontal offset and row is the vertical offset.
>Registered Localizer Bottom Right Hand Corner	(0022,1468)	1	Location of the Bottom Right Hand Corner (BRHC) of the registered localizer in which Registered Localizer Units (0022,1466), given as column\row. Column is the horizontal offset and row is the vertical offset.

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table 10-5 “General Anatomy Mandatory Macro Attributes”~~			~~*Anatomic Region Sequence (0008,2218) shall be* (81745001, SCT, "Eye").~~ ~~*Anatomic Region Modifier Sequence (0008,2220) D*CID 244 “Laterality”.~~ ~~*Primary Anatomic Structure Sequence (0008,2228) D*CID 4266 “Ophthalmic Anatomic Structure Reference Point”. *Only a single Item shall be included in this Sequence.*~~ ~~Note~~ ~~Although Primary Anatomic Structure Sequence (0008,2228) is Type 3, it is important to convey this information if able to be determined.~~
Include Table 10-5 “General Anatomy Mandatory Macro Attributes”			*Anatomic Region Sequence (0008,2218) shall be* (81745001, SCT, "Eye"). *Anatomic Region Modifier Sequence (0008,2220) D*CID 244 “Laterality”. *Primary Anatomic Structure Sequence (0008,2228) D*CID 4266 “Ophthalmic Anatomic Structure Reference Point”. *Only a single Item shall be included in this Sequence.* Note Although Primary Anatomic Structure Sequence (0008,2228) is Type 3, it is important to convey this information if able to be determined.
Relative Image Position Code Sequence	(0022,001D)	3	The position of this image on the retina (as defined by a specified nomenclature; the nomenclature is implicit in the code used). Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*BCID 4207 “Ophthalmic Image Position”.*
Anatomic Structure Reference Point	(0022,1463)	1C	Location of a point in the image identified by an anatomic structure. This is used in ophthalmology for a landmark within a patient's eye. Given as column\row. Column is the horizontal offset and row is the vertical offset. Image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The values must be within the range 0\0 to Columns\Rows. Required if Primary Anatomic Structure Sequence (0008,2228) contains an Item with the value (67046006, SCT, "Fovea centralis") or (81016008, SCT, "Optic nerve head") or (49755003, SCT, "Lesion") or (111934, DCM, "Disc-Fovea"). May be present otherwise.
Retinal Thickness Definition Code Sequence	(0022,1445)	1C	The definition of the retinal thickness for this image. Required if Attribute Image Type (0008,0008) value 3 is RETINAL_THICK. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4262 “Retinal Thickness Definition”*

C.8.28.2.1 Ophthalmic Thickness Map Module Attribute Descriptions

C.8.28.2.1.1 Image Type

For Ophthalmic Thickness Maps, Image Type (0008,0008) is specified to be Type 1 and uses one of the following Defined Terms for Value 3:

Defined Terms:

ONH identifies a topographic map of an optic nerve head
RETINAL_THICK identifies a Thickness Map for retinal layers or combination of several sub-layers

Note

1. The images created based upon the source data of the patient examination would be ORIGINAL\PRIMARY.
2. If the value is specified as "RETINAL_THICK", the definition of the retinal thickness is in Retinal Thickness Definition Code Sequence (0022,1445).

C.8.28.2.1.2 Referenced Instance Sequence

Equipment generating an ophthalmic map (OPM) image, may also obtain an accompanying "reference/localizer" image. This "reference/localizer" image serves the purpose of orienting and registering the OPM image to the actual retinal location. For example, a fundus photo may be obtained with ophthalmic tomography (OPT). When the retinal thickness map is generated based on OPT data, the OPM is registered with pixel precision to the fundus photo. This "reference/localizer" image is referenced in the OPM SOP Instance using the Attribute Referenced Instance Sequence (0008,114A).

An example of a "reference/localizer" image and its relationship to an OPM image is shown in Figure C.8.28.2.1-1. Legend: (**A**) a fundus photo is taken as the "reference/localizer" image. The green box indicates the area the OPT scans are obtained. (**B**) The retinal thickness map (OPM object) is overlaid on the "reference/localizer" fundus photo to show the correspondence. These examples could be referenced from different types of SOP Classes, such as Color Softcopy Presentation State Storage (referencing the OP SOP Instance of a fundus photo), True Color Secondary Capture Image Storage, Encapsulated PDF, etc. The Purpose of Reference Code Sequence (0040,A170) code is set to (121311, DCM, "Localizer") for example A. Registration to Localizer Sequence (0022,1465) would be used for example B.

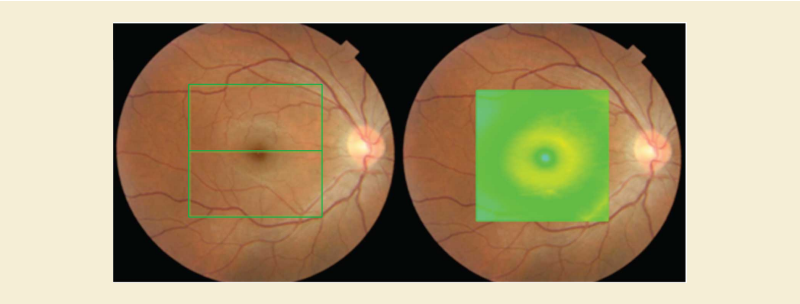


Figure C.8.28.2.1-1. Reference/Localizer Image Related to OPM Image

C.8.28.2.1.3 Ophthalmic Mapping Device Type

For Ophthalmic Mapping Device Type (0022,1415), Scanning Laser Ophthalmoscopy Tomography (SLO_TOMO) produces a topographical representation of the optic nerve head (ONH) rather than a thickness depiction. However, the topographical depiction can be considered as "thickness" measurements of multiple points of the ONH surface relative to an assigned datum plane. For this reason, the topographical image is included in the ophthalmic thickness map Module.

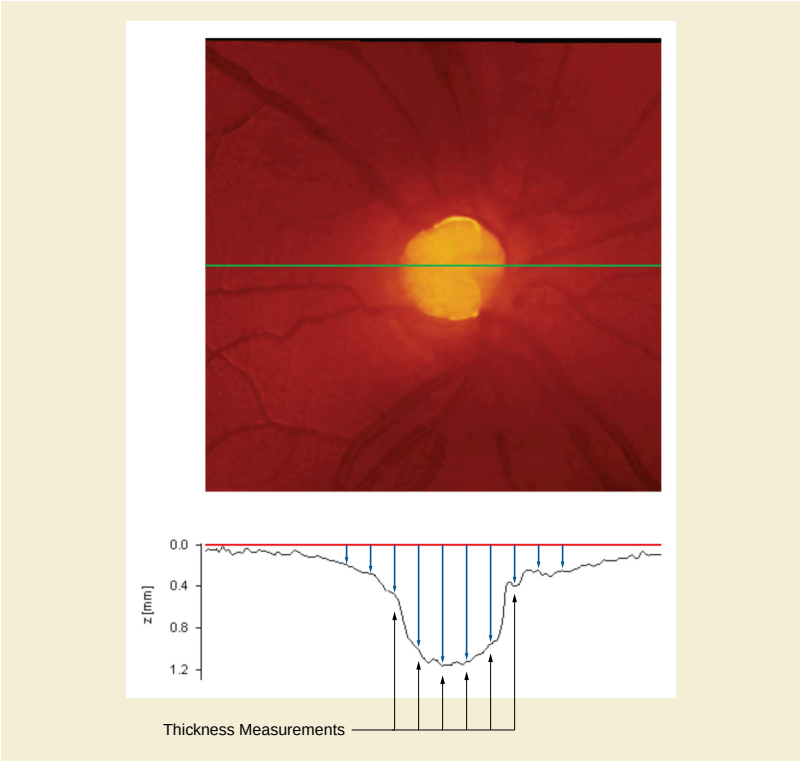


Figure C.8.28.2.1-2. Optic Nerve Head Thickness Example

For Ophthalmic Mapping Device Type (0022,1415), Polarimetric Tomography (POLARIMETRY) produces a thickness depiction based on birefringent phase shifts. This is a thickness measure but does not use typical international system of units such as micrometer, etc. Due to this, the unit of measurement is defined by the implementation, such as 'p-um'.

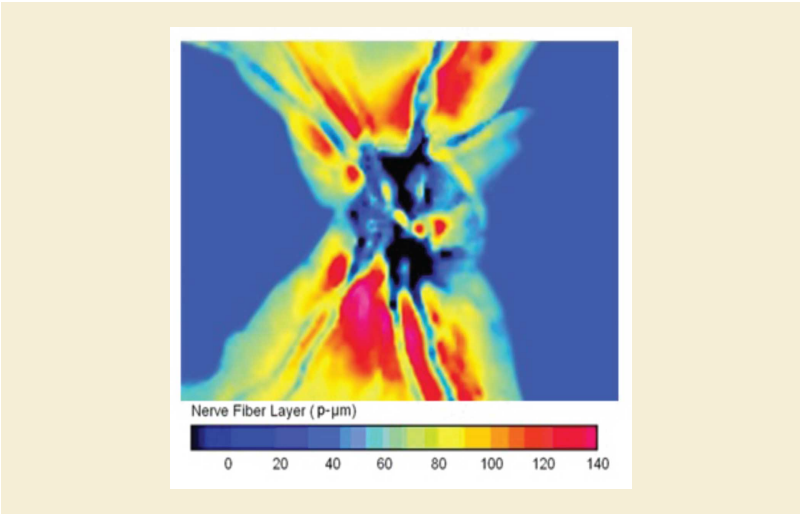


Figure C.8.28.2.1-3. Polarimetry Optic Nerve Head Thickness Example

C.8.28.3 Ophthalmic Thickness Map Quality Rating Module

Table C.8.28.3-1 specifies the Attributes that describe the quality rating for the ophthalmic mapping.

Table C.8.28.3-1. Ophthalmic Thickness Map Quality Rating Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Thickness Map Quality Rating Sequence	(0022,1470)	1	Type of metric and metric value used to evaluate the quality of the ophthalmic mapping for grading and diagnostic purposes for this SOP Instance. Only a single Item shall be included in this Sequence.
>Include Table 10-26 "Numeric Value Macro Attributes"			*DCID 4243 "Ophthalmic Quality Metric Type" shall be used for Concept Name Code Sequence (0040,A043).*
>Ophthalmic Thickness Map Quality Threshold Sequence	(0022,1458)	1	Quality threshold value and software algorithm used to provide the ophthalmic thickness map quality rating for this SOP Instance. Only a single Item shall be included in this Sequence.
>>Ophthalmic Thickness Map Threshold Quality Rating	(0022,1460)	1	Quality rating threshold value for acceptable ophthalmic map. Note The units of this Attribute is the same as defined in Measurement Unit Code Sequence (0040,08EA) of the Ophthalmic Thickness Map Quality Rating Sequence (0022,1470). The threshold value is not the same as the Attribute Numeric Value (0049,A30A) of the Ophthalmic Thickness Map Quality Rating Sequence (0022,1470). Therefore, it conveys the least stringent value that is acceptable, not the actual rating for this SOP Instance.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			

C.8.29 Optical Surface Scanner Modules

This Section describes Optical Surface Scanner Modules. These Modules contain Attributes that are specific to Optical Surface Scanner scans.

C.8.29.1 Optical Surface Scanner Series Module

Table C.8.29-1 contains IOD Attributes that describe an optical surface scan Series performed on the patient.

Table C.8.29-1. Optical Surface Scanner Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the images in this Series. Enumerated Values: **OSS** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
Referenced Surface Data Sequence	(0080,0013)	2	Lists the predecessor surfaces and/or point clouds Instances. Zero or more Items shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.29.2 Scan Procedure Module

Table C.8.29-2 specifies the Attributes of the Scan Procedure Module.

Table C.8.29-2. Scan Procedure Module Attributes

Attribute Name	Tag	Type	Attribute Description
Surface Scan Acquisition Type Code Sequence	(0080,0001)	1	Specify the type of acquisition method. For evaluation of the characteristics or quality of the data. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 8201 "Surface Scan Acquisition Types".*
Surface Scan Mode Code Sequence	(0080,0002)	2	Used scan mode. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 8202 "Surface Scan Mode Types".*
Registration Method Code Sequence	(0080,0003)	1C	Method for registering multiple shots. Required if the IOD stores data that has been derived from multiple shots. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 8203 "Surface Scan Registration Method Types".*
Instance Number	(0020,0013)	1	A number that identifies this shot. Shall start at 1 and monotonically increase by 1 within a single acquisition.
Acquisition Number	(0020,0012)	1	A number identifying the single continuous gathering of data over a period of time that resulted in this Instance.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this Instance started.
Shot Duration Time	(0080,0004)	1	The time in seconds from the start of this shot until the end of this shot.
Shot Offset Time	(0080,0005)	3	The time in seconds from the Acquisition DateTime to the start of this shot.

C.8.29.2.1 Scan Procedure Module Attribute Descriptions

C.8.29.2.1.1 Shot Duration Time and Shot Offset Time

Figure C.8.29.2-1 depicts the usages of some of the Attributes of the Scan Procedure Module.

The Shot Offset Time is the time required for the detection of focus points and exposure time settings.

The Shot Duration Time is the time required to acquire a surface from the scanned object.

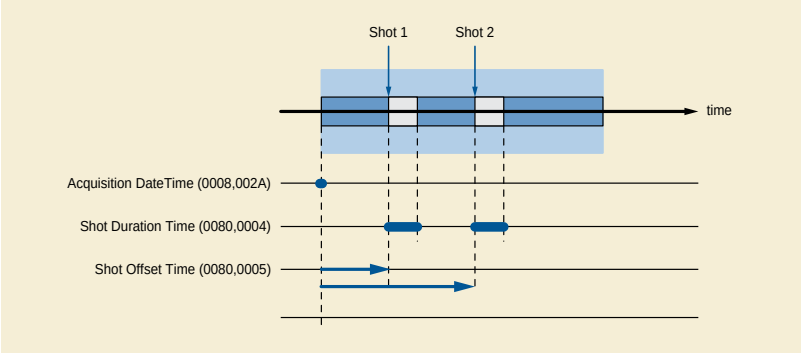


Figure C.8.29.2-1. Timing Attributes Illustration

C.8.30 Corneal Topography Map Modules

C.8.30.1 Corneal Topography Map Series Module

Table C.8.30.1-1 specifies the Attributes that identify and describe general information about the Corneal Topography Map Series.

Table C.8.30.1-1. Corneal Topography Map Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that created the maps in this Series. Enumerated Values: **OPM** See Section C.7.3.1.1.1 for further explanation.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related (e.g., a Modality or General-Purpose Performed Procedure Step SOP Instance). Only a single Item shall be included in this Sequence. Required if the Modality Performed Procedure Step SOP Class, or General Purpose Performed Procedure Step SOP Class is supported.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Body Part Examined	(0018,0015)	1	Text description of the part of the body examined. Enumerated Values: **EYE** Note Some IODs support the Anatomic Region Sequence (0008,2218), which can provide a more comprehensive mechanism for specifying the body part being examined.

C.8.30.2 Corneal Topography Map Image Module

Table C.8.30.2-1 specifies the Attributes that describe an Image produced by corneal topography mapping devices.

Table C.8.30.2-1. Corneal Topography Map Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies this Instance.
Content Date	(0008,0023)	1	The date the data creation was started.
Content Time	(0008,0033)	1	The time the data creation was started.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.30.2.1.1 for specialization.
Samples Per Pixel	(0028,0002)	1	Number of samples (planes) in this image. See Section C.7.6.3.1.1 for further explanation. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specified the intended interpretation of the pixel data. See Section C.7.6.3.1.2 for further explanation. Enumerated Values: **PALETTE COLOR**
Pixel Representation	(0028,0103)	1	Data representation of pixel samples. Enumerated Values: **0000H** unsigned integer
Include Table 10-10 "Basic Pixel Spacing Calibration Macro Attributes"			
Pixel Aspect Ratio	(0028,0034)	1	Ratio of the vertical size and horizontal size of the pixels in the image specified by a pair of integer values where the first value is the vertical pixel size, and the second value is the horizontal pixel size.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See PS3.5 for further explanation. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Shall be equal to Bits Allocated (0028,0100).
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. High Bit (0028,0102) shall be one less than Bits Stored (0028,0101).

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression. Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. See Section C.7.6.1.1.5 for further explanation.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Burned In Annotation	(0028,0301)	1	Indicates that the image does not contain burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** Note Corneal topography is similar to finger prints as it is unique to individuals. Therefore, it could be used by a trained person or an expert system to identify the patient.
Image Laterality	(0020,0062)	1	Laterality of object imaged (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right eye **L** left eye Note This Attribute is mandatory, in order to ensure that images may be positioned correctly relative to one another for display. Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present. Note Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent.

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"~~			~~DCID 4267 "Corneal Topography Mapping Units for Real World Value Mapping"~~
Include Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"			DCID 4267 "Corneal Topography Mapping Units for Real World Value Mapping"
Include Table 10-5 "General Anatomy Mandatory Macro Attributes"			*The concept code for Anatomic Region Sequence (0008,2218) shall be (81745001, SCT, "Eye"), and DCID 244 "Laterality" shall be used for Anatomic Region Modifier Sequence (0008,2220).* *DCID 4266 "Ophthalmic Anatomic Structure Reference Point" shall be used for Primary Anatomic Structure Sequence (0008,2228). Only a single Item shall be included in this Sequence.* Note Although Primary Anatomic Structure Sequence (0008,2228) is Type 3, it is important to convey this information if able to be determined.

C.8.30.2.1 Corneal Topography Map Image Module Attribute Descriptions

C.8.30.2.1.1 Image Type

For Corneal Topography Maps, Image Type (0008,0008) is specified to be Type 1.

Defined Terms for Image Type Value 3:

CORNEAL_TOPO Identifies a topographic map of the cornea

C.8.30.2.1.2 Corneal Topography Map Real World Value and Image Transformations

The Corneal Topography Map SOP Class supports a sequence of transformations that completely define the conversion of a stored image into a displayed image.

The sequence of transformations from corneal measurements to a displayable image is explicitly defined in Figure C.8.30.2.1-1. Figure C.8.30.2.1-1 also conveys the transformation to display the scaling of the color map using its Real World Value Macro (see Table C.7.6.16-12 for more details on the Real World Value Macro).

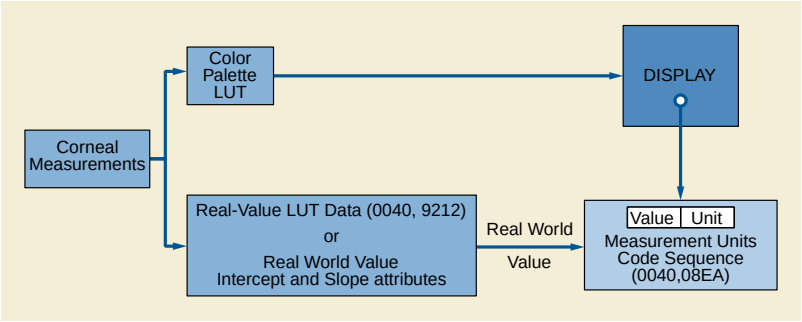


Figure C.8.30.2.1-1. Corneal Topography Map Real World Value and Image Transformation Pipeline

An SCP of the Corneal Topography Map Storage SOP Class, when rendering SOP Instances of the Class shall apply the image transformations (i.e., Palette Color LUT) and the Real World Value LUT to display the annotated color scale. The annotated color scale shall conform to the "ISO Standard 19980 - Ophthalmic instruments - Corneal topographers, second edition, section B.4 Standardized colour Scale."

C.8.30.3 Corneal Topography Map Analysis Module

Table C.8.30.3-1 specifies the Attributes that describe the corneal Topography map analysis.

Table C.8.30.3-1. Corneal Topography Map Analysis Module Attributes

Attribute Name	Tag	Type	Attribute Description
Ophthalmic Mapping Device Type	(0022,1415)	1	Describes the type of ophthalmic mapping acquisition device. See Section C.8.30.3.1.1 for further explanation. Defined Terms: **REFLECTION** Reflection topography (i.e., placido, grid, etc.) **SLIT_BASED** Slit based elevation tomography **INTERFEROMETRY** E.g., Optical coherence tomography
Corneal Vertex Location	(0046,0202)	1	Location of the corneal vertex. This is used for the reference point for other Attributes within this SOP Instance and determined by the Image referenced in the Attribute Source Image Sequence (0008,2112). Given as column\row. Column is the horizontal offset and row is the vertical offset. Image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The values must be within the range 0\0 to Columns\Rows. This location shall anchor the corneal vertex at the x, y and z coordinates of 0.0, 0.0, 0.0, in mm. See Section C.8.30.3.1.4 for further explanation.
Corneal Topography Surface	(0046,0201)	1	Identifies the surface of the corneal topography map. Enumerated Values: **A** Anterior **P** Posterior
Pupil Centroid X-Coordinate	(0046,0203)	1C	The horizontal coordinate of the centroid of the pupil relative to location of the cornea vertex specified in the Attribute Corneal Vertex Location (0046,0202), in mm, such that toward the right is positive. See Section C.8.30.3.1.4 for further explanation. Required if Attribute Corneal Topography Surface (0046,0201) is A (Anterior). Note This Attribute is conveyed in mm from the corneal vertex because display applications will have zoom and 3-D rotational capabilities.
Pupil Centroid Y-Coordinate	(0046,0204)	1C	The vertical coordinate of the centroid of the pupil relative to location of the cornea vertex specified in the Attribute Corneal Vertex Location (0046,0202), in mm, such that up is positive. See Section C.8.30.3.1.4 for further explanation. Required if Attribute Corneal Topography Surface (0046,0201) is A (Anterior). Note This Attribute is conveyed in mm from the corneal vertex because display applications will have zoom and 3-D rotational capabilities.

Attribute Name	Tag	Type	Attribute Description
Equivalent Pupil Radius	(0046,0205)	1C	The average physical distance in mm from the pupil centroid specified in the Attributes Pupil Centroid X-Coordinate (0046,0203) and Pupil Centroid Y-Coordinate (0046,0204) to the measured perimeter of the pupil. Required if Attribute Corneal Topography Surface (0046,0201) is A (Anterior). Note When the pupil is not able to be determined the typical estimate is 4mm.
Vertices of the Outline of Pupil	(0046,0208)	1C	A set of row/column vertices that outline the perimeter of the pupil. Two or more pairs of values follow and are the row and column coordinates of the other vertices that outline the perimeter of the pupil. For a two dimensional curve: X1, Y1, X2, Y2, etc. The first (X) dimension corresponds to the image column (horizontal offset), and the second (Y) dimension corresponds to the image row (vertical offset). This is a Polyline and the points are to be interpreted as an n-tuple list of end points between which straight lines are to be drawn. Required if Attribute Corneal Topography Surface (0046,0201) is A (Anterior).
Include Table C.8.25.10-2 “Keratometric Measurements Macro Attributes”			
Minimum Keratometric Sequence	(0046,0215)	1	A Sequence that specifies the lowest power obtained when averaging individual meridian. Only one Item shall be permitted. Note The measurement is typically taken at 3-4 mm from the corneal vertex.
>Radius of Curvature	(0046,0075)	1	The radius of curvature of the principal meridian of the cornea, measured in mm.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridian, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric radius of curvature or power is measured, measured in degrees.
Simulated Keratometric Cylinder Sequence	(0046,0218)	1	A Sequence that specifies simulated keratometric cylinder power of the corneal surface, measured in diopters. Only one Item shall be permitted. Note This information is obtained from the Steep and Flat Keratometric Axis readings.
>Keratometric Power	(0046,0076)	1	The refractive power of the cornea at the principal meridian, measured in diopters.
>Keratometric Axis	(0046,0077)	1	The meridian where the keratometric cylinder or power is measured, measured in degrees.

Attribute Name	Tag	Type	Attribute Description
Average Corneal Power	(0046,0220)	1	The area-corrected average of the corneal power ahead of the entrance pupil, measured in diopters. Note It is generally equal to the keratometric spherical equivalent except for decentered refractive surgical procedures. It is used in intraocular lens calculations.
Corneal I-S Value	(0046,0224)	1	Quantifies the inferior-superior dioptric asymmetry along the vertical meridian to discriminate Keratoconus, measured in diopters. Note 1. See Rabinowitz YS and McDonnell PJ. "Computer-assisted corneal topography in keratoconus. Refract Corneal Surg. 1989 Nov-Dec;5(6):400-8". 2. If I-S > 1.4 D, the cornea may be classified as Keratoconus Suspect. If I-S > 1.9, enough asymmetry is present in the topography to classify the cornea as clinical Keratoconus.
Analyzed Area	(0046,0227)	1	The corneal surface area that can be analyzed, measured in mm squared.
Maximum Corneal Curvature Sequence	(0046,0211)	3	A Sequence to convey the maximum curvature and location of the measured corneal topography. Only a single Item is permitted in this Sequence.
>Maximum Corneal Curvature	(0046,0212)	1	Maximum curvature in diopters of the measured corneal topography.
>Maximum Corneal Curvature Location	(0046,0213)	1	Location of the corneal maximum curvature. Given as column\row. Column is the horizontal offset and row is the vertical offset. Image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The values must be within the range 0\0 to Columns\Rows.
Surface Regularity Index	(0046,0230)	3	Measures local fluctuations in corneal power (i.e., irregular astigmatism) over the pupil (no units). Note This value would be about 0.4 for a cornea with good optical quality; at 1.5 and higher, vision falls below normal calculations.
Surface Asymmetry Index	(0046,0232)	3	This index sums the meridional mire-to-mire power changes over the entire corneal surface, increasing as topographic irregularities increase (no units).
Corneal Eccentricity Index	(0046,0234)	3	Index used to measure the eccentricity of the cornea (no units).
Keratoconus Prediction Index	(0046,0236)	3	Index used to indicate the presence of Keratoconus (no units) Note It is obtained by discrete analysis of the corneal topographic data. (e.g., Invest Ophthalmol Vis Sci 35:2749-2757, 1994).

Attribute Name	Tag	Type	Attribute Description
Decimal Potential Visual Acuity	(0046,0238)	3	The range of best spectacle-corrected distance that might be expected from a functionally normal eye with the topographical characteristics of the analyzed cornea, measured in decimal. Note 1. Typical examples: reference standard is 1, severe vision loss is 0.1. 2. See Annex RR “Ophthalmic Refractive Reports Use Cases (Informative)” in PS3.17 for guidance in converting Decimal Potential Visual Acuity to other customarily used display notation such as 20/20 in the US and 6/6 in Britain.
Corneal Topography Map Quality Evaluation	(0046,0242)	1C	Identifies the quality of the topography examination. Enumerated Values: **ACCEPTABLE** **MARGINAL** **NOT_ACCEPTABLE** Required if a quality rating value exists for the corneal topography map
Corneal Topography Map Type Code Sequence	(0046,0207)	1	The type of corneal topography map encoded in this SOP Instance. It specifies the meaning of the pixel values. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4268 “Corneal Topography Map Value Type”*
Corneal Topography Mapping Normals Sequence	(0046,0210)	1C	Identifies the Externally Sourced Data Set used for corneal topography mapping values from a normative data base. Required if a normative data base was used. Only a single Item shall be included in this Sequence.
>Include Table 10-22 “Externally-Sourced Data Set Identification Macro Attributes”			
Source Image Sequence	(0008,2112)	1	The Image SOP Class/Instance pair of the Image that was used to generate this corneal topography map. Note Attribute Corneal Vertex Location (0046,0202) in this corneal topography map has been generated by the source image and provides the registration of the Corneal Topography Map to the Source Image. See Section C.8.30.3.1.2 for further explanation. Only a single Item shall be included in this Sequence.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made, (i.e., the role the source image or frame(s) played in the generation of this image). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			The code used shall be (121322, DCM, "Source image for image processing operation").

Attribute Name	Tag	Type	Attribute Description
Source Image Corneal Processed Data Sequence	(0046,0244)	1	Attributes that contain various power, elevation and wavefront measurements at specific points on the cornea of the SOP Instance referenced in Attribute Source Image Sequence (0008,2112). The Attributes are obtained from measurements of curvature or shape of the cornea. See Section C.8.30.3.1.3 for further explanation. One or more Items shall be present.
>Corneal Point Location	(0046,0247)	1	The x, y, and z coordinate of a point in the image within the cornea, in mm. Where the origin is conveyed by the Attribute Corneal Vertex Location (0046,0202). Note For two dimensional maps z=0.
>Corneal Point Estimated	(0046,0248)	1	The point defined in Attribute Corneal Point Location (0046,0247) is an estimated point (i.e., interpolated or extrapolated; not an actual measured point). Enumerated Values: **Y** Yes **N** No
>Axial Power	(0046,0249)	1	Conveys corneal shape characteristics, in diopters. It is determined from the curvature, *r* in mm, of the equivalent sphere with the same slope at a given point on the surface. Axial power = *Km/r,* where Km is the Keratometric Index.
>Tangential Power	(0046,0250)	1	Determined from the curvature (2nd derivative = d2y/dx2) of a point on the cornea, in diopters; also called Instantaneous Power. Emphasizes irregular astigmatism (large variations in higher order aberrations).
>Refractive Power	(0046,0251)	1	Conveys the optical refraction properties of the cornea, in diopters. It is determined from ray tracing using Snell's Law to calculate the true refractive power. Note It is used to evaluate ocular optics.
>Relative Elevation	(0046,0252)	1	Relative elevation, in micrometers, is calculated from the corneal surface distance from a reference surface (i.e., a sphere or ellipsoid) that intersects the corneal vertex. This value is determined from z - z_{ref}. Where z is conveyed in Attribute Corneal Point Location (0046,0247) and z_{ref} is the elevation of the reference surface.
>Corneal Wavefront	(0046,0253)	1	Corneal wavefront, in micrometers, is calculated from the elevation data by fitting with the Zernike Series expansion. Note This permits measurement of both low and higher order aberrations and provides the total amount of distortion of the Corneal Wavefront with a Root Mean Square (RMS) value.

C.8.30.3.1 Corneal Topography Map Analysis Module Attribute Descriptions

C.8.30.3.1.1 Ophthalmic Mapping Device Type

For Ophthalmic Mapping Device Type (0022,1415), Reflection corneal topography, which measures corneal curvature directly, is based on the reflection of a specific pattern from the corneal surface. Placido-based topographers use variations of circular mires, while grid-based topographers use a rectangular array of point reflections. Slit-based corneal tomography, which measures elevation

directly, is based on the projection of multiple slit beams in succession through the cornea (and anterior segment). Some use the Schiempflug optical principle to achieve high resolution over a broad depth of field. Swept source OCT uses high speed scanning to produce its optical sections. Source images for these devices are shown in Figure C.8.30.3.1-1. Example A and B are for reflection types, C is an interferometry type, and D is a slit based type.

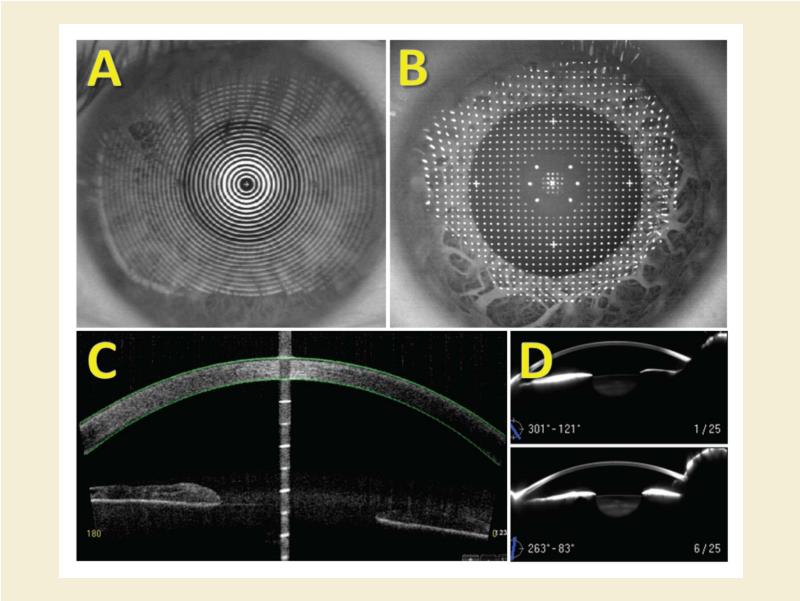


Figure C.8.30.3.1-1. Device types: A. Placido; B. Grid; C. OCT; D. Slit Based

C.8.30.3.1.2 Source Image Sequence

Equipment generating a corneal topography map image first obtains a source image. This image may be single-frame or multi-frame such as when the Attribute Ophthalmic Mapping Device Type (0022,1415) is SLIT_BASED or INTERFEROMETRY. From this source image, the necessary measurement data is obtained to build the corneal topography map.

A typical source image may be generated by the Ophthalmic Photography 8 bit or 16 bit SOP Classes for device types of REFLECTION and SLIT_BASED. A typical source image for device type of INTERFEROMETRY would be Ophthalmic Tomography Image SOP Class.

Figure C.8.30.3.1-2 illustrates an example where the source image (left) is generated using a device type of REFLECTION. The corneal topography map and color scale is shown in the center (this is the output of this SOP Class). The right figure shows an example of the corneal topography map and color scale superimposed on the source image.

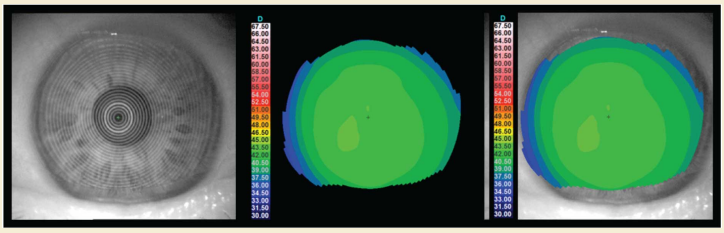


Figure C.8.30.3.1-2. Source Image (left), Corneal Topography Map Image (Center), Corneal Topography Map Presented as an Overlay on the Source Image (right)

C.8.30.3.1.3 Source Image Corneal Processed Data Sequence

The Source Image Corneal Processed Data Sequence (0046,0244) provides power, elevation and wavefront measurements taken at specific points of the Source Image. These Attributes were used to generate the corneal topography map and indices of this SOP Instance. This processed data can also be used to generate other corneal topography maps and indices.

C.8.30.3.1.4 Corneal Vertex Location

The Corneal Vertex Location (0046,0202) establishes the reference point for the corneal vertex, the origin of the Ophthalmic Coordinate System. The Ophthalmic Coordinate System is used as the Frame of Reference that establishes the spatial relationship for the corneal vertex (i.e., used within corneal topography maps) for a set of Images within a Series. It also allows Images across multiple Series to share the same Frame Of Reference. The corneal vertex is the point located at the intersection of the patient's line of sight (visual axis) and the corneal surface. It is represented by the corneal light reflex when the cornea is illuminated coaxially with fixation.

Note

Since the criteria used to group images into a Series is application specific, it is possible for imaging applications to define multiple Series within a Study that share the same imaging space. Therefore the images with the same Frame of Reference UID (0020,0052) Attribute value share the same corneal vertex location within the patient's eye.

Figure C.8.30.3.1-3 illustrates the representation of corneal topography. The corneal vertex lies at the center of the rulers. Typical circular grids are 3, 5, 7, and 9 mm diameters centered on the vertex. The annotations in Figure C.8.30.3.1-3 are R, right; L, left; H = Head; F = Foot.

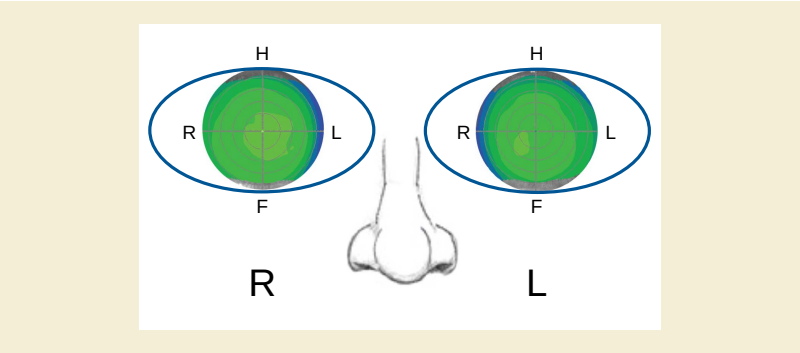


Figure C.8.30.3.1-3. Representation of Corneal Topography

Numerical position data shall use the Cartesian (i.e., two dimensional rectangular) coordinate system. The direction of the axes are determined by Patient Orientation (0020,0020), see Section C.7.6.1.1.1 for further explanation.

Devices that internally capture data in polar coordinates will need to convert to Cartesian coordinates, see Figure C.8.30.3.1-4.

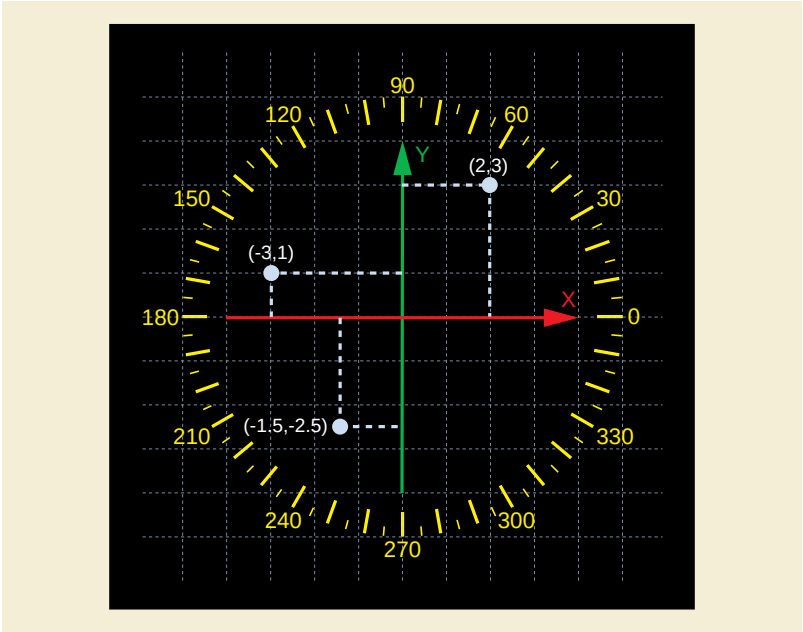


Figure C.8.30.3.1-4. Sample Coordinate Data Points

When using the 3 dimensional coordinates (X, Y, Z), the Z axis shall represent corneal elevation. Z shall be measured from the length of a vector normal to the plane that is normal to and intersects the corneal vertex at the intersection of the x, y, z, axes. It is shown in the diagram as "+" (0.0, 0.0, 0.0). The Z axis shall be positive towards the anterior direction of the eye; (i.e., it is a right-hand rule coordinate system. Thus the Z values (see Figure C.8.30.3.1-5 and Figure C.8.30.3.1-6) will be predominantly negative, as they are posterior to the plane of the corneal vertex.

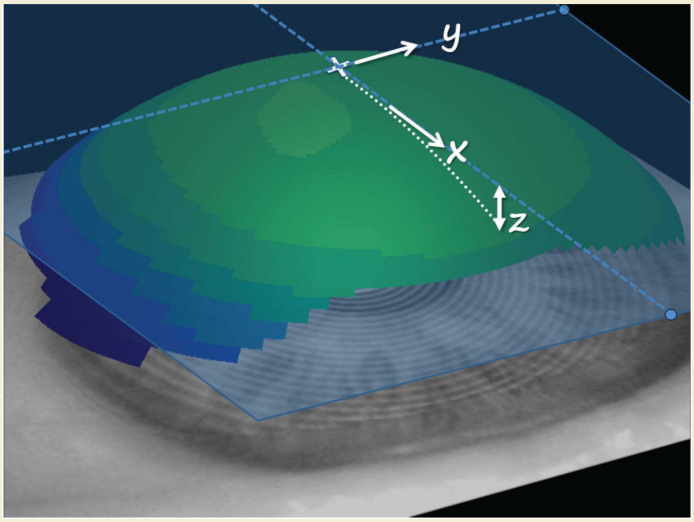


Figure C.8.30.3.1-5. Schematic of the 3-Dimensional Representation of Corneal Elevation

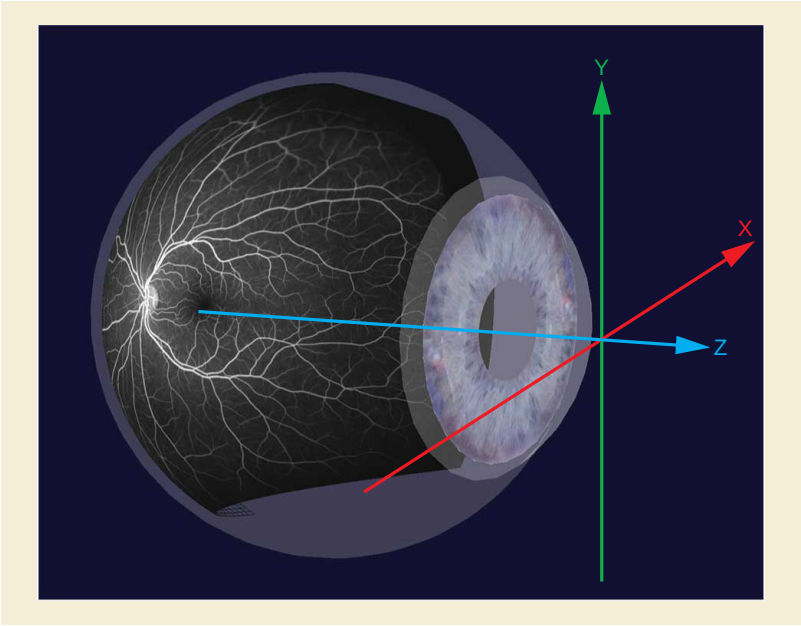


Figure C.8.30.3.1-6. Schematic of the Ophthalmic Coordinate System of the 3-Dimensional Representation used in Wide Field Measurements

C.8.31 Breast Projection Image Modules

C.8.31.1 Enhanced Mammography Image Module

Table C.8.31-1 specifies the Attributes that identify and describe general information about the Enhanced Mammography Image Module.

Table C.8.31-1. Enhanced Mammography Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Positioner Motion	(0018,1500)	1	Describes the activity of the X-Ray Source during acquisition. See C.8.31.1.1 for Defined Terms.
Positioner Type	(0018,1508)	1	Enumerated Values: **MAMMOGRAPHIC**
Content Qualification	(0018,9004)	1	Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See C.8.13.2.1.1 for further explanation.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this image started. Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).

Attribute Name	Tag	Type	Attribute Description
Acquisition Duration	(0018,9073)	1	The time in seconds needed for the compete acquisition. See C.7.6.16.2.2.1 for further explanation.
Include Table C.8-71b "Digital X-Ray Detector Macro Attributes"			
KVP	(0018,0060)	1	Average of the peak kilo voltage outputs of the X-Ray generator used for all frames.
X-Ray Tube Current in mA	(0018,9330)	1C	Average of the nominal X-Ray tube currents in milliamperes for all frames. Required if Exposure in mAs (0018,9332) is not present. May be present otherwise.
Exposure Time in ms	(0018,9328)	1C	Total (cumulative) duration of X-Ray exposure for all acquired frames in milliseconds. Required if Exposure in mAs (0018,9332) is not present. May be present otherwise.
Exposure in mAs	(0018,9332)	1C	The total (cumulative) exposure for all acquired frames expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current. Required if either Exposure Time in ms (0018,9328) or X-Ray Tube Current in mA (0018,9330) is not present. May be present otherwise.
Focal Spot(s)	(0018,1190)	1	Nominal focal spot size in mm used to acquire all frames.
Anode Target Material	(0018,1191)	1	The primary material in the anode of the X-Ray source. Defined Terms: **TUNGSTEN** **MOLYBDENUM** **RHODIUM**
Body Part Thickness	(0018,11A0)	1	The average thickness in mm of the body part examined when compressed, if compression has been applied during exposure.
Compression Force	(0018,11A2)	1	The compression force applied to the body part during exposure, measured in Newtons.
Compression Pressure	(0018,11A3)	3	The average compression pressure applied to the body part during exposure, calculated in kPa.
Compression Contact Area	(0018,11A5)	3	The area of the body part to which compression has been applied during exposure, measured in mm2. Note Area information is useful in addition to the Compression Pressure (0018,11A3) and Compression Force (0018,11A2) in the event that unusual values are encountered.
Paddle Description	(0018,11A4)	1	Description of the compression paddle, if compression was applied to the body part during exposure.
Exposure Control Mode	(0018,7060)	1	Type of exposure control Defined Terms: **AUTOMATIC** **MANUAL**

Attribute Name	Tag	Type	Attribute Description
Exposure Control Mode Description	(0018,7062)	1	Text description of the mechanism of exposure control. May describe the number and type of exposure sensors or position of the sensitive area of the imaging detector.
Patient Orientation	(0020,0020)	1C	Patient direction of the rows and columns of the most representative frame. Required if View Code Sequence (0054,0220) has an Item value other than one representing a specimen image. May be present otherwise.
Image Comments	(0020,4000)	3	User-defined comments about the image.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME1** **MONOCHROME2**
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. Enumerated Values: **8** **16**
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. Enumerated Values: **8** **9** **10** **11** **12** **13** **14** **15** **16**
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. Shall have an Enumerated Value of one less than the value of Bits Stored (0028,0101).
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. Enumerated Values: **0000H** unsigned integer

Attribute Name	Tag	Type	Attribute Description
Quality Control Image	(0028,0300)	3	Indicates whether or not this image is a quality control of phantom image. Enumerated Values: **YES** **NO**
Burned in Annotation	(0028,0301)	1	Indicates whether or not the image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if Lossy Image Compression (0028,2110) is "01".
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if Lossy Image Compression (0028,2110) is "01".
Organ Dose	(0040,0316)	1	Organ dose value measured in dGy representing the collective total for all acquired frames. Note This may be an estimated value.
Entrance Dose in mGy	(0040,8302)	1	Entrance dose value measured in mGy at the surface of the patient representing the collective total for all acquired frames. Note This may be an estimated value based on assumptions about the patient's body size and habitus.

Attribute Name	Tag	Type	Attribute Description
Entrance Dose Derivation	(0040,8303)	3	Describes what type of dose is represented by the values of Entrance Dose in mGy (0040,8302). Enumerated Values: **IAK** Represents air kerma at the entrance surface, no backscatter included, no air kerma to tissue dose conversion applied. **ESAK** Represents air kerma at the entrance surface, with backscatter included, no air kerma to tissue dose conversion applied. **ESDBS** Represents absorbed dose in tissue at the entrance surface, with backscatter included. **ESDNOBS** Represents absorbed dose in tissue at the entrance surface, without backscatter included.
Type of Detector Motion	(0054,0202)	1	Describes the activity of the Detector during acquisition. See C.8.31.1.1 for Defined Terms.
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See C.7.6.1.1.6 for further explanation.*
Presentation LUT Shape	(2050,0020)	1	Specifies a transformation for the Presentation LUT such that the output of all grayscale transformations, if any, is defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values; shall be used if Photometric Interpretation (0028,0004) is MONOCHROME2. **INVERSE** output after inversion is in P-Values; shall be used if Photometric Interpretation (0028,0004) is MONOCHROME1.

C.8.31.1.1 Positioner and Detector Motion Attribute Descriptions

Positioner Motion (0018,1500) and Type of Detector Motion (0054,0202) shall have the Defined Terms specified in Table C.8.31.1.1-1.

Table C.8.31.1.1-1. Types of Positioner and Detector Motion

STATIONARY	No motion
ROTATION_STEP	Circular arc motion, stepped, acquire only while stationary
ROTATION_CONT	Circular arc motion, continuous during acquisition
TRANSLATION_STEP	Linear motion, stepped, acquire only while stationary
TRANSLATION_CONT	Linear motion, continuous during acquisition
COMPLEX_STEP	Complex motion, stepped, acquire only while stationary
COMPLEX_CONT	Complex motion, continuous during acquisition

Complex motion is defined as that which is not simply described by linear translation or rotation around an axis.

C.8.31.2 Breast X-Ray Positioner Macro

Table C.8.31.2-1 specifies the Attributes of the Breast X-Ray Positioner Functional Group Macro.

Table C.8.31.2-1. Breast X-Ray Positioner Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Positioner Position Sequence	(0018,9405)	1	A Sequence that describes the geometrical position of the positioner. Only a single Item shall be included in this Sequence.
>Positioner Primary Angle	(0018,1510)	1C	Signed position in degrees of the X-Ray beam vector in the coronal anatomical plane as if the patient were standing facing the equipment where vertical is zero. Required if X-Ray source can be moved in the coronal anatomical plane. May be present otherwise.
>Positioner Primary Angle Direction	(0018,9559)	1C	The interpretation of the sign of the Positioner Primary Angle (0018,1510). Enumerated Values: **CW** Clockwise. Positioner Primary Angle movement is positive when movement is from vertical to the patient's right (with patient standing, facing the equipment). **CC** Counter-clockwise. Positioner Primary Angle is positive when movement is from vertical to the patient's left (with patient standing, facing the equipment). See Figure C.8.31.2-1. Required if Positioner Primary Angle (0018,1510) is present.
>Positioner Secondary Angle	(0018,1511)	1C	Position in degrees of the X-Ray beam vector in the sagittal anatomical plane as if the patient were standing where movement of the X-Ray source from anterior to posterior is positive, and vertical is zero. Required if the X-Ray source can be moved in the sagittal anatomical plane. May be present otherwise.

C.8.31.2.1 Breast X-Ray Positioner Attribute Descriptions

Figure C.8.31.2-1 illustrates the Defined Terms for Positioner Primary Angle Direction (0018,9559), indicating which C-arm movement direction defines a positive value for Positioner Primary Angle (0018,1510).

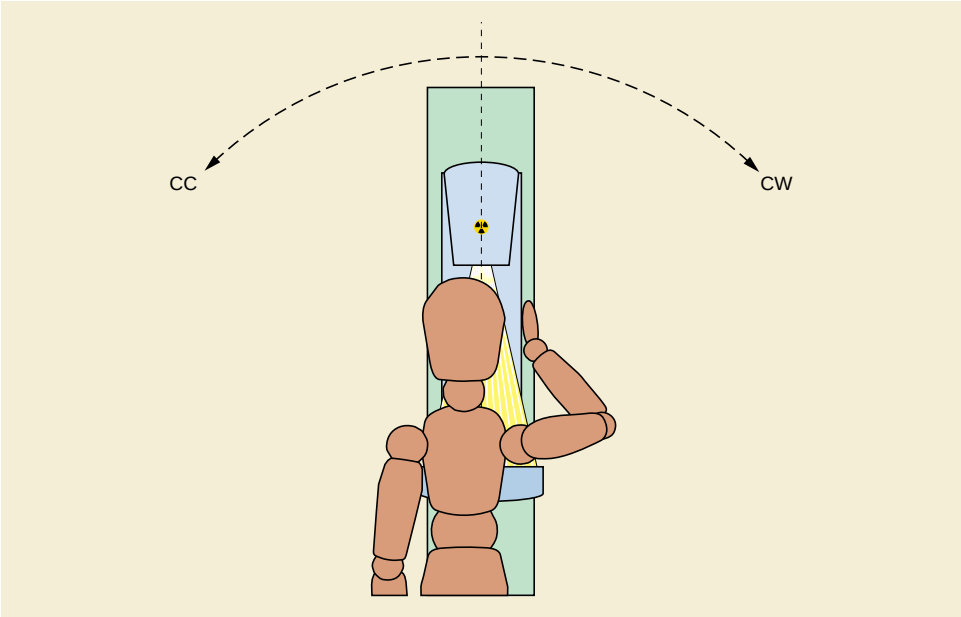


Figure C.8.31.2-1. Illustration of Positioner Primary Angle Direction

C.8.31.3 Breast X-Ray Detector Macro

Table C.8.31.3-1 specifies the Attributes of the Breast X-Ray Detector Functional Group Macro.

Table C.8.31.3-1. Breast X-Ray Detector Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Detector Position Sequence	(0018,9541)	1	A Sequence that describes the geometrical position of the detector. Only a single Item shall be included in this Sequence.
>Detector Primary Angle	(0018,1530)	1C	Angle of the X-Ray beam in the row direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted toward higher numbered columns. Negative values indicate that the X-Ray beam is tilted toward lower numbered columns. See C.8.11.7.1.2. Required if the detector can be moved in the row direction. May be present otherwise.
>Detector Secondary Angle	(0018,1531)	1C	Angle of the X-Ray beam in the column direction in degrees relative to the normal to the detector plane. Positive values indicate that the X-Ray beam is tilted toward lower numbered rows. Negative values indicate that the X-Ray beam is tilted toward higher numbered rows. See C.8.11.7.1.2. Required if the detector can be moved in the column direction. May be present otherwise.

C.8.31.4 Breast X-Ray Geometry Macro

Table C.8.31.4-1 specifies the Attributes of the Breast X-Ray Geometry Functional Group Macro.

Table C.8.31.4-1. Breast X-Ray Geometry Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray Geometry Sequence	(0018,9476)	1	Sequence containing the geometric properties for this frame or set of frames. Only a single Item shall be included in this Sequence.
>Distance Source to Detector	(0018,1110)	1C	Distance in mm from source to detector center on the chest wall line. Required if Presentation Intent Type (0008,0068) = FOR PROCESSING. May be present otherwise. Note 1. This value is traditionally referred to as Source Image Distance (SID). 2. See C.8.11.7.1.1.
>Distance Source to Patient	(0018,1111)	1C	Distance in mm from source to the Breast Support side that is closest to the Imaging Subject, as measured along the X-Ray beam vector. Required if Presentation Intent Type (0008,0068) = FOR PROCESSING. May be present otherwise. Note 1. This value is traditionally referred to as Source Object Distance (SOD). 2. See notes for this Attribute in C.8.11.5. 3. See C.8.11.7.1.1 for description of X-Ray beam vector.
>Distance Source to Isocenter	(0018,9402)	1C	Distance from source to isocenter in mm. Required if Presentation Intent Type (0008,0068) = FOR PROCESSING. May be present otherwise.
>Distance Source to Entrance	(0040,0306)	3	Distance in mm from the source to the surface of the patient closest to the source during the acquisition of this image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
>Estimated Radiographic Magnification Factor	(0018,1114)	1	Ratio of Source Image Distance (SID) over Source Object Distance (SOD).

C.8.31.5 Breast X-Ray Acquisition Dose Macro

Table C.8.31.5-1 specifies the Attributes of the X-Ray Acquisition Dose Functional Group Macro.

Table C.8.31.5-1. Breast X-Ray Acquisition Dose Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray Acquisition Dose Sequence	(0018,9542)	1	Sequence containing the X-Ray exposure information for this frame. Only a single Item shall be included in this Sequence.
>Exposure Time in ms	(0018,9328)	1	Duration of X-Ray exposure in milliseconds.

Attribute Name	Tag	Type	Attribute Description
>Exposure in mAs	(0018,9332)	1	The exposure expressed in mAs, for example calculated from Exposure Time and X-Ray Tube Current.
>Relative X-Ray Exposure	(0018,1405)	3	Indication of the applied dose, in manufacturer specific units. Note 1. This value is intended to provide a single location where manufacturer specific information can be found for annotation on a display or film, that has meaning to a knowledgeable observer. 2. This may be a calculated or measured value. Examples are the detector entrance dose (KB) , the CR sensitivity value (S), or the logarithmic median (lgM). 3. DICOM specifies Standard Attributes in Table 10-23 “Exposure Index Macro Attributes”, which are recommended.
>Half Value Layer	(0040,0314)	3	The thickness of Aluminum in mm required to reduce the X-Ray Output (0040,0312) by a factor of two. Note This value may be a calibrated value rather than measured during the exposure.
>Organ Dose	(0040,0316)	1	Average organ dose value measured in dGy during the acquisition of this image. Note This may be an estimated value.
>Entrance Dose in mGy	(0040,8302)	1	Average entrance dose value measured in mGy at the surface of the patient during the acquisition of this image. Note This may be an estimated value based on assumptions about the patient's body size and habitus.
>Entrance Dose Derivation	(0040,8303)	3	Describes what type of dose is represented by the values of Entrance Dose in mGy (0040,8302). Enumerated Values: **IAK** Represents air kerma at the entrance surface, no backscatter included, no air kerma to tissue dose conversion applied. **ESAK** Represents air kerma at the entrance surface, with backscatter included, no air kerma to tissue dose conversion applied. **ESDBS** Represents absorbed dose in tissue at the entrance surface, with backscatter included. **ESDNOBS** Represents absorbed dose in tissue at the entrance surface, without backscatter included.

C.8.31.6 Breast X-Ray Isocenter Reference System Macro

Table C.8.31.6-1 specifies the Attributes of the Breast X-Ray Isocenter Reference System Functional Group Macro.

Table C.8.31.6-1. Breast X-Ray Isocenter Reference System Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Isocenter Reference System Sequence	(0018,9462)	1	A Sequence that describes the Isocenter Reference Coordinate System (O, X, Y, Z). Only a single Item shall be included in this Sequence.
>X-Ray Source Isocenter Primary Angle	(0018,9543)	1	Primary angle of the X-Ray source in the isocenter reference system (deg). See C.8.31.6.1.2 for further explanation.
>X-Ray Source Isocenter Secondary Angle	(0018,9544)	1	Secondary angle of the X-Ray source in the isocenter reference system (deg). See C.8.31.6.1.2 for further explanation.
>Breast Support Isocenter Primary Angle	(0018,9545)	1	Primary angle of the Breast Support in the isocenter reference system (deg). See C.8.31.6.1.3 for further explanation.
>Breast Support Isocenter Secondary Angle	(0018,9546)	1	Secondary angle of the Breast Support in the isocenter reference system (deg). See C.8.31.6.1.3 for further explanation.
>Breast Support X Position to Isocenter	(0018,9547)	1C	X position of the Breast Support Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.3 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Breast Support Y Position to Isocenter	(0018,9548)	1C	Y position of the Breast Support Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.3 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Breast Support Z Position to Isocenter	(0018,9549)	1C	Z position of the Breast Support Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.3 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Detector Isocenter Primary Angle	(0018,9550)	1	Primary angle of the Detector in the isocenter reference system (deg). See C.8.31.6.1.4 for further explanation.
>Detector Isocenter Secondary Angle	(0018,9551)	1	Secondary angle of the Detector in the in the isocenter reference system (deg). See C.8.31.6.1.4 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Detector X Position to Isocenter	(0018,9552)	1C	X position of the Detector Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.4 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Detector Y Position to Isocenter	(0018,9553)	1C	Y position of the Detector Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.4 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Detector Z Position to Isocenter	(0018,9554)	1C	Z position of the Detector Reference Point with respect to the Isocenter (mm). See C.8.31.6.1.4 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Detector Active Area TLHC Position	(0018,9557)	1C	The x, y, and z coordinates in mm of the center of the top left hand corner detector element of the detector active area in the Detector coordinate system. See C.8.31.6.1.5 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.
>Detector Active Area Orientation	(0018,9558)	1C	The direction cosines of the first row and the first column with respect to the Detector coordinate system. See C.8.31.6.1.5 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.

C.8.31.6.1 Isocenter Reference System Attribute Descriptions

The Isocenter Reference System Attributes describe the 3D geometry of the X-Ray equipment composed by the X-Ray Source, Breast Support and the Detector.

These Attributes define four coordinate systems in the 3D space:

- Isocenter coordinate system
- X-Ray Source coordinate system
- Breast Support coordinate system
- Detector coordinate system

The Isocenter Reference System Attributes describe the relationship between the 3D coordinates of a point in the Breast Support coordinate system and the 3D coordinates of such point in the X-Ray Source and Detector coordinate systems (which may move in the equipment), by using the Isocenter coordinate system that is fixed in the equipment.

Unlike in X-Ray Angiography, in stereotactic biopsy and breast tomosynthesis the X-Ray source does not move in lock-step with the detector. The detector may be stationary, may translate, or may rotate as the X-Ray source moves. Thus for the purpose of stereotactic

biopsy and breast tomosynthesis, the X-Ray Source and Detector Coordinate Systems are defined separately, and each of the potential detector positionings is considered separately.

Note

Annex Z “X-Ray Isocenter Reference Transformations (Informative)” in PS3.17 describes the transformations necessary to transpose between coordinate systems.

The detector is anterior to the patient standing upright and facing the front of the gantry, as shown in Figure C.8.31.6-1.

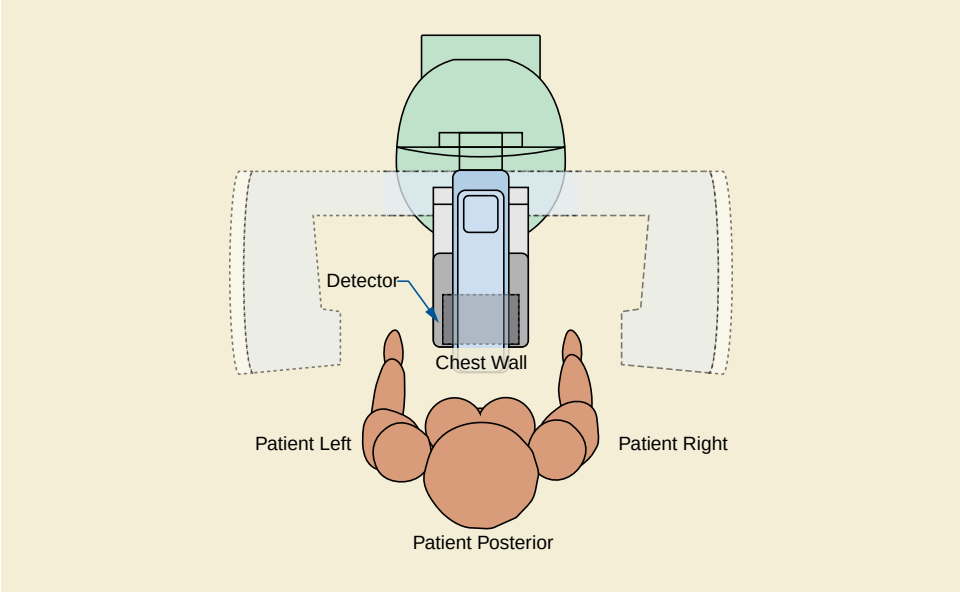
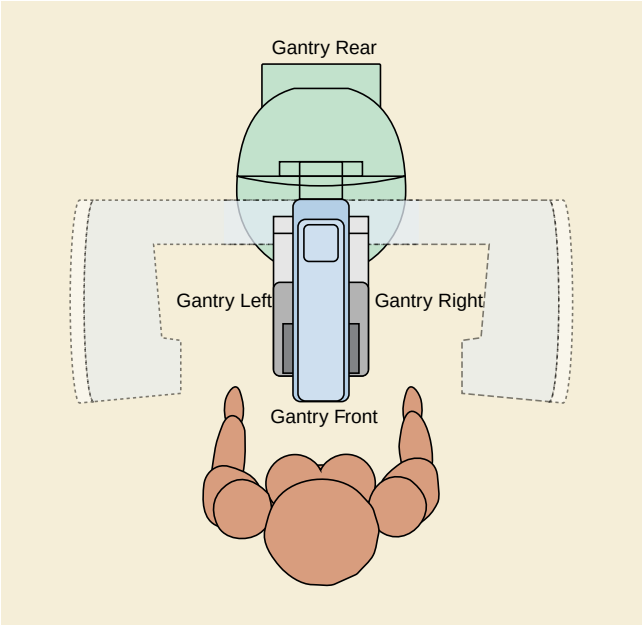


Figure C.8.31.6-1. Patient/Detector Relationship (Patient Standing)

As breast projection X-Ray imaging traditionally uses devices with similar physical appearance, the following terms are defined for the purpose of helping later convey the geometry associated with breast projection X-Ray imaging:

GANTRY FRONT	The side of the equipment closest to the patient when the patient is standing, positioned for breast projection X-Ray imaging.	 **Figure C.8.31.6-2. Gantry Sides**
GANTRY RIGHT	The right-hand side of the equipment when the patient is standing facing GANTRY FRONT.	
GANTRY LEFT	The left-hand side of the equipment when the patient is standing facing GANTRY FRONT.	
GANTRY REAR	The side of the equipment furthest from the patient when the patient is standing, positioned for breast projection X-Ray imaging.	

C.8.31.6.1.1 Isocenter Coordinate System

The Isocenter coordinate system (O,X,Y,Z) of the equipment is defined as follows (see Figure C.8.31.6-3) :

- Origin O is the System Isocenter, which is the point where the plane of motion of the X-Ray Source spot intersects the axis of rotation of the X-Ray Source.
- +X direction is from GANTRY LEFT to GANTRY RIGHT in the horizontal plane (gravity plane).
- +Y direction is from GANTRY FRONT to GANTRY REAR in the horizontal plane (gravity plane).
- +Z direction is upward (anti-gravity).
- The isocenter coordinate system does not rotate when the tube head or C-arm rotates.

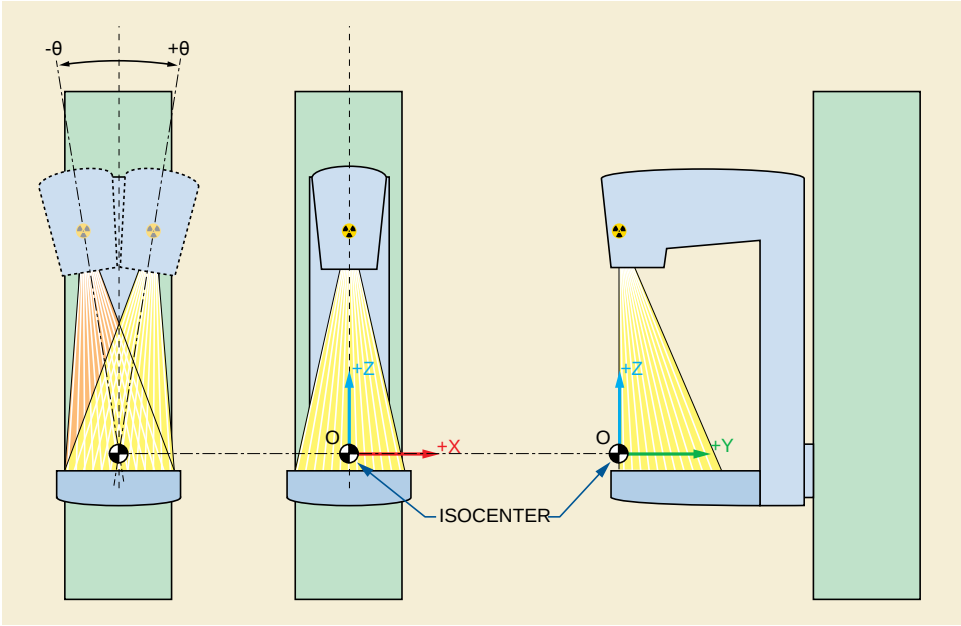


Figure C.8.31.6-3. Isocenter Coordinate System

C.8.31.6.1.2 X-Ray Source Coordinate System

The X-Ray Source coordinate system (O_s, X_s, Y_s, Z_s) is defined as follows (see Figure C.8.31.6-4):

- Origin O_s is identical to the origin of the Isocenter coordinate system O.
- X_s axis is in the plane normal to the axis of rotation of the X-Ray source through O_s and is perpendicular to the X-Ray source. Positive direction is from GANTRY LEFT to GANTRY RIGHT when the X-Ray source is overhead (As_1 equals 0°).
- Y_s axis is the axis of rotation of the X-Ray source. Positive direction is from GANTRY FRONT to GANTRY REAR.
- Z_s axis is normal to the X_s Y_s plane. The $+Z_s$ direction is generally toward the X-Ray source, defined by the right-hand rule from $+X_s$ and $+Y_s$.

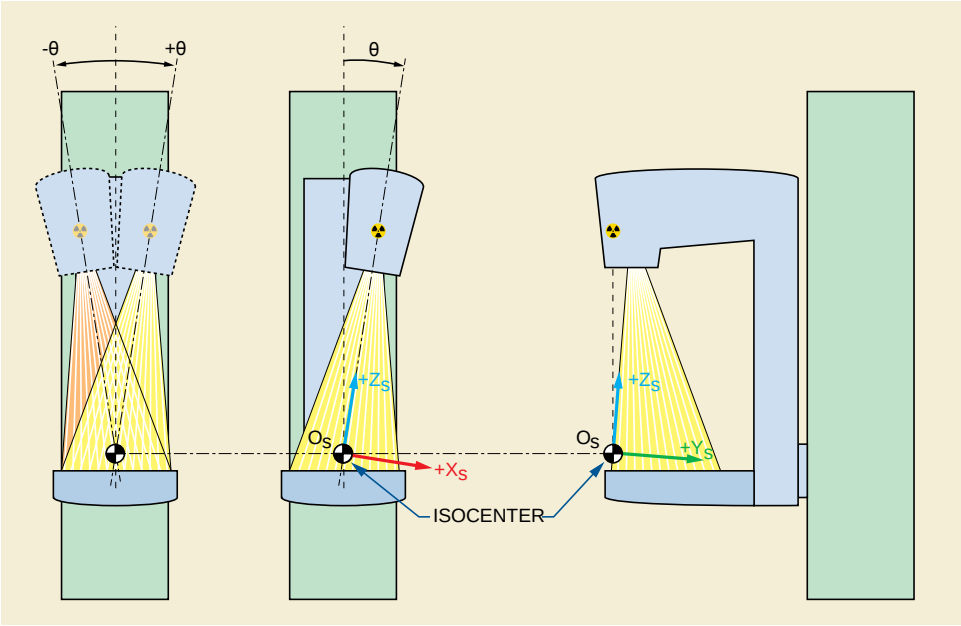


Figure C.8.31.6-4. X-Ray Source Coordinate System

The X-Ray Source coordinate system (O_s, X_s, Y_s, Z_s) is characterized with respect to the Isocenter coordinate system (O, X, Y, Z), by two angles describing the X-Ray center beam. These angles are relative to the Isocenter reference system, and independent from the patient position on the equipment.

X-Ray Source Isocenter Primary Angle (0018,9543) (so-called As_1 in Figure C.8.31.6-5) is defined as the angle between the YZ plane and the YZ_s plane. The angle from $+Z_s$ toward $+X_s$ is positive.

X-Ray Source Isocenter Secondary Angle (0018,9544) (so-called As_2 in Figure C.8.31.6-5) is defined as the angle between the XZ plane and the XZ_s plane. The angle from $+Z_s$ toward $+Y_s$ is positive.

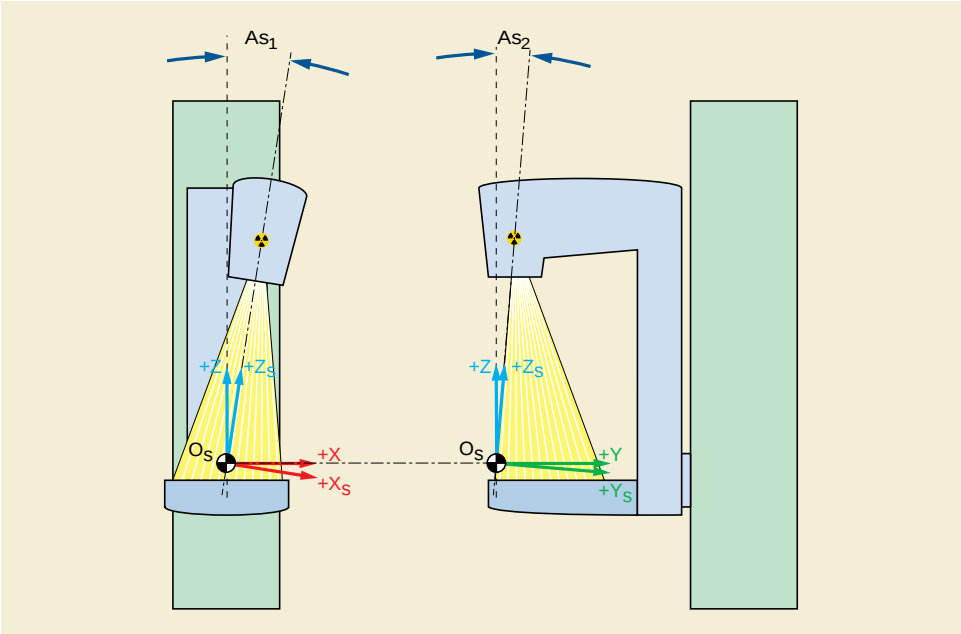


Figure C.8.31.6-5. X-Ray Source Isocenter Angles

C.8.31.6.1.3 Breast Support Coordinate System

The Breast Support (see Figure C.8.31.6-6) is the housing over the detector onto which the breast is placed before imaging. For the purpose of this description, Breast Support top surface refers to the patient contact surface of the Breast Support, closest to the X-Ray source.

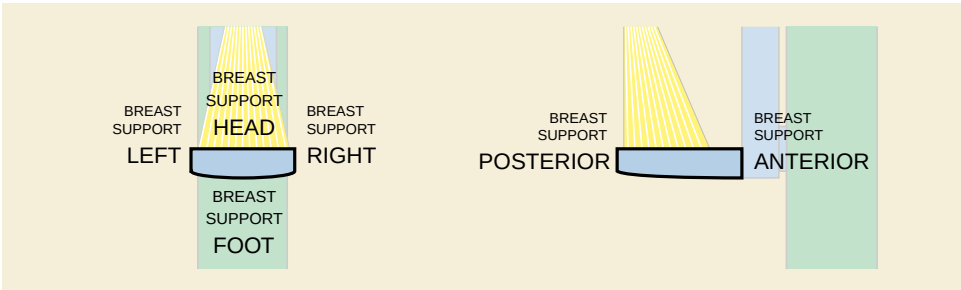


Figure C.8.31.6-6. Breast Support Orientation

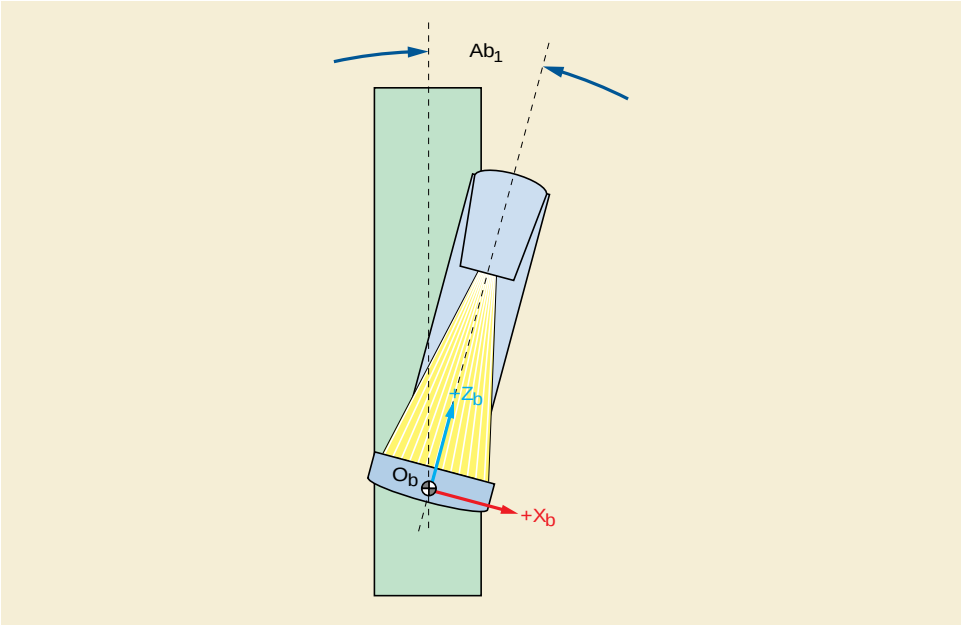
The Breast Support coordinate system (O_b, X_b, Y_b, Z_b) is defined as follows (see Figure C.8.31.6-7):

- Origin O_b, the so-called Breast Support Reference Point, is an ~~arbitary~~arbitrary point, as defined by the equipment manufacturer, on the axis of the center of rotation of the Breast Support.
- X_b axis lies parallel to the Breast Support top surface, passes through O_b, and is parallel to X when the Breast Support top surface is normal to gravity. The $+X_b$ direction is toward BREAST SUPPORT RIGHT.
- Y_b axis lies parallel to the Breast Support top surface, passes through O_b, and is perpendicular to the X_b axis. The $+Y_b$ direction is toward BREAST SUPPORT ANTERIOR.
- Z_b axis is normal to the Breast Support top surface and passes through O_b. The $+Z_b$ direction is toward BREAST SUPPORT HEAD.

The Breast Support coordinate system (O_b, X_b, Y_b, Z_b) is characterized, with respect to the Isocenter coordinate system (O, X, Y, Z), by two rotations that describe the Breast Support tilt and a 3D translation (see Figure C.8.31.6-7). It is the most common convention in breast projection X-Ray system design to have the Breast Support rotate identically and in synchronization with the system C-arm (they are most often rigidly integrated):

Breast Support Isocenter Primary Angle (0018,9545) (so-called Ab_1) is defined as the angle between the YZ plane and the YZ_b plane. The angle is positive when the Breast Support Right end of the Breast Support is lower than the Breast Support Left end of the Breast Support, and is 0° when the Breast Support surface is normal to the +Z direction. In digital breast tomosynthesis, because the X-Ray source moves independently of the Breast Support, the Breast Support Isocenter Primary Angle is the principal place where the user's perception of the C-arm angle is encoded.

Breast Support Isocenter Secondary Angle (0018,9546) (so-called Ab_2) is defined as the angle between the XY plane and the XY_b plane. The angle is positive when the Breast Support Anterior side of the Breast Support is lower than the Breast Support Posterior end of the Breast Support, and is 0° when the Breast Support surface is normal to the +Z axis. In most breast projection X-Ray imaging equipment the value of Ab_2 is 0°.



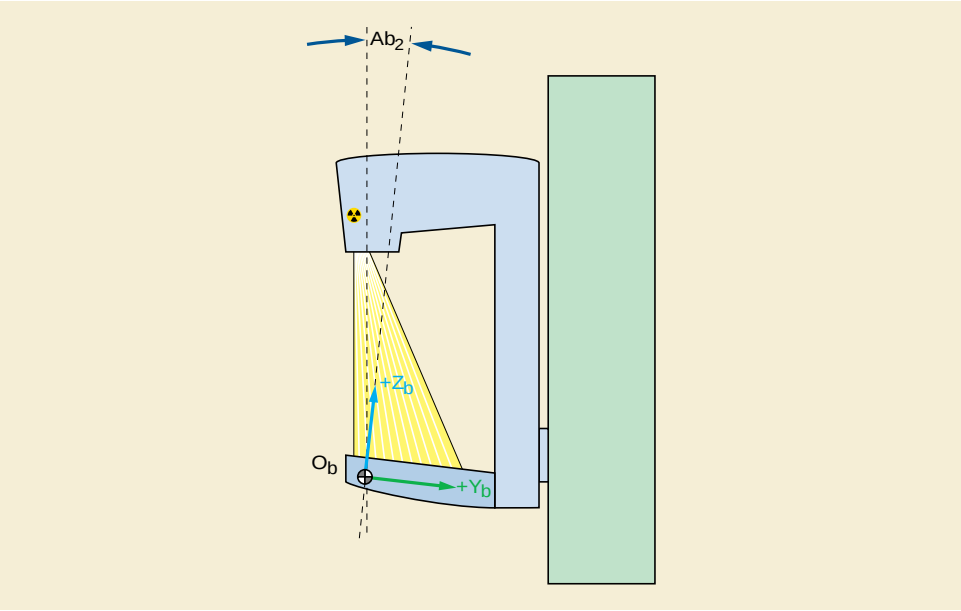


Figure C.8.31.6-7. Breast Support Angles with respect to the Isocenter Reference System

Breast Support X Position to Isocenter (0018,9547) (so-called B_X) is defined as the translation of the Breast Support Reference Point O_b with respect to the Isocenter coordinate system in the +X axis direction. Breast support translation toward +X is positive.

Breast Support Y Position to Isocenter (0018,9548) (so-called B_Y) is defined as the translation of the Breast Support Reference Point O_b with respect to the Isocenter coordinate system in the +Y axis direction. Breast support translation toward +Y is positive.

Breast Support Z Position to Isocenter (0018,9459) (so-called B_Z) is defined as the translation of the Breast Support Reference Point O_b with respect to the Isocenter coordinate system in the +Z axis direction. Breast support translation toward +Z is positive.

Note

A translation of (B_X, B_Y, B_Z) = (0, 0, 0) means that the Breast Support Reference Point O_b is at the System Isocenter.

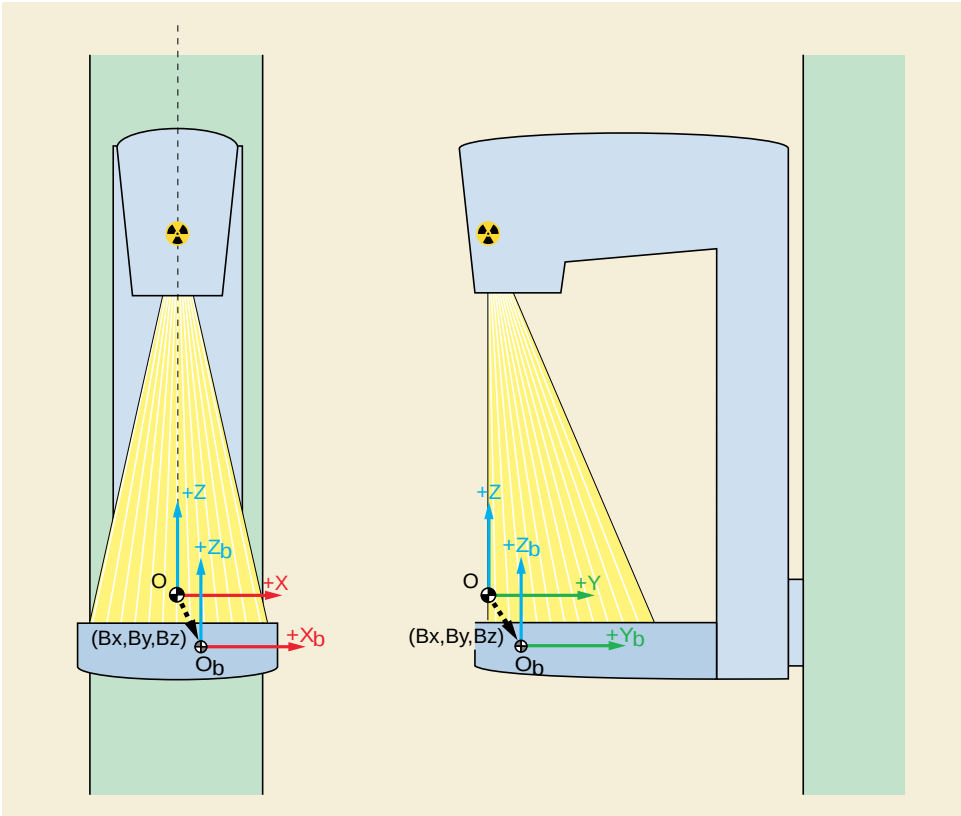


Figure C.8.31.6-8. Breast Support Translation with respect to the Isocenter Reference System

C.8.31.6.1.4 Detector Coordinate System

A detector coordinate system is defined that allows the detector to be either stationary or in motion. For clarity of understanding and interoperability, detector motion terms that may be used during image acquisition are defined, as indicated in Type of Detector Motion (0054,0202):

- Stationary Detector
- Rotating Detector
- Translating Detector
- Complex Detector

An infinite variation of detector motions is possible through time- and angle- dependent combinations of detector rotation and detector translation.

At any given point in time during image acquisition the detector origin O_d may be translated with respect to the system isocenter and/or the detector coordinate system rotated with respect to the isocenter coordinate system. The detector coordinate system (O_d, X_d, Y_d, Z_d) is defined as follows (see Figure C.8.31.6-9):

- Detector Reference Point O_d, is an arbitrary point, defined by the equipment manufacturer, that lies on the axis of rotation of the detector, if any.
- X_d axis lies in the plane parallel to the detector surface, through the point O_d, and perpendicular to the axis of rotation. The $+X_d$ direction is in the same direction as the +X direction when the detector surface is normal to gravity.
- Y_d axis is the axis of rotation of the detector and is parallel to Y. The $+Y_d$ direction is in the same direction as the +Y direction when the detector surface is normal to gravity.
- Z_d axis is normal to the detector surface and through the point O_d. The $+Z_d$ direction is upward, defined by the right-hand rule from $+X_d$ and $+Y_d$.

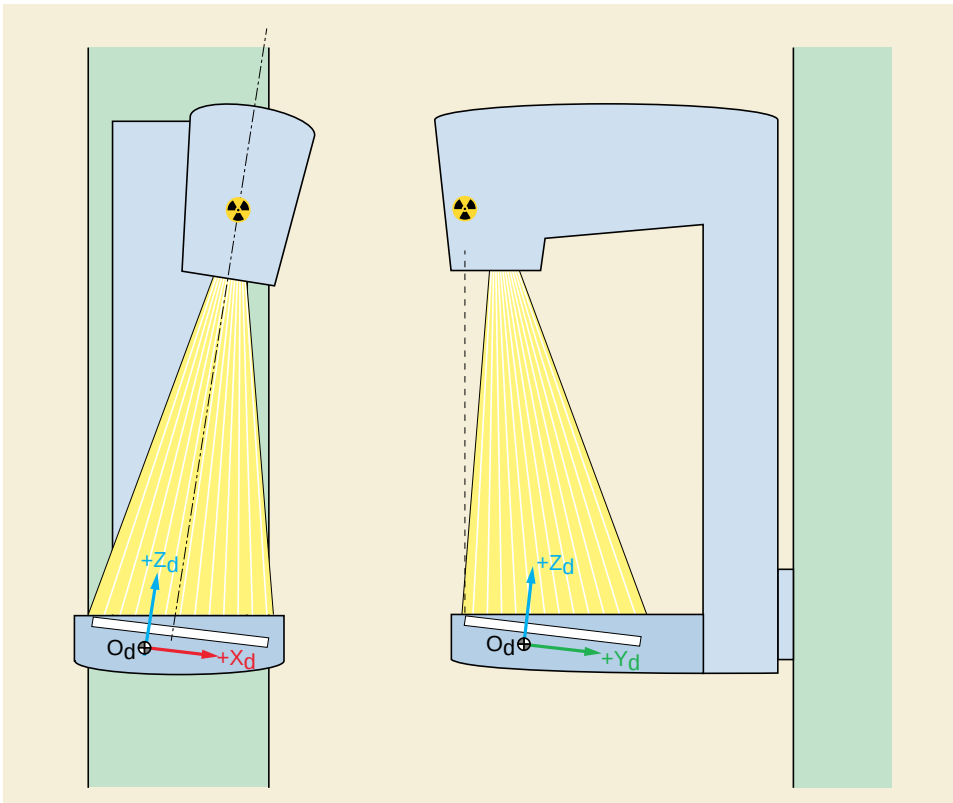


Figure C.8.31.6-9. Detector Coordinate System

The Detector coordinate system (O_d, X_d, Y_d, Z_d) is characterized with respect to the Isocenter coordinate system (O, X, Y, Z), by two angles describing the tilt of the detector. These angles are relative to the Isocenter reference system, and independent from the patient position on the equipment.

Detector Isocenter Primary Angle (0018,9550) (so-called Ad_1) is defined as the angle between the YZ plane and the YZ_d plane. The angle is positive when the $+X_d$ axis is lower than the $-X_d$ axis with respect to Z, and is 0°when the detector surface is normal to the +Z axis.

Detector Isocenter Secondary Angle (0018,9551) (so-called Ad_2) is defined as the angle between the plane XZ and the plane XZ_d. The angle is positive when the $+Y_d$ axis is lower than the $-Y_d$ axis with respect to Z. In most cases this angle is 0°, inferring that the XZ plane is parallel to the X_d plane.

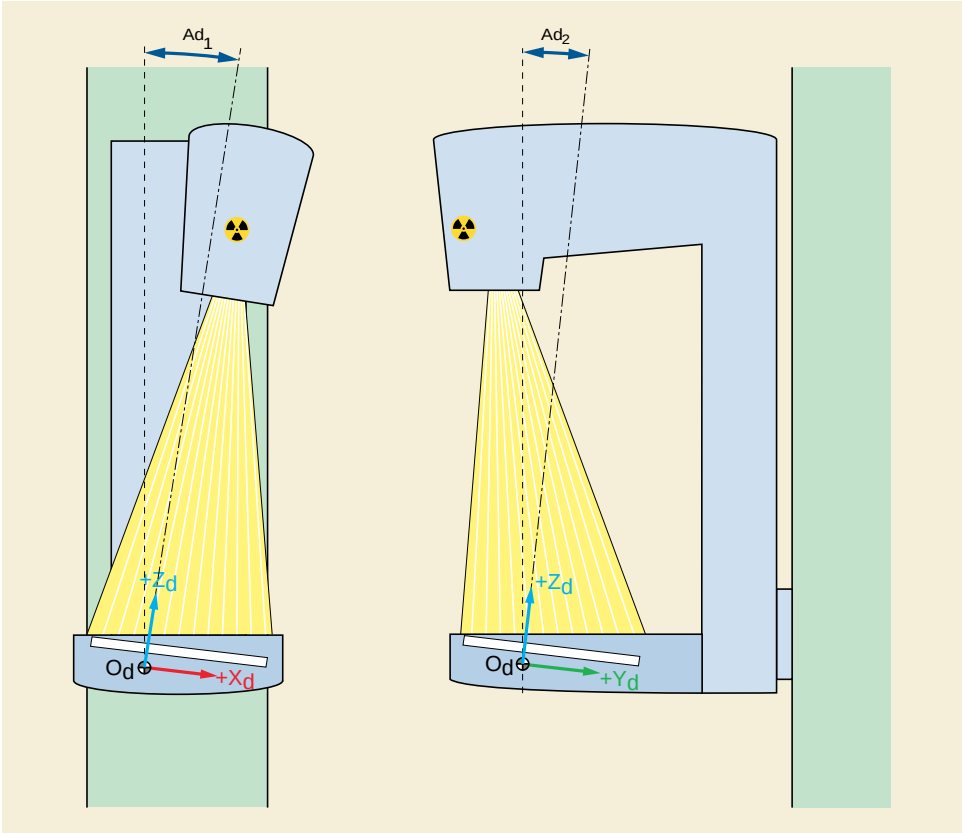


Figure C.8.31.6-10. Detector Isocenter Angles

Detector X Position to Isocenter (0018,9552) (so-called D_X) is defined as the translation of the Detector Reference Point O_d with respect to the Isocenter coordinate system in the X direction. A translation of D_X toward Breast Support Right from Detector O_d is positive.

Detector Y Position to Isocenter (0018,9553) (so-called D_Y) is defined as the translation of the Detector Reference Point O_d with respect to the Isocenter coordinate system in the Y direction. A translation of D_Y toward Breast Support Anterior from Detector O_d is positive.

Detector Z Position to Isocenter (0018,9554) (so-called D_Z) is defined as the translation of the Detector Reference Point O_d with respect to the Isocenter coordinate system in the Z direction. A translation of D_Z toward Breast Support Head from Detector O_d is positive.

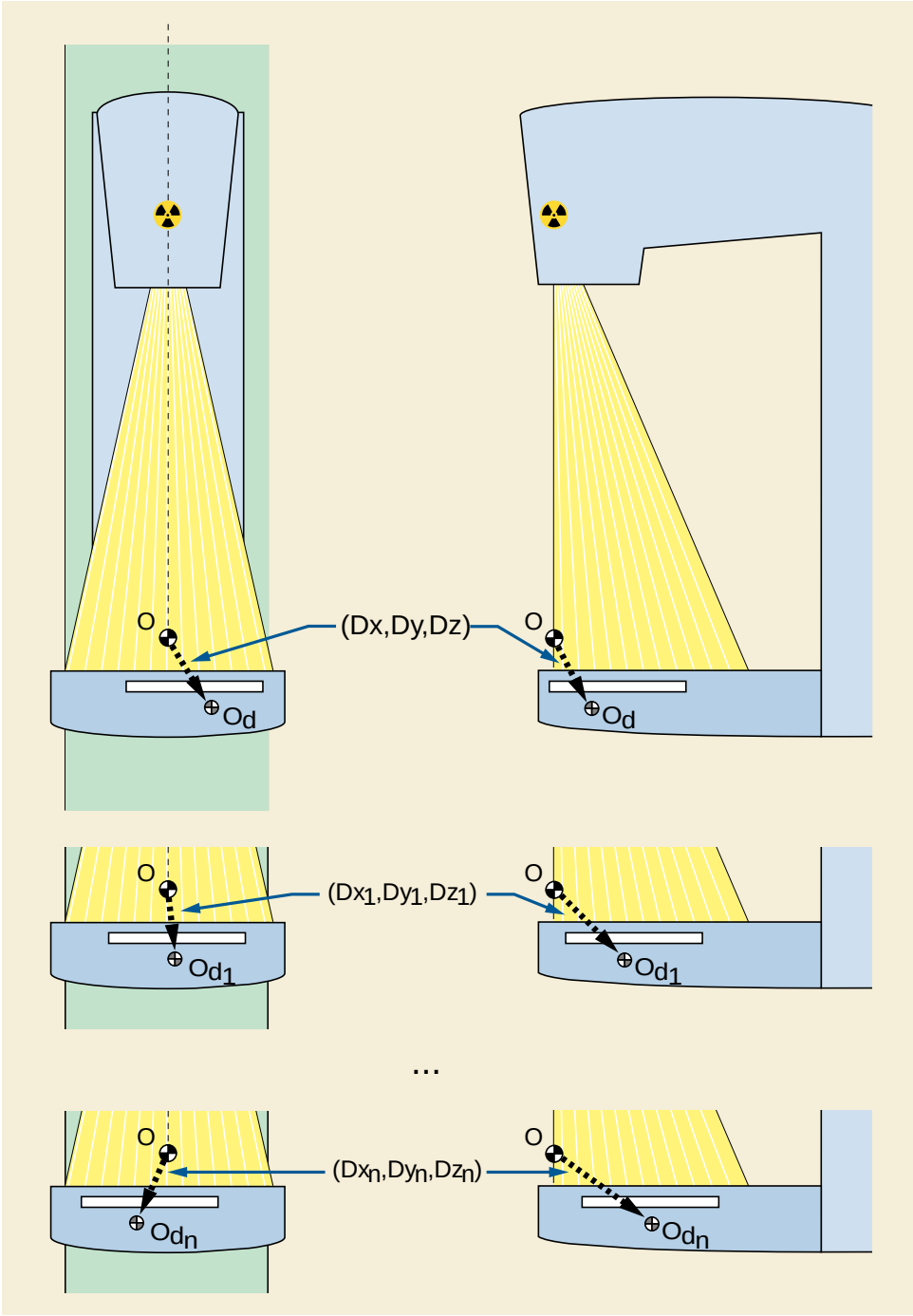


Figure C.8.31.6-11. Translation of the Detector Coordinate System

Although not shown in Figure C.8.31.6-11, translation of the detector moves the Detector Origin O_d relative to the Isocenter. Thus during translation of the detector, at least one of D_X, D_Y and D_Z will change.

Note

A translation of (D_X, D_Y, D_Z) = (0, 0, 0) means that the Detector Reference Point O_d is at the System Isocenter.

The case where the detector is stationary during image acquisition is a degenerate case, but still defined in the same manner.

Note

1. An angulation of (Ad_1, Ad_2) = (0, 0) means that the Detector is not rotated relative to the System Isocenter coordinate system.
2. A translation of (D_X, D_Y, D_Z) = (0, 0, 0) means that the Detector Reference Point O_d is at the System Isocenter.

C.8.31.6.1.5 Detector Active Area Relationship

The image and planes in conventional mammography and digital breast tomosynthesis are expressed in relation to Detector FOV and Detector Active area (see C.8.11.4.1.1). As manufacturers design their systems differently, the detector may be mounted or positioned differently in different breast imaging systems. As a result, the TLHC position of the Detector Active Area, together with row and column directions, must be specified (see Figure C.8.31.6-12). The relationship between the Detector Active Area TLHC, the row and column directions of the Active Area, and the Field of View and Detector Coordinate System (defined in C.8.31.6.1.4) is defined by two Attributes.

- Detector Active Area TLHC Position (0018,9557) specifies the x, y and z ~~cooordinates~~coordinates in mm of the center of the pixel defined as Detector Active Area TLHC within the Detector coordinate system, where the Z-direction value is always 0 since the detector itself is in X_dY_d plane. A value of Detector Active Area TLHC Position (0018,9557) = (0,0,0) means that the Detector Active Area TLHC Position is at the origin O_d of the Detector coordinate system.
- Detector Active Area Orientation (0018,9558) specifies the direction cosines of the first row followed by the direction cosines of the first column within the Detector coordinate system. The first three values contain the cosine of the angle between the first row and the X_d, Y_d and Z_d axes, respectively. The next three values contain the cosine of the angle between the first column and the X_d, Y_d and Z_d axes, respectively.

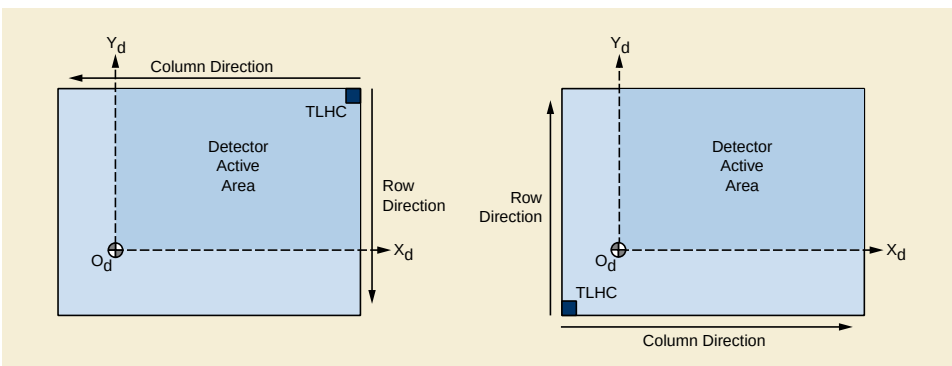


Figure C.8.31.6-12. Examples of Detector Active Area TLHC Position and Orientation

In Figure C.8.31.6-12, the left picture illustrates Detector Active Area Orientation (0018,9558) = (0,-1,0,-1,0,0), while the right picture illustrates Detector Active Area Orientation (0018,9558) = (0,1,0,1,0,0).

C.8.31.7 X-Ray Grid Macro

Table C.8.31.7-1 specifies the Attributes of the X-Ray Grid Functional Group Macro.

Table C.8.31.7-1. X-Ray Grid Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray Grid Sequence	(0018,9555)	1	A Sequence that describes the geometrical position of the positioner. Only a single Item shall be included in this Sequence.
>Grid	(0018,1166)	1	Identified the grid. May be multi-valued. Defined Terms: **FIXED** **FOCUSED** **RECIPROCATING** **PARALLEL** **CROSSED** **NONE**
Include Table C.8-36b "X-Ray Grid Description Macro Attributes"			

C.8.31.8 X-Ray Filter Macro

Table C.8.31.8-1 specifies the Attributes of the X-Ray Filter Functional Group Macro.

Table C.8.31.8-1. X-Ray Filter Macro Attributes

Attribute Name	Tag	Type	Attribute Description
X-Ray Filter Sequence	(0018,9556)	1	A Sequence that describes the Attributes related to the filtration of X-Rays during image acquisition. Only a single Item shall be included in this Sequence.
> Include Table C.8-35a "X-Ray Filtration Macro Attributes"			

C.8.32 Parametric Map

This section describes the specific Modules for the Parametric Map IOD.

C.8.32.1 Parametric Map Series Module

Table C.8.32-1 defines the general Attributes of the Parametric Map Series Module.

Table C.8.32-1. Parametric Map Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type Note 1. It is expected that the majority of Parametric Maps will use the appropriate value for the acquisition modality, e.g., "MR", and so no specific Defined Terms or Enumerated Values are specified here. 2. If the image is derived from multiple modalities, then a value of "OT" is appropriate.
Series Number	(0020,0011)	1	A number that identifies this Series

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.8.32.2 Parametric Map Image Module

Table C.8.32-2 defines the general Attributes of the Parametric Map Image Module.

Table C.8.32-2. Parametric Map Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. Enumerated Values for Value 1: **DERIVED** Enumerated Values for Value 2: **PRIMARY** Value 3 shall be Image Flavor, common Defined Terms for which are specified in Section C.8.16.1.3, CT-specific Defined Terms for which are specified in Section C.8.15.2.1.1.3 and MR-specific Defined Terms for which are specified in Section C.8.13.1.1.1.3. Value 4 shall be Derived Pixel Contrast, common Defined Terms for which are specified in Section C.8.16.1.4, CT-specific Defined Terms for which are specified in Section C.8.15.2.1.1.4 and MR-specific Defined Terms for which are specified in Section C.8.13.1.1.1.4.
Include Table 10-12 "Content Identification Macro Attributes"			
Total Pixel Matrix Columns	(0048,0006)	1C	Total number of columns in pixel matrix; i.e., width of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Total Pixel Matrix Rows	(0048,0007)	1C	Total number of rows in pixel matrix; i.e., height of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Total Pixel Matrix Focal Planes	(0048,0303)	1C	Total number of focal planes (Z locations) in the pixel matrix; i.e., depth of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise. Note Total Pixel Matrix Focal Planes (0048,0303) describes the number of focal planes separately encoded, and is distinct from Number of Focal Planes (0048,0013), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).
Total Pixel Matrix Origin Sequence	(0048,0008)	1C	Location of pixel 1\1 of the total pixel matrix in the Slide Coordinate System Frame of Reference. Only a single Item shall be included in this Sequence. See Section C.8.12.4.1.4 and Section C.8.12.2.1.1 for further explanation. Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in millimeters from the Origin of the Slide Coordinate System.
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in millimeters from the Origin of the Slide Coordinate System.
Image Orientation (Slide)	(0048,0102)	1C	The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4. Required if Plane Position (Slide) Sequence (0048,021A) is present within a Functional Group Sequence or Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
Pixel Presentation	(0008,9205)	3	Indication of the presence or absence of color information that may be used during rendering. Enumerated Values: **COLOR_RANGE** A Palette Color LUT is supplied or referenced. Image is best displayed using that Palette Color LUT, but can be displayed in grayscale if current display does not support color. **MONOCHROME** No Palette Color LUT is supplied or referenced. Image is intended to be displayed in grayscale only.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) in this image. Enumerated Values: **1**
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. Enumerated Values: **MONOCHROME2**

Attribute Name	Tag	Type	Attribute Description
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Enumerated Values if Pixel Data (7FE0,0010) or Pixel Data Provider URL (0028,7FE0) is present: **16** Enumerated Values if Float Pixel Data (7FE0,0008) is present: **32** Enumerated Values if Double Float Pixel Data (7FE0,0009) is present: **64**
Bits Stored	(0028,0101)	1C	Number of bits stored for each pixel sample. Enumerated Values: **16** Required if Pixel Data (7FE0,0010) or Pixel Data Provider URL (0028,7FE0) is present.
High Bit	(0028,0102)	1C	Most significant bit for pixel sample data. Enumerated Values: **15** Required if Pixel Data (7FE0,0010) or Pixel Data Provider URL (0028,7FE0) is present.
Presentation LUT Shape	(2050,0020)	1	Specifies an identity transformation for the Presentation LUT such that the output of all grayscale transformations are defined to be in P-Values. Enumerated Values: **IDENTITY** output is in P-Values. Note The intent of specifying this Attribute for Parametric Maps is only to achieve consistency of rendering when displayed as grayscale, not to imply that grayscale contrast of the displayed image is meaningful. It is not applicable when the image is rendered with pseudo-color, for example.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime), or is derived from lossy compressed images. Enumerated Values: **00** Image has NOT been subjected to lossy compression. **01** Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.8.32.2.1 and Section C.7.6.1.1.5.
Lossy Image Compression Ratio	(0028,2112)	1C	Describes the approximate lossy compression ratio(s) that have been applied to this image. See Section C.7.6.1.1.5.2. Required if present in the source images or this SOP Instance has been compressed.

Attribute Name	Tag	Type	Attribute Description
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See Section C.7.6.1.1.5.1. Required if present in the source images or this SOP Instance has been compressed. See Section C.8.32.2.1.
Burned In Annotation	(0028,0301)	1	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Enumerated Values: **NO**
Recognizable Visual Features	(0028,0302)	1	Indicates whether or not the image contains sufficiently recognizable visual features to allow the image or a reconstruction from a set of images to identify the patient. Enumerated Values: **YES** **NO**
Content Qualification	(0018,9004)	1	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation.
Palette Color Lookup Table UID	(0028,1199)	1C	Palette Color Lookup Table UID. See Section C.7.9.1 for further explanation. Required if Pixel Presentation (0008,9205) equals COLOR_RANGE and the Palette Color Lookup Table Module is not present.
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Parametric Map See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of COLOR_RANGE.
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.8.32.2.1 Lossy Image Compression and Lossy Image Compression Method

If Lossy Image Compression (0028,2110) in any of the source images is "01", the value shall be "01" for the Parametric Map Instance.

The process of derivation of a Parametric Map itself is defined not to be lossy compression, even though it involves loss. If the Parametric Map Instance is encoded using a lossy compression Transfer Syntax, then the value shall be set to "01".

Note

To state the obvious, it is not advisable to lossy compress a Parametric Map SOP Instance, since that will alter the quantitative values that are the intent of the object.

C.8.32.3 Parametric Map Functional Group Macros

The following sections contain Functional Group Macros specific to the Parametric Map IOD.

Note

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean "for all frames".

C.8.32.3.1 Parametric Map Frame Type Macro

Table C.8.32-3 specifies the Attributes of the Parametric Map Frame Type Functional Group Macro.

Table C.8.32-3. Parametric Map Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Parametric Map Frame Type Sequence	(0040,9092)	1	Identifies the characteristics of this Parametric Map frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)	1	Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008), except that the value MIXED is not allowed. See Section C.8.32.2.

C.8.33 Tractography Results Modules

This Section describes Tractography Results Modules.

C.8.33.1 Tractography Results Series Module

Table C.8.33-1 specifies the Attributes that identify and describe general information about a Tractography Results Series.

Table C.8.33-1. Tractography Results Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the Instances in this Series. Enumerated Values: **MR** See Section C.7.3.1.1.1 for further explanation.
Series Number	(0020,0011)	1	A number that identifies this Series.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance to which the Series is related. Only a single Item shall be included in this Sequence. Required if a Performed Procedure Step SOP Class was involved in the creation of this Series.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.8.33.2 Tractography Results Module

Table C.8.33-2 specifies the Attributes that describe the tracks and measurements in the tractography results.

Table C.8.33-2. Tractography Results Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-12 "Content Identification Macro Attributes"			
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Track Set Sequence	(0066,0101)	1	Describes the track sets that are contained within the data. One or more Items shall be included in this Sequence.
>Track Set Number	(0066,0105)	1	Identification number of the Track Set. Uniquely identifies a track set within this SOP Instance. Shall start at a value of 1, and increase monotonically by 1.
>Track Set Label	(0066,0106)	1	User-defined label identifying this Track Set. This may be the same as Code Meaning (0008,0104) of Track Set Anatomical Type Code Sequence (0066,0108).
>Track Set Description	(0066,0107)	3	User-defined description for this Track Set.
>Track Set Anatomical Type Code Sequence	(0066,0108)	1	Sequence defining the specific property type of this Track Set. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7710 "Tractography Anatomic Sites".*
>> Modifier Code Sequence	(0040,A195)	3	A Sequence of Items modifying or specializing the Track Set Anatomical Type Code Sequence. One or more Items shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 244 "Laterality".*
>Track Sequence	(0066,0102)	1	Describes individual tracks part of the track set. One or more Items shall be included in this Sequence.
>>Point Coordinates Data	(0066,0016)	1	Contains two or more point coordinates that define the track, encoded in x-y-z order, in mm in the Patient-Based Coordinate System associated with the Frame of Reference. The order of the encoded points is from the first point to the last point of the track. When referencing points in Point Coordinates Data (0066,0016) the index of the first point x,y,z triplet is 1 See Section C.27.2.1.1.
>>Recommended Display CIELab Value List	(0066,0103)	1C	Default triplet values in which it is recommended that the point shall be rendered. The units are specified in PCS-Values and the value is encoded as CIELab. See Section C.10.7.1.1. The number of triplets shall match the number of points stored in Point Coordinates Data (0066, 0016), and be encoded in the same order so as to correspond. Required if Recommended Display CIELab Value (0062, 000D) is not present in this Sequence Item nor in the containing Track Set Sequence (0066,0101) Item.

Attribute Name	Tag	Type	Attribute Description
>>Recommended Display CIELab Value	(0062,000D)	1C	Default triplet value in which it is recommended that the track shall be rendered. The units are specified in PCS-Values and the value is encoded as CIELab. See Section C.10.7.1.1. Required if Recommended Display CIELab Value List (0066,0103) is not present in this Sequence Item and Recommended Display CIELab Value (0062, 000D) is not present in the containing Track Set Sequence (0066,0101) Item.
>Recommended Display CIELab Value	(0062,000D)	1C	Default triplet value in which it is recommended that the track set be rendered. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. Required if neither Recommended Display CIELab Value (0062, 000D) nor Recommended Display CIELab Value List (0066,0103) are present in every Item of the Track Sequence (0066,0102).
>Recommended Line Thickness	(0066,0038)	3	Specifies the thickness of each track in the track set with which it is recommended to be rendered. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
>Measurements Sequence	(0066,0121)	3	Measurements for some or all points along the tracks. Each Item describes one type of measurement. See Section C.8.33.2.1 for more details. One or more Items shall be included in this Sequence.
>>Concept Name Code Sequence	(0040,A043)	1	Defines the type of measurement stored in this Item. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			DCID 7263 “Diffusion Tractography Measurement Types”
>>Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement for the value in this Item. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 82 “Units of Measurement”.*
>>Measurement Values Sequence	(0066,0132)	1	The measurement values for each track. The number and order of Items shall equal the Items in Track Sequence (0066,0102).

Attribute Name	Tag	Type	Attribute Description
>>>Floating Point Values	(0066,0125)	1	Measurement values for points stored ~~inPoint~~in Point Coordinates Data (0066, 0016) of the corresponding track in Track Sequence (0066,0102). If Track Point Index List (0066,0129) is absent, measurement values are stored for every point in Point Coordinates Data (0066,0016) and the number of values shall match ~~thenumber~~the number and order of points stored in Point Coordinates Data (0066, 0016). If Track Point Index List (0066,0129) is present, measurement values are stored for a subset of points in Point Coordinates Data (0066, 0016) and the number of values shall match the number and order of point indices in Track Point Index List (0066,0129). See Section C.8.33.2.1.
>>>Track Point Index List	(0066,0129)	1C	List of indices referencing points stored in Point Coordinates Data (0066,0016) within the corresponding track for which measurement values shall be stored. Required if Measurement Values stored in Floating Point Values (0066,0125) shall be associated to only a subset of points in Point Coordinates Data (0066,0016). See Section C.8.33.2.1.
>Track Statistics Sequence	(0066,0130)	3	One statistic for one data value per track in the Track Sequence (0066,0102). See Section C.8.33.2.1 for more details. One or more Items shall be included in this Sequence.
>>Concept Name Code Sequence	(0040,A043)	1	The value (quantity) for which the statistic is a summary. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 7263 "Diffusion Tractography Measurement Types"
>>Modifier Code Sequence	(0040,A195)	1	Specified the statistic and modifies the Concept Name Code Sequence (0040,A0143) of this Sequence Item. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			DCID 7464 "General Region of Interest Measurement Modifiers"
>>Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement for the statistic. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 82 "Units of Measurement".*
>>Floating Point Values	(0066,0125)	1	A value per track in the Track Sequence (0066,0102). The number and order of values shall equal the Items in the Track Sequence (0066,0102).
>Track Set Statistics Sequence	(0066,0124)	3	Statistics derived from the values for this Track Set. One or more Items shall be included in this Sequence.
>>Include Table C.8.33-3 "Table Summary Statistics Macro Attributes"			*Concept Name Code Sequence (0040,A043) DCID 7263 "Diffusion Tractography Measurement Types"*

Attribute Name	Tag	Type	Attribute Description
>Diffusion Acquisition Code Sequence	(0066,0133)	3	The diffusion acquisition (including post-processing) used to derive this track set. See Section C.8.33.2.2 for more details. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7260 "Diffusion Acquisition Value Types"*
>Diffusion Model Code Sequence	(0066,0134)	1	The diffusion model used to derive this track set. See Section C.8.33.2.2 for more details. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7261 "Diffusion Model Value Types"*
>Tracking Algorithm Identification Sequence	(0066,0104)	1	The tractography algorithms used to derive this track set. See Section C.8.33.2.2 for more details. One or more Items shall be included in this Sequence.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			*Algorithm Family Code Sequence (0066,002F) DCID 7262 "Diffusion Tractography Algorithm Families".*
Referenced Instance Sequence	(0008,114A)	1C	The set of images used for tractography for all Track Sets within this Instance. One or more Items shall be included in this Sequence. Required if this Instance was created from DICOM images.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			

C.8.33.2.1 Tractography Results Module Attributes

This Module encodes one or more Track Sets, each of which consists of one or more Tracks, each of which is defined by one or more points. For each Track, optionally one or more measurements may be defined, either for every point or a subset of points. Measurements are described by coded type and unit. For each Track and/or Track Set, summary statistics derived from measurements may be included (whether or not the actual measurements are encoded).

When a measurement (i.e., an Item of Measurements Sequence (0066,0121)) is encoded for every point in a track, then Floating Point Values (0066,0125) contains the corresponding values for every point. When a measurement is encoded for a subset of points, then Floating Point Values (0066,0125) contains measurement values for the points in Point Coordinates Data (0066,0016) which are referenced in Track Point Index List (0066,0129).

More than one Measurements Sequence (0066,0121) Item may be used, for example to encode different types of measurements, such as Fractional Anisotropy (FA) and Apparent Diffusion Coefficient (ADC), or to encode different components of a measurement that is a tuple, e.g., a diffusion tensor. In the latter case, which component, and which tensor, will be identified by the fully pre-coordinated code in the Concept Name Code Sequence (0040,A043).

Within one Track Set the different types of measurements or statistics must be the same for all Tracks within that set (i.e., it is not allowed to store one track to a set that does not contain a measurement of a specific type in case all other tracks within that set do).

C.8.33.2.2 Acquisition, Model and Algorithm Attributes

The Attributes Diffusion Acquisition Code Sequence (0066,0133), Diffusion Model Code Sequence (0066,0134) and Tracking Algorithm Identification Sequence (0066,0104) describe the main parameters influencing the tractography calculation. They are for documentation purposes. With these parameters, a receiver may infer an assessment of the reliability or quality of the tractography result.

C.8.33.3 Summary Statistics Macro

This Macro encodes summary statistics derived from a set of values.

Table C.8.33-3. Table Summary Statistics Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Concept Name Code Sequence	(0040,A043)	1	The value (quantity) for which the statistic is a summary. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*CID defined by invocation*
Modifier Code Sequence	(0040,A195)	1	Specified the statistic and modifies the Concept Name Code Sequence (0040,A0143) of this Macro. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7464 "General Region of Interest Measurement Modifiers"*
Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement for the statistic. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 82 "Units of Measurement".*
Floating Point Value	(0040,A161)	1	The value of the statistic. Only a single value shall be present.

C.9 Overlays

C.9.1 Overlay Identification Module

Retired. See PS3.3-2004.

C.9.2 Overlay Plane Module

Table C.9-2 contains Attributes that describe characteristics of an Overlay Plane.

An Overlay Plane describes graphics or bit-mapped text that is associated with an Image. It may also describe a Region of Interest in an Image.

Each Overlay Plane is one bit deep. Sixteen separate Overlay Planes may be associated with an Image.

Overlay data is stored in Overlay Data (60xx,3000). See the Section Repeating Groups in PS3.5 for a description of permitted values of 60xx.

Note

Overlay data stored in unused bit planes of Pixel Data (7FE0,0010) with Samples Per Pixel (0028,0002) of 1 was previously described in DICOM. This usage has now been retired. See PS3.3-2004 and PS3.5-2004.

Attributes describing display of grayscale and color overlays were defined in a previous version of the DICOM Standard. These have now been retired. How an Overlay Plane is rendered is undefined; specifically there is no mechanism to specify with what color or intensity an Overlay Plane is to be displayed, except when rendered under the control of a Softcopy Presentation State SOP Instance.

Table C.9-2. Overlay Plane Module Attributes

Attribute Name	Tag	Type	Attribute Description
Overlay Rows	(60xx,0010)	1	Number of Rows in Overlay.
Overlay Columns	(60xx,0011)	1	Number of Columns in Overlay.

Attribute Name	Tag	Type	Attribute Description
Overlay Type	(60xx,0040)	1	Indicates whether this overlay represents a region of interest or other graphics. Enumerated Values: **G** Graphics **R** ROI
Overlay Origin	(60xx,0050)	1	Location of first overlay point with respect to pixels in the image, given as row\column. The upper left pixel of the image has the coordinate 1\1. Column values greater than 1 indicate the overlay plane origin is to the right of the image origin. Row values greater than 1 indicate the overlay plane origin is below the image origin. Values less than 1 indicate the overlay plane origin is above or to the left of the image origin. Note Values of 0\0 indicate that the overlay pixels start 1 row above and one column to the left of the image pixels.
Overlay Bits Allocated	(60xx,0100)	1	Number of Bits Allocated in the Overlay. The value of this Attribute shall be 1. Note Formerly the Standard described embedding the overlay data in the Image Pixel Data (7FE0,0010), in which case the value of this Attribute was required to be the same as Bits Allocated (0028,0100). This usage has been retired. See PS3.3-2004.
Overlay Bit Position	(60xx,0102)	1	The value of this Attribute shall be 0. Note Formerly the Standard described embedding the overlay data in the Image Pixel Data (7FE0,0010), in which case the value of this Attribute specified the bit in which the overlay was stored. This usage has been retired. See PS3.3-2004.
Overlay Data	(60xx,3000)	1	Overlay pixel data. The order of pixels encoded for each overlay is left to right, top to bottom, i.e., the upper left pixel is encoded first followed by the remainder of the first row, followed by the first pixel of the 2nd row, then the remainder of the 2nd row and so on. Overlay data shall be contained in this Attribute. See Section C.9.2.1.1 for further explanation.
Overlay Description	(60xx,0022)	3	User-defined comments about the overlay.
Overlay Subtype	(60xx,0045)	3	Defined Term that identifies the intended purpose of the Overlay Type. See Section C.9.2.1.3 for further explanation.
Overlay Label	(60xx,1500)	3	A user defined text string that may be used to label or name this overlay.
ROI Area	(60xx,1301)	3	Number of pixels in ROI area. See Section C.9.2.1.2 for further explanation.

Attribute Name	Tag	Type	Attribute Description
ROI Mean	(60xx,1302)	3	ROI Mean. See Section C.9.2.1.2 for further explanation.
ROI Standard Deviation	(60xx,1303)	3	ROI standard deviation. See Section C.9.2.1.2 for further explanation.

C.9.2.1 Overlay Attribute Descriptions

C.9.2.1.1 Overlay Type

There are two specific types of overlays. The type is specified in this Attribute.

A Region of Interest (ROI) is a specific use of an Overlay. The overlay bits corresponding to all the pixels included in the ROI shall be set to 1. All other bits are set to 0. This is used to specify an area of the image of particular interest.

A Graphics overlay may express reference marks, graphic annotation, or bit mapped text, etc. A Graphics overlay may be used to mark the boundary of a ROI. If this is the case and the ROI statistical parameters are used, they will only refer to the pixels under the boundaries, not those in the included regions.

The overlay bits corresponding to all the pixels included in the Graphics shall be set to 1. All other bits are set to 0.

C.9.2.1.2 ROI Area, ROI Mean and ROI Standard Deviation

These Attributes contain the statistical parameters of the ROI. The values of these parameters are for the overlay pixel values set to 1.

C.9.2.1.3 Overlay Subtype

Defined Terms:

USER User created graphic annotation (e.g., operator)
AUTOMATED Machine or algorithm generated graphic annotation, such as output of a Computer Assisted Diagnosis algorithm

Note

Additional or alternative Defined Terms may be specified in modality specific Modules, such as in the Overlay Subtype.

C.9.2.1.4 Multi-frame Image

When an overlay is part of a Multi-frame Image and is not a Multi-frame Overlay (Number of Frames in Overlay (60xx,0015) and Image Frame Origin (60xx,0051) are absent), the overlay shall be applied to all frames in the image.

C.9.3 Multi-frame Overlay Module

Table C.9-3 specifies the Attributes of a Multi-frame overlay~~.~~, or of a single frame overlay applied to a specific image frame. This Module specifies additional attributes for overlay planes specified in Section C.9.2 Overlay Plane Module. All Overlay frames have the same characteristics.

A Multi-frame Overlay is defined as an Overlay whose overlay data consists of a sequential set of individual Overlay frames.

Note

A Multi-frame Overlay is encoded as a single contiguous stream of overlay data. Neither frame delimiters nor padding between overlay frames are contained within the overlay bit stream. See Section 8.1.2 Overlay Data Encoding of Related Data Elements in PS3.5.

A Multi-frame Overlay applies only to a Multi-frame Image.

Table C.9-3. Multi-frame Overlay Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Frames in Overlay	(60xx,0015)	1	Number of Frames in Overlay. ~~Required if Overlay data contains multiple frames.~~
Image Frame Origin	(60xx,0051)	~~3~~1C	Frame number of Multi-frame Image to which this ~~overlay~~Overlay applies; frames are numbered from 1. Required if the starting Image frame number to which this Multi-frame Overlay corresponds is not 1. May be present otherwise.

C.9.3.1 Multi-frame Overlay Attribute Descriptions

C.9.3.1.1 Number of Frames in Overlay

~~A Multi-frame Overlay is defined as an Overlay whose overlay data consists of a sequential set of individual Overlay frames. A Multi-frame Overlay is transmitted as a single contiguous stream of overlay data. Frame delimiters are not contained within the data stream.~~

~~Each individual frame shall be defined (and thus can be identified) by the Attributes in the Overlay Plane Module (see Section C.9.2).~~

The total number of frames contained within a Multi-frame Overlay is conveyed in the Number of Frames in Overlay (60xx,0015).

The frames within a Multi-frame Overlay shall be conveyed as a logical sequence. ~~If Multi-frame Overlays are related to a Multi-frame Image, the~~The order of the Overlay Frames ~~are~~correspond one to one with the order of the Image frames. ~~Otherwise, no Attribute is used to indicate the sequencing of the Overlay Frames.~~ If Image Frame Origin (60xx,0051) is present, the Overlay frames ~~are applied~~correspond one to one to the Image frames, beginning at the indicated frame number. Otherwise, ~~no Attribute is used to indicated the sequencing of the Overlay Frames~~the Overlay Frames correspond beginning with the first Image frame.

> Note
>
> When an Overlay consisting of one frame is to be applied to one frame of a Multi-frame Image, it is specified with a Number of Frames in Overlay (60xx,0015) value of 1, and a frame number in Image Frame Origin (60xx,0051), because Image Frame Origin is invoked only by this Module, in which Number of Frames in Overlay (60xx,0015) is Type 1. In the absence of Number of Frames in Overlay (60xx,0015) and Image Frame Origin (60xx,0051), per Section C.9.2.1.4, a single frame overlay applies to all frames of a multi-frame image.

The Number of Frames in Overlay (60xx,0015) plus the Image Frame Origin (60xx,0051) minus 1 shall be less than or equal to the total number of frames in the Multi-frame Image.

C.9.4 Bi-plane Overlay Module (Retired)

C.9.5 Basic Print Image Overlay Box Module (Retired)

Retired. See PS3.3-2004.

C.10 Curve, Graphic and Waveform

C.10.1 Curve Identification Module (Retired)

Retired. See PS3.3-2004.

C.10.2 Curve Module (Retired)

Retired. See PS3.3-2004.

C.10.3 Audio Module (Retired)

Retired. See PS3.3-2004.

C.10.4 Displayed Area Module

This Module describes Attributes required to define a Specified Displayed Area space.

The Specified Displayed Area is that portion of the image displayed on the device.

If Presentation Size Mode (0070,0100) is specified as SCALE TO FIT, then the specified area shall be displayed as large as possible within the available area on the display or window, i.e., magnified or minified if necessary to fit the display or window space available.

If Presentation Size Mode (0070,0100) is specified as TRUE SIZE, then the physical size of the rendered image pixels shall be the same on the screen as specified in Presentation Pixel Spacing (0070,0101).

If Presentation Size Mode (0070,0100) is specified as MAGNIFY, then the factor that shall be used to spatially interpolate image pixels to create pixels on the display is defined.

Note

If this factor is specified as 1.0, then one image pixel will correspond to one displayed pixel, and if the Specified Displayed Area is the entire image, and it fits on the display, then the number of displayed pixels will equal the number of image pixels.

In all modes, the actual area rendered on a display device may be greater than the Specified Display Area, if the ratio of rows and columns of the Specified Display Area differs from the ratio of rows and columns of the display device or window. The Displayed Area relative annotations specified in Section C.10.5 Graphic Annotation Module are rendered relative to the Specified Displayed Area, not the actual rendered displayed area.

Note

1. The content of a display outside the Specified Display Area is not defined. In particular no padding value (such as black) is specified.
2. In the TRUE SIZE and MAGNIFY modes, if the entire Specified Displayed Area is not visible, then display relative graphic annotations may be obscured.

This Module explicitly specifies the aspect ratio to be used to display the image, even if it is 1:1, and it may be different from that specified in the referenced image.

Note

1. Depending on the mode, the aspect ratio is either specified using the Presentation Pixel Aspect Ratio (0070,0102), or derived from the Presentation Pixel Spacing (0070,0101).
2. This explicit definition of aspect ratio implies that graphic objects that are specified relative to the Specified Display Area will not change their shape regardless of the size or shape of the presentation device (e.g., whether a landscape or portrait monitor is used).
3. The mechanism of interpolation, if necessary, is not specified.
4. The image may need to be cropped and scroll bars or a panning mechanism provided in order to provide access to sections of the image that do not fit within the available area on the display or window.

Table C.10-4. Displayed Area Module Attributes

Attribute Name	Tag	Type	Attribute Description
Displayed Area Selection Sequence	(0070,005A)	1	A Sequence of Items each of which describes the displayed area selection for a group of images or frames. Sufficient Items shall be present to describe every image and frame listed in the Presentation State Relationship Module. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Referenced Image Sequence	(0008,1140)	1C	The subset of images and frames listed in the Presentation State Relationship Module, to which this displayed area selection applies. One or more Items shall be included in this Sequence. Required if the displayed area selection in this Item does not apply to all the images and frames listed in the Presentation State Relationship Module.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Pixel Origin Interpretation	(0048,0301)	1C	For a referenced multi-frame image, specifies whether the Displayed Area Top Left Hand Corner (0070,0052) and Displayed Area Bottom Right Hand Corner (0070,0053) are to be interpreted relative to the individual frame pixel origins, or relative to the Total Pixel Matrix origin (see Section C.8.12.4.1.4). Required if the value of Referenced SOP Class UID (0008,1150) within Referenced Image Sequence (0008,1140) is 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image). May be present otherwise. Enumerated Values: **FRAME** relative to individual frame **VOLUME** relative to Total Image Matrix If not present, TLHC and BRHC are defined relative to the frame pixel origins.
>Displayed Area Top Left Hand Corner	(0070,0052)	1	The top left (after spatial transformation) pixel in the referenced image to be displayed, given as column\row. Column is the horizontal (before spatial transformation) offset (X) and row is the vertical (before spatial transformation) offset (Y) relative to the origin of the pixel data before spatial transformation, which is 1\1. See Figure C.10.4-1.
>Displayed Area Bottom Right Hand Corner	(0070,0053)	1	The bottom right (after spatial transformation) pixel in the referenced image to be displayed, given as column\row. Column is the horizontal (before spatial transformation) offset (X) and row is the vertical (before spatial transformation) offset (Y) relative to the origin of the pixel data before spatial transformation, which is 1\1. See Figure C.10.4-1.
>Presentation Size Mode	(0070,0100)	1	Manner of selection of display size. Enumerated Values: **SCALE TO FIT** **TRUE SIZE** **MAGNIFY** See Section C.10.4 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Presentation Pixel Spacing	(0070,0101)	1C	Physical distance between the center of each pixel in the referenced image (before spatial transformation), specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order. Note 1. This value may be different from Pixel Spacing (0028,0030) or Imager Pixel Spacing (0018,1164) specified in the referenced image, which are ignored, since some form of calibration may have been performed (for example by reference to an object of known size in the image). 2. If the row and column spacing are different, then the pixel aspect ratio of the image is not 1:1. Required if Presentation Size Mode (0070,0100) is TRUE SIZE, in which case the values will correspond to the physical distance between the center of each pixel on the display device. May be present if Presentation Size Mode (0070,0100) is SCALE TO FIT or MAGNIFY, in which case the values are used to compute the aspect ratio of the image pixels.
>Presentation Pixel Aspect Ratio	(0070,0102)	1C	Ratio of the vertical size and the horizontal size of the pixels in the referenced image, to be used to display the referenced image, specified by a pair of integer values where the first value is the vertical pixel size and the second value is the horizontal pixel size. See Section C.7.6.3.1.7. Required if Presentation Pixel Spacing (0070,0101) is not present. Note 1. This value may be different from the aspect ratio specified by Pixel Aspect Ratio (0028,0034) in the referenced image, or implied by the values of Pixel Spacing (0028,0030) or Imager Pixel Spacing (0018,1164) specified in the referenced image, which are ignored. 2. This value must be specified even if the aspect ratio is 1:1.
>Presentation Pixel Magnification Ratio	(0070,0103)	1C	Ratio of displayed pixels to source pixels, specified in one dimension. Required if Presentation Size Mode (0070,0100) is MAGNIFY. Note 1. A value of 1.0 would imply that one pixel in the referenced image would be displayed as one pixel on the display (i.e., it would not be interpolated if the aspect ratio of the image pixels is 1:1). 2. A value of 2.0 would imply that one pixel in the referenced image would be displayed as 4 pixels on the display (i.e., up-sampled by a factor of 2 in each of the row and column directions). 3. A value of 0.5 would imply that 4 pixels in the referenced image would be displayed as 1 pixel on the display (i.e., down-sampled by a factor of 2 in each of the row and column directions). 4. If the source pixels have an aspect ratio of other than 1:1, then they are assumed to have been interpolated to a display pixel aspect ratio of 1:1 prior to magnification.

Note

1. In scale to fit mode, the Displayed Area Top Left Hand Corner (TLHC) and Bottom Right Hand Corner (BRHC) have the effect of defining how any zoom or magnification and/or pan has been applied to select a region of an image to be displayed (the Specified Displayed Area), without assuming anything about the size of the actual display.

2. The TLHC and BRHC may be outside the boundaries of the image pixel data (e.g., the TLHC may be 0 or negative, or the BRHC may be greater than Rows or Columns), allowing minification or placement of the image pixel data within a larger Specified Displayed Area. There is no provision to position a zoomed selected sub-area of the image pixel data within a larger Specified Displayed Area.

3. When Pixel Origin Interpretation (0048,0301) value is VOLUME, the selected Display Area may extend across multiple frames, and may include pixel locations for which there is no pixel data (outside the edge of the imaged volume, not encoded in a sparse encoding, or not within explicitly selected frames).

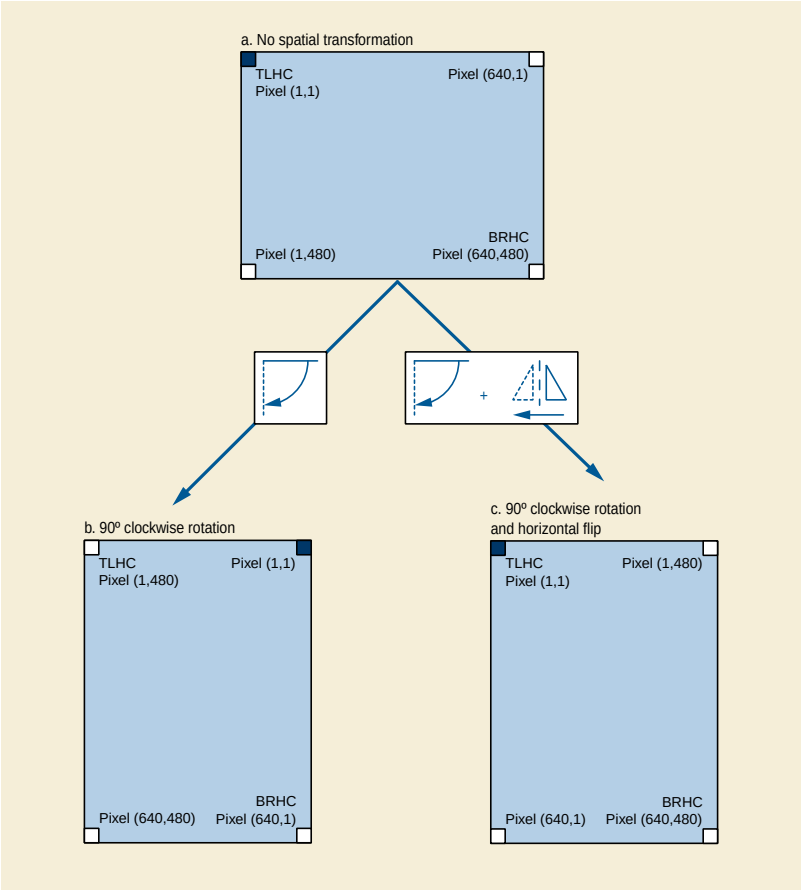


Figure C.10.4-1. Example of Displayed Area Selection Addressing of Pixels Before and After Spatial Transformation

C.10.5 Graphic Annotation Module

This Module defines Attributes of vector graphics and text annotation that shall be made available by a display device to be applied to an image. The graphics and text are defined in position and size relative to the image pixel coordinates or the Specified Displayed Area space (defined in Section C.10.4); in the context of a Volumetric Presentation State IOD, the annotation is relative to the Volumetric Presentation View (e.g., the MPR view defined in Section C.11.26). A Graphic Annotation shall be related to an Image.

Note

See Section A.80.1.4.3 for constraints on Attributes in this Module when used in the Planar MPR Volumetric Presentation State IOD.

Table C.10-5. Graphic Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Graphic Annotation Sequence	(0070,0001)	1	A Sequence of Items each of which represents a group of annotations composed of graphics or text or both. One or more Items shall be included in this Sequence.
>Referenced Image Sequence	(0008,1140)	1C	The subset of images and frames listed in the Presentation State Relationship Module, to which this graphic annotation applies. One or more Items shall be included in this Sequence. Required if graphic annotations in this Item do not apply to all the images and frames listed in the Presentation State Relationship Module.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Graphic Layer	(0070,0002)	1	The layer defined in the Graphic Layer Module in which the graphics or text is to be rendered.
>Text Object Sequence	(0070,0008)	1C	Sequence that describes a text annotation. One or more Items shall be included in this Sequence. Either one or both of Text Object Sequence (0070,0008) or Graphic Object Sequence (0070,0009) are required.

Attribute Name	Tag	Type	Attribute Description
>>Bounding Box Annotation Units	(0070,0003)	1C	Units of measure for the axes of the text bounding box. Defines whether or not the annotation is Image or Displayed Area relative. Both dimensions shall have the same units. Enumerated Values: **PIXEL** Image relative position specified with sub-pixel resolution such that the origin, which is at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The values must be within the range 0\0 to Columns\Rows. **DISPLAY** Fraction of Specified Displayed Area where 0.0\0.0 is the TLHC and 1.0\1.0 is the BRHC. The values must be within the range 0.0 to 1.0. **MATRIX** Image relative position specified with sub-pixel resolution such that the origin, which is at the Top Left Hand Corner (TLHC) of the TLHC pixel of the Total Pixel Matrix, is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel of the Total Pixel Matrix is Total Pixel Matrix Columns\Total Pixel Matrix Rows (see Section C.8.12.4.1.3). The values must be within the range 0.0\0.0 to Total Pixel Matrix Columns\Total Pixel Matrix Rows. MATRIX may be used only if the value of Referenced SOP Class UID (0008,1150) within Referenced Image Sequence (0008,1140) is 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image). Required if Bounding Box Top Left Hand Corner (0070,0010) or Bounding Box Bottom Right Hand Corner (0070,0011) is present.
>>Anchor Point Annotation Units	(0070,0004)	1C	Units of measure for the axes of the text anchor point annotation. Enumerated Values for Anchor Point Annotation Units (0070,0004) are the same as for Bounding Box Annotation Units (0070,0003). Required if Anchor Point (0070,0014) is present.
>>Unformatted Text Value	(0070,0006)	1	Text data that is unformatted and whose manner of display within the defined bounding box or relative to the specified anchor point is implementation dependent. See Section C.10.5.1.1. The text value may contain spaces, as well as multiple lines separated by CR LF, but otherwise no format control characters (such as horizontal or vertical tab and form feed) shall be present, even if permitted by the Value Representation of ST. The text shall be interpreted as specified by Specific Character Set (0008,0005) if present in the SOP Common Module. Note The text may contain single or multi-byte characters and use code extension techniques as described in PS3.5 if permitted by the values of Specific Character Set (0008,0005).
>>Include Table C.10-5a "Text Style Sequence Macro Attributes"			See Section C.10.5.1.3.12.

Attribute Name	Tag	Type	Attribute Description
>>Bounding Box Top Left Hand Corner	(0070,0010)	1C	Location of the Top Left Hand Corner (TLHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed, in Bounding Box Annotation Units (0070,0003), given as column\row. Column is the horizontal offset and row is the vertical offset. Required if Anchor Point (0070,0014) is not present. May be present otherwise. Required if Bounding Box Bottom Right Hand Corner (0070,0011) is present.
>>Bounding Box Bottom Right Hand Corner	(0070,0011)	1C	Location of the Bottom Right Hand Corner (BRHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed, in Bounding Box Annotation Units (0070,0003), given as column\row. Column is the horizontal offset and row is the vertical offset. Required if Anchor Point (0070,0014) is not present. May be present otherwise. Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>>Bounding Box Text Horizontal Justification	(0070,0012)	1C	Location of the text relative to the vertical edges of the bounding box. Enumerated Values: **LEFT** closest to left edge **RIGHT** closest to right edge **CENTER** centered Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>>Anchor Point	(0070,0014)	1C	Location of a point in the image or Specified Displayed Area to which the Unformatted Text Value (0070,0006) is related, in Anchor Point Annotation Units (0070,0004), given as column\row. Column is the horizontal offset and row is the vertical offset. Required if Bounding Box Top Left Hand Corner (0070,0010) and Bounding Box Bottom Right Hand Corner (0070,0011) are not present. May be present otherwise.
>>Anchor Point Visibility	(0070,0015)	1C	Flag to indicate whether or not a visible indication (such as a line or arrow) of the relationship between the text and the anchor point is to be displayed. Enumerated Values: **Y** yes **N** no Required if Anchor Point (0070,0014) is present.
>>Compound Graphic Instance ID	(0070,0226)	3	The identifier of the Compound Graphic represented, in part, by this Item. The value of this Attribute shall be equal to the value of Compound Graphic Instance ID (0070,0226) of the corresponding Item in the Compound Graphic Sequence (0070,0209). See Section C.10.5.1.3.1.
>>Graphic Group ID	(0070,0295)	3	A number identifying the group from the Graphic Group Sequence (0070,0234) to which this Item belongs. If this Attribute is not present, this Item does not belong to a group. If Compound Graphic Instance ID (0070,0226) is present in this Item, the value of Graphic Group ID (0070,0295) shall be the same as the value of Graphic Group ID (0070,0295) of the corresponding Item in the Compound Graphic Sequence (0070,0209) with the same Compound Graphic Instance ID (0070,0226).

Attribute Name	Tag	Type	Attribute Description
>>Tracking ID	(0062,0020)	1C	A text label used for tracking a finding or feature, potentially across multiple reporting objects, over time. This label shall be unique within the domain in which it is used. Required if Tracking UID (0062,0021) is present. Note This Attribute allows linkage to segments in Segmentation Instances with the same value of Tracking ID (0062,0020), and to Content Items in SR Instances with observation context (112039, DCM, "Tracking Identifier") having the same value.
>>Tracking UID	(0062,0021)	1C	A unique identifier used for tracking a finding or feature, potentially across multiple reporting objects, over time. Required if Tracking ID (0062,0020) is present. Note This Attribute allows linkage to segments in Segmentation Instances with the same value of Tracking UID (0062,0021), and to Content Items in SR Instances with observation context (112040, DCM, "Tracking Unique Identifier") having the same value.
>Graphic Object Sequence	(0070,0009)	1C	Sequence that describes a graphic annotation. One or more Items shall be included in this Sequence. Either one or both of Text Object Sequence (0070,0008) or Graphic Object Sequence (0070,0009) are required.
>>Graphic Annotation Units	(0070,0005)	1	Units of measure for the axes of the graphic annotation. Enumerated Values for Graphic Annotation Units (0070,0005) are the same as for Bounding Box Annotation Units (0070,0003).
>>Graphic Dimensions	(0070,0020)	1	Enumerated Values: **2**
>>Number of Graphic Points	(0070,0021)	1	Number of data points in this graphic.
>>Graphic Data	(0070,0022)	1	Coordinates that specify this graphic annotation. See Section C.10.5.1.2 for further explanation.
>>Graphic Type	(0070,0023)	1	The shape of graphic that is to be drawn. See Section C.10.5.1.2. Enumerated Values: **POINT** **POLYLINE** **INTERPOLATED** **CIRCLE** **ELLIPSE**
>>Include Table C.10-5b "Line Style Sequence Macro Attributes"			See Section C.10.5.1.3.13.

Attribute Name	Tag	Type	Attribute Description
>>Graphic Filled	(0070,0024)	1C	Whether or not the closed graphics element is displayed as filled (in some unspecified manner that shall be distinguishable from an outline) or as an outline. See Section C.10.5.1.2. Enumerated Values: **Y** yes **N** no Required if Graphic Data (0070,0022) is "closed", that is Graphic Type (0070,0023) is CIRCLE or ELLIPSE, or Graphic Type (0070,0023) is POLYLINE or INTERPOLATED and the first data point is the same as the last data point.
>>Include Table C.10-5c "Fill Style Sequence Macro Attributes"			See Section C.10.5.1.3.14.
>>Compound Graphic Instance ID	(0070,0226)	3	The identifier of the Compound Graphic represented, in part, by this Item. The value of this Attribute shall be equal to the value of Compound Graphic Instance ID (0070,0226) of the corresponding Item in the Compound Graphic Sequence (0070,0209). See Section C.10.5.1.3.1.
>>Graphic Group ID	(0070,0295)	3	A number identifying the group from the Graphic Group Sequence (0070,0234) to which this Item belongs. If this Attribute is not present, this Item does not belong to a group. If Compound Graphic Instance ID (0070,0226) is present in this Item, the value of Graphic Group ID (0070,0295) shall be the same as the value of Graphic Group ID (0070,0295) of the corresponding Item in the Compound Graphic Sequence (0070,0209) with the same Compound Graphic Instance ID (0070,0226).
>>Tracking ID	(0062,0020)	1C	A text label used for tracking a finding or feature, potentially across multiple reporting objects, over time. This label shall be unique within the domain in which it is used. Required if Tracking UID (0062,0021) is present. Note This Attribute allows linkage to segments in Segmentation Instances with the same value of Tracking ID (0062,0020), and to Content Items in SR Instances with observation context (112039, DCM, "Tracking Identifier") having the same value.
>>Tracking UID	(0062,0021)	1C	A unique identifier used for tracking a finding or feature, potentially across multiple reporting objects, over time. Required if Tracking ID (0062,0020) is present. Note This Attribute allows linkage to segments in Segmentation Instances with the same value of Tracking UID (0062,0021), and to Content Items in SR Instances with observation context (112040, DCM, "Tracking Unique Identifier") having the same value.

Attribute Name	Tag	Type	Attribute Description
>Compound Graphic Sequence	(0070,0209)	3	A Sequence of Items that describe Compound Graphics. One or more Items are permitted in this Sequence. For each Compound Graphic there shall be an alternate rendering encoded as Items in the Text Object Sequence (0070,0008) and Graphic Object Sequence (0070,0009) linked by the Compound Graphic Instance ID (0070,0226). See Section C.10.5.1.3.1.
>>Compound Graphic Instance ID	(0070,0226)	1	A number that identifies the Compound Graphic described in this Item. The value shall be unique within this SOP Instance. See Section C.10.5.1.3.1.
>>Compound Graphic Units	(0070,0282)	1	Type of dimension used in Attributes for the Compound Graphic when specifying distances and locations. Enumerated Values: **PIXEL** When an Attribute value specifies a location, it shall be an image relative position specified with sub-pixel resolution such that the origin at the Top Left Hand Corner (TLHC) of the TLHC pixel is 0.0\0.0, the Bottom Right Hand Corner (BRHC) of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows (see Figure C.10.5-1). The values must be within the range 0\0 to Columns\Rows. When an Attribute value specifies a distance the distance shall be in pixels. **DISPLAY** When an Attribute value specifies a location, it shall be a fraction of Specified Displayed Area where 0.0\0.0 is the TLHC and 1.0\1.0 is the BRHC. The values must be within the range 0.0 to 1.0. When an Attribute value specifies a distance the distance shall be in fraction of Specified Displayed Area.
>>Graphic Dimensions	(0070,0020)	1	Enumerated Values: **2**
>>Number of Graphic Points	(0070,0021)	1	Number of data Items, e.g., points, in this Compound Graphic.
>>Graphic Data	(0070,0022)	1	Numerical data Items that specify this Compound Graphic (points, vectors and scalars). See Section C.10.5.1.3 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>>Compound Graphic Type	(0070,0294)	1	The shape of this Compound Graphic. See Section C.10.5.1.3. Defined Terms: **MULTILINE** **INFINITELINE** **CUTLINE** **RANGELINE** **RULER** **AXIS** **CROSSHAIR** **ARROW** **RECTANGLE** **ELLIPSE** Note Implementers may add private graphic types.
>>Include Table C.10-5a "Text Style Sequence Macro Attributes"			See Section C.10.5.1.3.12
>>Include Table C.10-5b "Line Style Sequence Macro Attributes"			See Section C.10.5.1.3.13
>>Rotation Angle	(0070,0230)	3	The rotation of this Compound Graphic in degrees. Value shall be in degrees, between 0 and 360. See Section C.10.5.1.3.
>>Rotation Point	(0070,0273)	1C	The rotation point of this Compound Graphic. See Section C.10.5.1.3. Required if Rotation Angle (0070,0230) is present or if Compound Graphic Type (0070,0294) is CUTLINE or INFINITELINE.
>>Gap Length	(0070,0261)	1C	Diameter of the circle around Rotation Point (0070,0273) where the CUTLINE or INFINITELINE is not rendered. Diameter of the circle around the origin, specified by Graphic Data (0070,0022) where the CROSSHAIR is not rendered. The Compound Graphic Units (0070,0282) of Gap Length (0070,0261) shall be DISPLAY. See Section C.10.5.1.3. Required if Compound Graphic Type (0070,0294) equals CUTLINE, INFINITELINE or CROSSHAIR.
>>Diameter of Visibility	(0070,0262)	1C	Diameter of the circle around the CROSSHAIR origin where the CROSSHAIR is visible. The Compound Graphic Units (0070,0282) of the Diameter of Visibility (0070,0262) shall be DISPLAY. See Section C.10.5.1.3.10 Required if Compound Graphic Type (0070,0294) equals CROSSHAIR.

Attribute Name	Tag	Type	Attribute Description
>>Major Ticks Sequence	(0070,0287)	1C	The sequence of major ticks on the AXIS object. Two or more Items shall be present. Required if Compound Graphic Type (0070,0294) equals AXIS.
>>>Tick Position	(0070,0288)	1	The position of the tick in the range 0.0 (start point) to 1.0 (end point).
>>>Tick Label	(0070,0289)	1	The label of the tick.
>>Tick Alignment	(0070,0274)	1C	The alignment of the ticks with respect to the line. Enumerated Values: **BOTTOM** **CENTER** **TOP** See Section C.10.5.1.3. Required if Compound Graphic Type (0070,0294) equals RULER, AXIS or CROSSHAIR.
>>Tick Label Alignment	(0070,0279)	1C	The alignment of the label with respect to the tick. Enumerated Values: **BOTTOM** **TOP** See Section C.10.5.1.3. Required if Compound Graphic Type (0070,0294) equals RULER, AXIS. or CROSSHAIR.
>>Show Tick Label	(0070,0278)	1C	Indicates whether the tick label should be initially visible. Enumerated Values: **Y** Yes **N** No Required if Compound Graphic Type (0070,0294) equals RULER, AXIS or CROSSHAIR.
>>Graphic Filled	(0070,0024)	1C	Indicates whether or not the Compound Graphics is displayed as filled. Enumerated Values: **Y** yes **N** no Required if Compound Graphic Type (0070,0294) equals RECTANGLE or ELLIPSE.
>>Include Table C.10-5c "Fill Style Sequence Macro Attributes"			In this Module, Attribute Fill Style Sequence (0070,0233) is Type 1C. Required if Graphic Filled (0070,0024) equals Y. See Section C.10.5.1.3.14
>>Graphic Group ID	(0070,0295)	3	A number that defines the corresponding group object in the Graphic Group Sequence (0070,0234). If the Attribute is not present the object does not belong to a group.

C.10.5.1 Graphic Annotation Attribute Descriptions

C.10.5.1.1 Unformatted Text Value

The text shall be displayed if any part of the bounding box or anchor point is within the Specified Display Area.

The text need not be confined to within the bounding box, but shall be rendered in a direction from the Top Left Hand Corner (TLHC) of the bounding box to the Bottom Right Hand Corner (BRHC) of the bounding box, even if these coordinates have been specified in an image relative space and then transformed (rotated, flipped or scaled).

Note

1. An implementation may render text outside the confines of the bounding box if necessary to display all the specified text.
2. Alternatively, an implementation may choose to render the text in a scrolling box, or a link to another fixed or popup window as appropriate.

Whether the contents of the bounding box completely opacify the underlying image or whether the box is "transparent" is undefined.

Note

1. For example, an implementation may choose an "exclusive or" style opacification to be sure that the text is discernible over light and dark portions of the image.
2. Commonly, the region of the bounding box around the text will be rendered "transparently", i.e., the image will be visible, though some implementations may choose to opacify the bounding box behind the text to improve its readability.

An alternative to specifying a bounding box, is to specify an Anchor Point (0070,0014), i.e., some point in an image or Specified Displayed Area that is related to the text. The semantics of this relationship, and the manner of positioning or linking the text to this point, are unspecified.

Note

1. For example, a description of a feature may be linked to a point in the image, and when that image is displayed, if it is magnified and panned, the rendered text (and any arrow or line drawn in response to Anchor Point Visibility (0070,0015)) might be repositioned as appropriate so as not to be cropped out of the Specified Displayed Area.
2. As another example, the text could be rendered in a pop-up window when a hypertext link flagged on the displayed image at the location of Anchor Point (0070,0014) is selected.
3. The bounding box and anchor point need not be defined with the same axis units, i.e., one can be image pixel relative, and the other displayed area relative.

The size, font and rotation of the individual rendered text characters are unspecified.

C.10.5.1.2 Graphic Data and Graphic Type

Graphic Data (0070,0022) contains the points in the graphic annotation, each dimension for the first point, followed by dimensions for second point, etc. For a two dimensional curve: X1, Y1, X2, Y2, etc. The first (X) dimension corresponds to the image or Specified Displayed Area column (horizontal offset), and the second (Y) dimension corresponds to the image or Specified Displayed Area row (vertical offset). The Value Representation of all components of the N-tuple shall be the same. The image or Specified Displayed Area relative drawing space is defined in Graphic Annotation Units (0070,0005).

If Graphic Type (0070,0023) is POINT, then two values (one point) shall be specified and the single point specified is to be drawn.

If Graphic Type (0070,0023) is POLYLINE, then the points are to be interpreted as an n-tuple list of end points between which straight lines are to be drawn.

If Graphic Type (0070,0023) is INTERPOLATED, then the points are to be interpreted as an n-tuple list of end points between which some form of implementation dependent curved lines are to be drawn. The rendered line shall pass through all the specified points.

If Graphic Type (0070,0023) is CIRCLE, then exactly two points shall be present; the first point is to be interpreted as the center and the second point as a point on the circumference of a circle, some form of implementation dependent representation of which is to be drawn.

If Graphic Type (0070,0023) is ELLIPSE, then exactly four points shall be present; the first two points are to be interpreted as the endpoints of the major axis and the second two points as the endpoints of the minor axis of an ellipse, some form of implementation dependent representation of which is to be drawn.

The notion of "open" or "closed" has no inherent meaning in the context of an arbitrary graphic, other than in the condition for the presence of Graphic Filled (0070,0024). The graphic has no semantic notion of an associated observation such as a region of interest, except that which the unformatted text in the same Item may describe.

The choice of pixel value used to represent the graphic on a display is defined in the Graphic Layer Module.

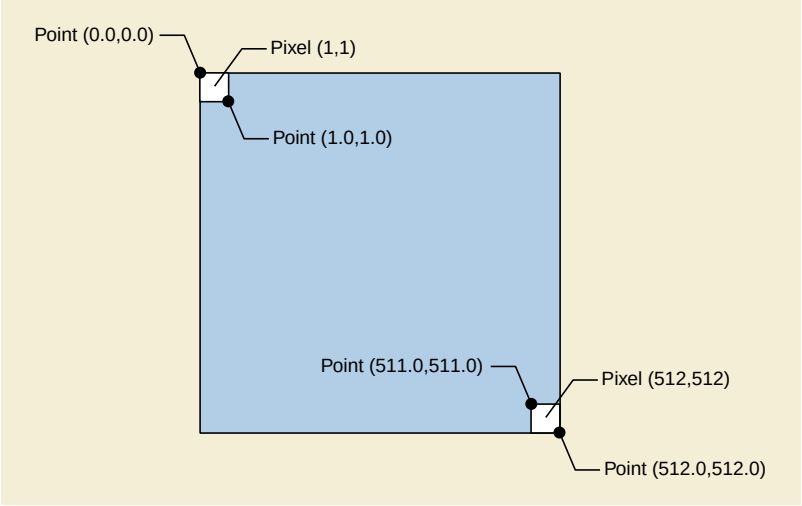


Figure C.10.5-1. Sub-pixel Addressing Units in PIXEL Space

C.10.5.1.3 Compound Graphic Sequence

The Attributes of the Compound Graphic Sequence (0070,0209) are described within this section.

For point encoding rules of Graphic Data (0070,0022) See Section C.10.5.1.2.

All graphics are applied after the application of the image rendering pipeline.

C.10.5.1.3.1 Compound Graphic Instance ID

Every Item in the Compound Graphic Sequence shall have a Compound Graphic Instance ID (0070,0226) with a value that is unique within this Sequence.

There shall be one or more Items in the Graphic Object Sequence or Text Object Sequence that represents an alternate rendering of the Compound Object Sequence Item. As a linkage for backward compatibility these Items share the same Compound Graphic Instance ID (0070,0226).

Note

Every Compound Graphic has an equivalent rendering encoded as a set of simple graphic objects linked by the Compound Graphic Instance ID (0070,0226). Simple graphic objects are elements such as points, polylines, interpolated lines, circles and ellipses. The equivalent rendering is a set of simple graphic objects to support an SCP that only understands the simple graphical objects.

C.10.5.1.3.2 Rotation

All Compound Graphics can be rotated by specifying a Rotation Angle (0070,0230) value and a Rotation Point (0070,0273). The convention for rotation is that positive angle values are defined as counterclockwise around Rotation Point (0070,0273).

C.10.5.1.3.3 Ellipses

For the Compound Graphic Type (0070,0294) ELLIPSE, exactly 2 points shall be present inside Graphic Data (0070,0022). The first point is the top/left hand corner (TLHC) and the second point is the bottom/right hand corner (BRHC) of the bounding rectangle (see Figure C.10.5-2).

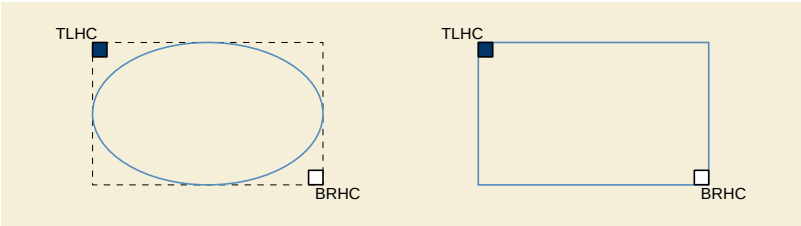


Figure C.10.5-2. ELLIPSE on the left and RECTANGLE object on the right

C.10.5.1.3.4 Rectangles

For the Compound Graphic Type (0070,0294) RECTANGLE, exactly 2 points shall be present inside Graphic Data (0070,0022). The first point is the top/left hand corner of the rectangle (TLHC) and the second point is the bottom/right hand corner (BRHC) of the rectangle (see Figure C.10.5-2).

C.10.5.1.3.5 Multi-lines

For the Compound Graphic Type (0070,0294) MULTILINE, the list of points inside Graphic Data (0070,0022) is an n-tuple list of start and end points of straight lines to be drawn (see Figure C.10.5-3).

If Rotation Angle (0070,0230) is present, all points in the MULTILINE are rotated around the same Rotation Point (0070,0273).

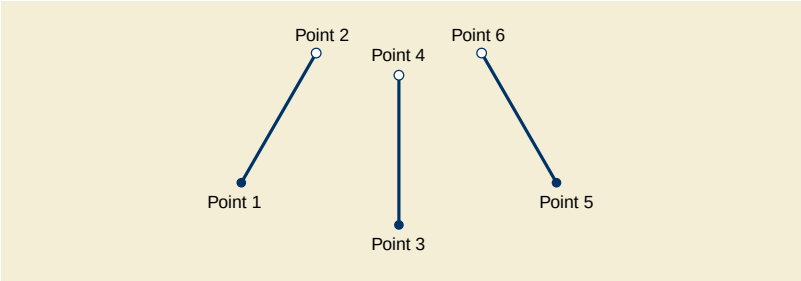


Figure C.10.5-3. Example for MULTILINE Object

C.10.5.1.3.6 Cut and Infinite-lines

For the Compound Graphic Type (0070,0294) CUTLINE or INFINITELINE, exactly two points shall be present inside Graphic Data (0070,0022). The rendering of these lines always extends to the borders of the render area of a view(see Figure C.10.5-4).

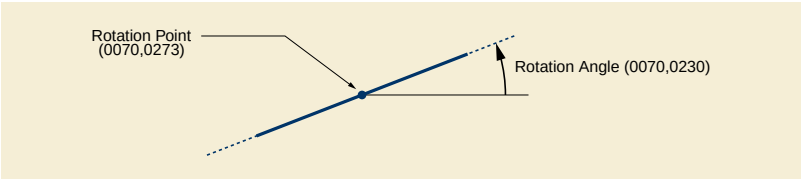


Figure C.10.5-4. INFINITELINE

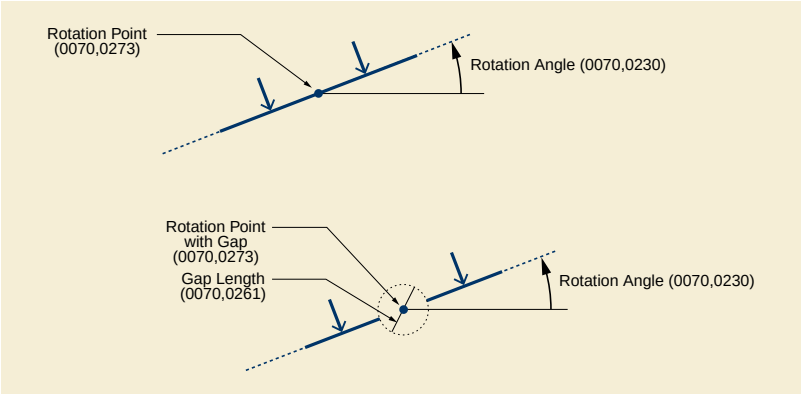


Figure C.10.5-5. CUTLINE on the Left and CUTLINE with gap on the Right

In case of a CUTLINE, two arrows shall be drawn perpendicular to the cutline. The arrows ends shall be positioned at the midpoints of each half of the cutline. The arrow heads shall point toward the cutline and shall be drawn in the positive right half-plane of the cutline before rotation. Typically, the arrows indicate the viewing direction for MPR renderings that are referenced by these lines.

Gap Length (0070,0261) defines the diameter of the circular area where the CUTLINE or INFINITELINE is not rendered. Center of the circular area is Rotation Point (0070,0273). Since the dimension units of the Gap Length is DISPLAY, independent of the value of Compound Graphic Units (0070,0282), the length of the gap is not changed by zoom operations on the image performed by the application.

C.10.5.1.3.7 Range Lines

For the Compound Graphic Type (0070,0294) RANGELINE exactly two points shall be present inside Graphic Data (0070,0022).

Figure C.10.5-6. RANGELINE Example

C.10.5.1.3.8 Ruler

For the Compound Graphic Type (0070,0294) RULER, exactly two points shall be present inside Graphic Data (0070,0022) defining the ruler line.

Tick Alignment (0070,0274) defines the alignment of the ticks.

BOTTOM - ticks are aligned to the lower part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

CENTER - ticks are centered on the line.

TOP - ticks are aligned to the upper part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

Tick Label Alignment (0070,0279) defines the alignment of the tick labels.

BOTTOM - labels are aligned to the lower part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

TOP - labels are aligned to the upper part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

The presence, labeling and units of the ticks on the line is application dependent(see Figure C.10.5-7). If present as numerical values, the labels of the ticks shall increase toward the second point.

C.10.5.1.3.9 Axis

For the Compound Graphic Type (0070,0294) AXIS, exactly two points shall be present inside Graphic Data (0070,0022) defining the axis line.

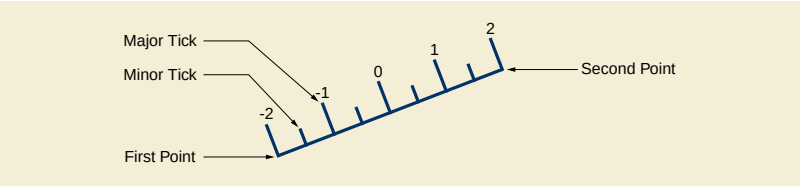


Figure C.10.5-7. RULER / AXIS Example Showing TOP Tick Alignment and TOP Tick Label Alignment

The Major Ticks Sequence (0070,0287) specifies the placement and label of the ticks. The rendering of the minor ticks is left to the application.

Tick Alignment (0070,0274) defines the alignment of the ticks.

BOTTOM - ticks are aligned to the lower part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

CENTER - ticks are centered on the line.

TOP - ticks are aligned to the upper part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

Tick Label Alignment (0070,0279) defines the alignment of the tick labels.

BOTTOM - labels are aligned to the lower part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

TOP - labels are aligned to the upper part of the line, where the first point of the line is on the left and the line extends horizontally to the right.

C.10.5.1.3.10 Crosshairs

For Compound Graphic Type (0070,0294) CROSSHAIR, exactly one point shall be present inside Graphic Data (0070,0022). This point is the origin of the CROSSHAIR (see Figure C.10.5-8).

Tick Alignment (0070,0274) and Tick Label Alignment (0070,0279) are also valid for the CROSSHAIR. Tick rendering is application dependent.

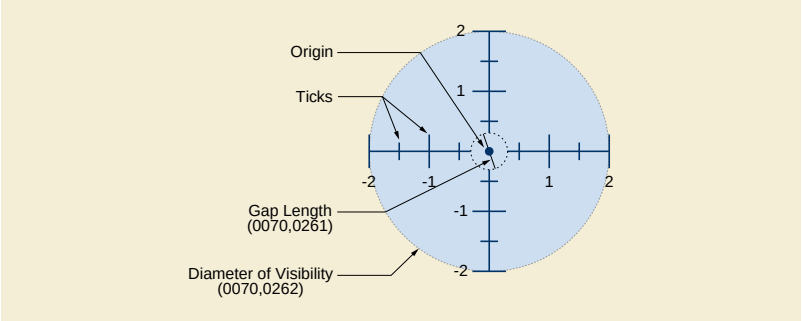


Figure C.10.5-8. CROSSHAIR Example Showing BOTTOM Tick Labels Alignment

Gap Length (0070,0261) defines the diameter of the circular area around the origin where the CROSSHAIR is not rendered. Since the dimension units of the Gap Length is DISPLAY, independent of the value of Compound Graphics Units (0070,0282), the length of the gap is not changed by zoom operations on the image performed by the application.

Diameter of Visibility (0070,0262) defines the diameter of the circular area around the origin where the CROSSHAIR is rendered. Since the dimension units of the Diameter of Visibility is DISPLAY, independent of the value of Compound Graphic Units (0070,0282), the size of the crosshair is not changed by zoom operations on the image performed by the application.

The value of Tick Alignment (0070,0274) shall be CENTER.

C.10.5.1.3.11 Arrows

For the Compound Graphic Type (0070,0294) ARROW, two points shall be present inside Graphic Data (0070,0022). The first point is the anchor point, the second point is the foot point of the arrow(see Figure C.10.5-9). The arrow head style at the anchor point is not specified.

Figure C.10.5-9. ARROW Example

C.10.5.1.3.12 Text Style Sequence

Text Style Sequence (0070,0231) contains the text style for each text object. This Attribute gives recommendations on how the annotation text should be rendered at the display.

Table C.10-5a specifies the Attributes that describe Text Style Sequence Macro.

Table C.10-5a. Text Style Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Text Style Sequence	(0070,0231)	3	Sequence that describes the text style. Only a single Item shall be included in this Sequence.
>Font Name	(0070,0227)	3	Font name in a standard type.

Attribute Name	Tag	Type	Attribute Description
>Font Name Type	(0070,0228)	1C	Defined Terms: **ISO_32000** Required if Font Name (0070,0227) is present. Note This is the font naming system used by Adobe PDF and defined in ISO/IEC 14496-22.
>CSS Font Name	(0070,0229)	1	Generic font name as defined within CSS (Cascading Style Sheets). Default fontname, if the font specified in Font Name (0070,0227) is not present or can not be rendered.
>Text Color CIELab Value	(0070,0241)	1	A default color triplet value used to specify the text color in which it is recommended that the text be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. This value shall override the Graphic Layer Recommended Display CIELab Value (0070,0401).
>Horizontal Alignment	(0070,0242)	1C	Specifies the horizontal position of the text relative to the vertical edges of the bounding box. Horizontal Alignment shall override the Bounding Box Text Horizontal Justification (0070,0012) of the Text Object Sequence (0070,0008) Item. See Section C.10.5.1.3.12.1 Enumerated Values: **LEFT** **CENTER** **RIGHT** Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>Vertical Alignment	(0070,0243)	1C	Specifies the vertical position of the text relative to the horizontal edges of the bounding box. See Section C.10.5.1.3.12.1 Enumerated Values: **TOP** **CENTER** **BOTTOM** Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>Shadow Style	(0070,0244)	1	The shadow style of the text to be displayed. Enumerated Values: **NORMAL** the shadow is drawn on 1 side of the contour of the text object **OUTLINED** the shadow is drawn around the contour of the text object **OFF** no shadow See Section C.10.5.1.3.13.1
>Shadow Offset X	(0070,0245)	1C	Floating point value that defines the shadow offset in X direction in Anchor Point Annotation Units (0070,0004) if used in Text Object Sequence (0070,0008) Item or in Graphic Annotation Units (0070,0005) if used in Graphic Object Sequence (0070,0009) Item. See Section C.10.5.1.3.13.1 Required if Shadow Style (0070,0244) value is not OFF.

Attribute Name	Tag	Type	Attribute Description
>Shadow Offset Y	(0070,0246)	1C	Floating point value that defines the shadow offset in Y direction in Anchor Point Annotation Units (0070,0004) if used in Text Object Sequence (0070,0008) Item or in Graphic Annotation Units (0070,0005) if used in Graphic Object Sequence (0070,0009) Item. See Section C.10.5.1.3.13.1 Required if Shadow Style (0070,0244) value is not OFF.
>Shadow Color CIELab Value	(0070,0247)	1C	A color triplet value used to encode the Shadow Color. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. Required if Shadow Style (0070,0244) value is not OFF.
>Shadow Opacity	(0070,0258)	1C	Encodes the shadow opacity. The value is encoded as floating point alpha value (0.0-1.0). Required if Shadow Style (0070,0244) value is not OFF.
>Underlined	(0070,0248)	1	Specifies whether or not the text shall be rendered underlined. Enumerated Values: **Y** yes **N** no
>Bold	(0070,0249)	1	Specifies whether or not the text shall be rendered in bold. Enumerated Values: **Y** yes **N** no
>Italic	(0070,0250)	1	Specifies whether or not the text shall be rendered italicized. Enumerated Values: **Y** yes **N** no

C.10.5.1.3.12.1 Text Alignment

Horizontal Alignment (0070,0242) and Vertical Alignment (0070,0243) define the position of the text relative to the bounding box of the text object (see Figure C.10.5-10).

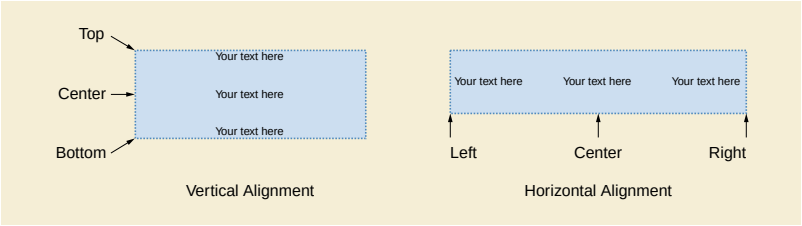


Figure C.10.5-10. Example of Horizontal and Vertical CENTER Alignment

C.10.5.1.3.13 Line Style Sequence

Table C.10-5b specifies the Attributes that describe Line Style Sequence Macro.

Table C.10-5b. Line Style Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Line Style Sequence	(0070,0232)	3	Sequence that describes the line style. Only a single Item shall be included in this Sequence.
>Pattern On Color CIELab Value	(0070,0251)	1	A color triplet value used to encode the foreground. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. This value shall override the Graphic Layer Recommended Display CIELab Value (0070,0401).
>Pattern Off Color CIELab Value	(0070,0252)	3	A color triplet value used to encode the color of parts of the line that are off, i.e., the background. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Pattern On Opacity	(0070,0284)	1	Encodes the foreground opacity. The value is encoded as floating point alpha value (0.0-1.0).
>Pattern Off Opacity	(0070,0285)	3	Encodes the background opacity. The value is encoded as floating point alpha value (0.0-1.0).
>Line Thickness	(0070,0253)	1	Specifies the line thickness. The dimension for this Attribute is defined by Graphic Annotation Units (0070,0005) or Compound Graphic Units (0070,0282).
>Line Dashing Style	(0070,0254)	1	The dashing style of the line to be displayed. Enumerated Values: **SOLID** **DASHED** Draws one part of the line with the Pattern On Color CIELab Value (0070,0251) and the other part with the Pattern Off Color CIELab Value (0070,0252). See Section C.10.5.1.3.13.1.
>Line Pattern	(0070,0255)	1C	Pattern that defines the line dashing style. The Line Pattern is a 32 bit value. If the bit inside the pattern is set to 1 the foreground color is drawn, else the background color is drawn. Note For example, 00FFH defines the dashes with an equal size. Required if Line Dashing Style (0070,0254) has a value of DASHED.
>Shadow Style	(0070,0244)	1	The shadow style of the line to be displayed. Enumerated Values: **NORMAL** the shadow is drawn on 1 side of the contour of the text object **OUTLINED** the shadow is drawn around the contour of the text object **OFF** no shadow See Section C.10.5.1.3.13.2
>Shadow Offset X	(0070,0245)	1	Floating point value that defines the shadow offset in X direction in Graphic Annotation Units (0070,0005). See Section C.10.5.1.3.13.2.
>Shadow Offset Y	(0070,0246)	1	Floating point value that defines the shadow offset in Y direction in Graphic Annotation Units (0070,0005). See Section C.10.5.1.3.13.2.
>Shadow Color CIELab Value	(0070,0247)	1	A color triplet value used to encode the Shadow Color. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

Attribute Name	Tag	Type	Attribute Description
>Shadow Opacity	(0070,0258)	1	Encodes the shadow opacity. The value is encoded as floating point alpha value (0.0-1.0).

C.10.5.1.3.13.1 Line Dashing Style

The Line Dashing Style (0070,0254) value SOLID indicates the line to be drawn with the foreground color, which is specified by Pattern On Color CIELab Value (0070,0251).

The Line Dashing Style (0070,0254) Attribute does not apply to shadows, which shall always be rendered in SOLID background color.

C.10.5.1.3.13.2 Shadows

Shadow Style (0070,0244) contains one of the values OFF, NORMAL or OUTLINED (see Figure C.10.5-11 and Figure C.10.5-12). Shadow shall be applied after rotation. The coordinate system of the shadow is relative to the line. Shadow Offset X (0070,0245) extends to the right and Shadow Offset Y (0070,0246) extends downward.

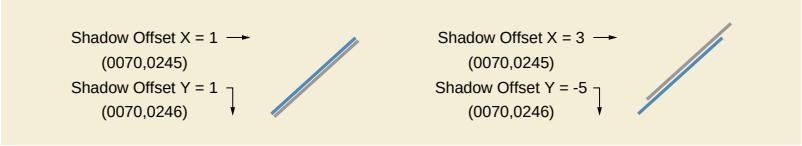


Figure C.10.5-11. Example for Shadow Style (0070,0244) NORMAL

The OUTLINED shadow defines a filled outline shadow. The length of the vector given by Shadow Offset X (0070,0245) and Shadow Offset Y (0070,0246) defines the radius of the shadow.

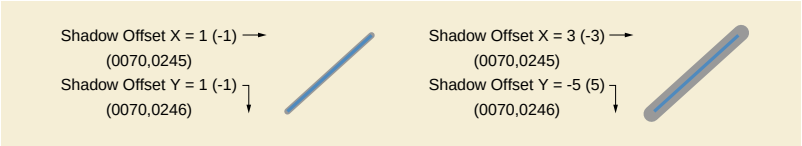


Figure C.10.5-12. Example for Shadow Style (0070,0244) OUTLINED

C.10.5.1.3.14 Fill Style Sequence

Table C.10-5c specifies the Attributes that describe Fill Style Sequence Macro.

Table C.10-5c. Fill Style Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Fill Style Sequence	(0070,0233)	3	Sequence that describes the fill style. Only a single Item is permitted in this Sequence.
>Pattern On Color CIELab Value	(0070,0251)	1	A color triplet value used to encode the foreground color. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. This value shall override the Graphic Layer Recommended Display CIELab Value (0070,0401).
>Pattern Off Color CIELab Value	(0070,0252)	3	A color triplet value used to encode the background color. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Pattern On Opacity	(0070,0284)	1	Encodes the foreground opacity. The value is encoded as floating point alpha value (0.0-1.0).

Attribute Name	Tag	Type	Attribute Description
>Pattern Off Opacity	(0070,0285)	1	Encodes the background opacity. The value is encoded as floating point alpha value (0.0-1.0).
>Fill Mode	(0070,0257)	1	The texture of the closed object to be displayed. Enumerated Values: **SOLID** **STIPPELED** See Section C.10.5.1.3.14.1.
>Fill Pattern	(0070,0256)	1C	A binary fill pattern. A set bit corresponds to foreground. An unset bit corresponds to background. A 128 byte value defining a 32x32 1 bit matrix. This fill pattern is replicated in tiles inside the boundaries of the graphic type. The most significant bit corresponds to the leftmost pixel in the row. The fill pattern relates to display pixels where one bit value corresponds to one display pixel. Required if Fill Mode (0070,0257) equals STIPPELED.

C.10.5.1.3.14.1 Fill Mode

Fill Mode (0070,0257) value SOLID indicates that the graphic object is filled with the foreground.

Fill Mode (0070,0257) Attribute does not interfere with (line) shadows, which shall always be rendered in SOLID background color.

C.10.6 Spatial Transformation Module

This Module defines a manner of rotating an image by increments of ninety degrees and flipping an image.

Table C.10-6. Spatial Transformation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Rotation	(0070,0042)	1	How far to rotate the image clockwise in degrees, before any Image Horizontal Flip (0070,0041) is applied. Enumerated Values: **270** **180** **90** **0** Note Negative values are not permitted since the Value Representation is unsigned.

Attribute Name	Tag	Type	Attribute Description
Image Horizontal Flip	(0070,0041)	1	Whether or not to flip the image horizontally after any Image Rotation has been applied such that the left side of the image becomes the right side. Enumerated Values: **Y** yes **N** no Note No vertical flip is specified since the same result can be achieved by a combination of a 180 degree rotation and a horizontal flip.

Note

Given the definition of the Grayscale Transformation Sequence in PS3.4, it is apparent that the rotation, flipping and magnification will be applied AFTER the application of any bit-mapped overlays or graphic annotations that are specified in the image pixel spaces, but BEFORE the application of graphic annotations that apply in the Specified Displayed Area relative space.

C.10.7 Graphic Layer Module

This Module defines the characteristics of the layers in which overlays, graphic and text may be rendered.

Layers group together graphics that are related. It is recommended that a layer be displayed such that it may be distinguished from other layers that have a different value for Graphic Layer Order (0070,0062).

Note

The transparency, opacity, and any other interaction (such as exclusive or) with underlying layers or image data are not specified and are at the discretion of the implementation.

Table C.10-7. Graphic Layer Module Attributes

Attribute Name	Tag	Type	Attribute Description
Graphic Layer Sequence	(0070,0060)	1	A Sequence of Items each of which represents a single layer in which overlays, curves, graphics or text may be rendered. One or more Items shall be included in this Sequence. An Item is required for each layer referenced from the Graphic Annotation Module or the Overlay Activation Module.
>Graphic Layer	(0070,0002)	1	A string that identifies the layer. Note This identifier may be used by other Attributes within the same Presentation State Instance to reference this layer. There is no requirement for the same identifiers to be used in different presentation states, and there is no mechanism for referencing layers in other presentation states. That is, a UID is not required.
>Graphic Layer Order	(0070,0062)	1	An integer indicating the order in which it is recommended that the layer be rendered, if the display is capable of distinguishing. Lower numbered layers are to be rendered first.

Attribute Name	Tag	Type	Attribute Description
>Graphic Layer Recommended Display Grayscale Value	(0070,0066)	3	A default single gray unsigned value in which it is recommended that the layer be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Graphic Layer Recommended Display CIELab Value	(0070,0401)	3	A default color triplet value in which it is recommended that the layer be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>Graphic Layer Description	(0070,0068)	3	A free text description of the contents of this layer.

Note

Graphic Layer Recommended Display RGB Value (0070,0067) was previously used in this Module, but has been retired and its function replaced by Graphic Layer Recommended Display CIELab Value (0070,0401). See PS3.3-2004.

C.10.7.1 Graphic Layer Module Attributes

C.10.7.1.1 Encoding of CIELab Values

Attributes such as Graphic Layer Recommended Display CIELab Value (0070,0401) consist of three unsigned short values:

- An L value linearly scaled to 16 bits, such that 0x0000 corresponds to an L of 0.0, and 0xFFFF corresponds to an L of 100.0.
- An a* then a b* value, each linearly scaled to 16 bits and offset to an unsigned range, such that 0x0000 corresponds to an a* or b* of -128.0, 0x8080 corresponds to an a* or b* of 0.0 and 0xFFFF corresponds to an a* or b* of 127.0

Note

This is the same form of encoding as used for the PCS in ICC Profiles.

C.10.8 Waveform Identification Module

The table in this section contains Attributes that identify a Waveform as a separate information entity.

Table C.10-8. Waveform Identification Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies this Waveform.
Content Date	(0008,0023)	1	The date the Waveform data was created.
Content Time	(0008,0033)	1	The time the Waveform data was created.
Acquisition DateTime	(0008,002A)	1	The date and time that the acquisition of data that resulted in this waveform started; the reference timestamp for the Multiplex Group Time Offset (0018,1068) for a waveform multiplex group Note The synchronization of this time with an external clock is specified in the Synchronization Module in Acquisition Time Synchronized (0018,1800).

Attribute Name	Tag	Type	Attribute Description
Referenced Instance Sequence	(0008,114A)	3	Composite SOP Instances that are significantly related to this Waveform. One or more Items are permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Code describing the purpose of the reference to the Instance(s). Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7004 "Waveform Purposes of Reference" for referenced waveforms.*

Note

Acquisition DateTime (0008,002A) is the time of the original waveform data capture. Derived waveforms that are processed (e.g., averaged or filtered) and encoded subsequent to the waveform Acquisition DateTime have a Content Date (0008,0023) and Content Time (0008,0033) representing the time of the processing. In all cases the actual date and time of creation of the SOP Instance for transmission or storage may be recorded in the Instance Creation Date (0008,0012) and Instance Creation Time (0008,0013) (see Section C.12.1).

C.10.9 Waveform Module

The table in this section contains Attributes that describe a time-based waveform. A waveform consists of one or more multiplex groups, each encoded into an Item in the Waveform Sequence. All channels within a multiplex group are synchronously digitized at a common sampling frequency.

Table C.10-9. Waveform Module Attributes

Attribute Name	Tag	Type	Attribute Description
Waveform Sequence	(5400,0100)	1	Sequence of Items, each representing one waveform multiplex group. One or more Items shall be included in this Sequence. Ordering of Items in this Sequence is significant for external reference to specific multiplex groups.
>Multiplex Group Time Offset	(0018,1068)	1C	Offset time in milliseconds from a reference time (see Section C.10.9.1.1). Required if Acquisition Time Synchronized (0018,1800) value is Y; may be present otherwise.
>Trigger Time Offset	(0018,1069)	1C	Offset time in milliseconds from a synchronization trigger to the first sample of a waveform multiplex group. May be positive or negative. Required if waveform acquisition is synchronized to a trigger.
>Trigger Sample Position	(0018,106E)	3	Sample number whose time corresponds to a synchronization trigger (see Section C.10.9.1.2).
>Waveform Originality	(003A,0004)	1	See Section C.10.9.1.3. Enumerated Values: **ORIGINAL** **DERIVED**
>Number of Waveform Channels	(003A,0005)	1	Number of channels for this multiplex group.

Attribute Name	Tag	Type	Attribute Description
>Number of Waveform Samples	(003A,0010)	1	Number of samples per channel in this multiplex group.
>Sampling Frequency	(003A,001A)	1	Frequency in Hz
>Multiplex Group Label	(003A,0020)	3	Label for multiplex group
>Multiplex Group UID	(003A,0310)	1C	Unique Identifier for the multiplex group. Required if the same Multiplex Group is used in more than one SOP Instance. May be present otherwise.
>Powerline Frequency	(003A,0311)	3	Frequency of the power line in Hz.
>Channel Definition Sequence	(003A,0200)	1	Sequence of Items, with one Item per channel (see Section C.10.9.1.4). One or more Items shall be included in this Sequence. Ordering of Items in this Sequence is significant for reference to specific channels.
>>Waveform Channel Number	(003A,0202)	3	Equipment physical channel number used for acquisition.
>>Channel Label	(003A,0203)	3	Text label for channel, which may be used for display purposes
>>Channel Status	(003A,0205)	3	One or more values for the status of this channel within this SOP Instance. Defined Terms: **OK** **TEST DATA** **DISCONNECTED** **QUESTIONABLE** **INVALID** **UNCALIBRATED** **UNZEROED** Precise location of a change in status may be noted in an Annotation.
>>Channel Source Sequence	(003A,0208)	1	A coded descriptor of the waveform channel source (metric, anatomical position, function, and technique). Only a single Item shall be included in this Sequence. (see Section C.10.9.1.4.1)
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*Baseline CID determined by IOD specialization*
>>Channel Source Modifiers Sequence	(003A,0209)	1C	Sequence of Items that further qualify the Waveform Source. One or more Items shall be included in this Sequence. Ordering of Items in this Sequence may be semantically significant. Required if Channel Source Sequence (003A,0208) does not fully specify the semantics of the source.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*Baseline CID determined by IOD specialization*
>>Source Waveform Sequence	(003A,020A)	3	A Sequence that provides reference to a DICOM waveform from which this channel was derived. One or more Items are permitted in this Sequence.
>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>>>Referenced Waveform Channels	(0040,A0B0)	1	Identifies the waveform multiplex group and channel within the referenced SOP Instance. Pair of values (M,C).
>>Channel Derivation Description	(003A,020C)	3	Additional description of waveform channel derivation
>>Channel Sensitivity	(003A,0210)	1C	Nominal numeric value of unit quantity of sample. Required if samples represent defined (not arbitrary) units.
>>Channel Sensitivity Units Sequence	(003A,0211)	1C	A coded descriptor of the Units of measure for the Channel Sensitivity. Only a single Item shall be included in this Sequence. (see Section C.10.9.1.4.2). Required if Channel Sensitivity (003A,0210) is present.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 82 "Units of Measurement".*
>>Channel Sensitivity Correction Factor	(003A,0212)	1C	Multiplier to be applied to encoded sample values to match units specified in Channel Sensitivity (003A,0210) (e.g., based on calibration data) (see Section C.10.9.1.4.2). Required if Channel Sensitivity (003A,0210) is present.
>>Channel Baseline	(003A,0213)	1C	Offset of encoded sample value 0 from actual 0 using the units defined in the Channel Sensitivity Units Sequence (003A,0211). Required if Channel Sensitivity (003A,0210) is present.
>>Channel Time Skew	(003A,0214)	1C	Offset of first sample of channel from waveform multiplex group start time, in seconds (see Section C.10.9.1.4.3) Required if Channel Sample Skew is not present.
>>Channel Sample Skew	(003A,0215)	1C	Offset of first sample of channel from waveform multiplex group start time, in samples (see Section C.10.9.1.4.3) Required if Channel Time Skew is not present.
>>Channel Offset	(003A,0218)	3	Additional offset of first sample of channel to be used in aligning multiple channels for presentation or analysis, in seconds (see Section C.10.9.1.4.3)
>>Waveform Bits Stored	(003A,021A)	1	Number of significant bits within the waveform samples (see Section C.10.9.1.4.4)
>>Filter Low Frequency	(003A,0220)	3	Nominal 3dB point of lower frequency of pass band; in Hz
>>Filter High Frequency	(003A,0221)	3	Nominal 3dB point of upper frequency of pass band; in Hz
>>Notch Filter Frequency	(003A,0222)	3	Center frequency of notch filter(s); in Hz
>>Notch Filter Bandwidth	(003A,0223)	3	Nominal 3dB bandwidth of notch filter(s); in Hz
>>Channel Impedance Sequence	(003A,0312)	3	Sequence of items with impedance values for the given channel (see Section C.10.9.1.9). One or more Items are permitted in this Sequence.
>>>Impedance Value	(003A,0313)	1	Measured value of the impedance in Ohm.
>>>Impedance Measurement DateTime	(003A,0314)	1	Point in time the measurement took place.
>>>Impedance Measurement Frequency	(003A,0315)	3	Frequency of the impedance measurement current in Hz.

Attribute Name	Tag	Type	Attribute Description
>>>Impedance Measurement Current Type	(003A,0316)	3	Type of current used to measure the impedance Defined Terms: **AC** **DC**
>>Channel Minimum Value	(5400,0110)	3	Minimum valid sample value as limited by the acquisition equipment (see Section C.10.9.1.4.5)
>>Channel Maximum Value	(5400,0112)	3	Maximum valid sample value as limited by the acquisition equipment (see Section C.10.9.1.4.5)
>Waveform Bits Allocated	(5400,1004)	1	Size of each waveform data sample within the Waveform Data; See Section C.10.9.1.5
>Waveform Sample Interpretation	(5400,1006)	1	Data representation of the waveform data points. See Section C.10.9.1.5.
>Waveform Padding Value	(5400,100A)	1C	Value of waveform samples inserted in channels when input is absent or invalid. Required if acquisition equipment inserts padding. See Section C.10.9.1.6.
>Waveform Data	(5400,1010)	1	Encoded data samples - channel multiplexed. See Section C.10.9.1.7
Waveform Data Display Scale	(003A,0230)	3	The recommended time-based waveform data display scale in units of mm/s (see Section C.10.9.1.8).
Waveform Display Background CIELab Value	(003A,0231)	3	A color triplet value recommended for rendering the waveform display background on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
Waveform Presentation Group Sequence	(003A,0240)	3	Sequence of Items, each Item describing a Presentation Group of one or more waveform channels to be displayed together. Note A Presentation Group is conventionally denoted a "display page", and a waveform object may be rendered using several Presentation Groups under user display control. One or more Items are permitted in this Sequence.
>Presentation Group Number	(003A,0241)	1	A number that identifies the Presentation Group.
>Channel Display Sequence	(003A,0242)	1	Sequence of Items, each Item describing a channel to be displayed in the Presentation Group. One or more Items shall be included in this Sequence.
>>Referenced Waveform Channels	(0040,A0B0)	1	Identifier of the displayed channel, specified as a pair of values (M,C) where the first value is the ordinal of the Item of Waveform Sequence (5400,0100) (i.e., the Multiplex Group Number), and the second value is the ordinal of the Item of the Channel Definition Sequence (003A,0200) Attribute (i.e., the Waveform Channel Number) within the multiplex group. Note In the context of a Channel Display Sequence (003A,0242) Item, only a single channel shall be referenced.
>>Channel Offset	(003A,0218)	3	The offset in seconds from the beginning of the channel waveform data to the first sample to be used for presentation. Value may be negative.

Attribute Name	Tag	Type	Attribute Description
>>Channel Recommended Display CIELab Value	(003A,0244)	1	A color triplet value recommended for rendering the channel on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
>>Channel Position	(003A,0245)	1	Position of the Channel within the Presentation Group display area (see Section C.10.9.1.11).
>>Display Shading Flag	(003A,0246)	3	Specifies display area shading between the displayed waveform channel and another line. The nature of the shading (e.g., solid, or cross-hatching) is implementation dependent. Enumerated Values: **NONE** no shading **BASELINE** shading between the waveform and the channel display baseline (sample value 0 equivalent location) **ABSOLUTE** shading between the waveform and the channel real world actual value 0 (i.e., taking into account the Channel Baseline (003A,0213) value) **DIFFERENCE** shading between the waveform and a second waveform in the Presentation Group at the same Channel Position that also has Display Shading Flag (003A,0246) value DIFFERENCE.
>>Fractional Channel Display Scale	(003A,0247)	1C	Fraction of the Presentation Group vertical display dimension assigned to the unit quantity (least significant bit) of the Channel samples (see Section C.10.9.1.10). Required if Absolute Channel Display Scale (003A,0248) is not present, may be present otherwise.
>>Absolute Channel Display Scale	(003A,0248)	1C	Nominal vertical display height in mm assigned to the unit quantity (least significant bit) of the Channel samples (see Section C.10.9.1.10). Required if Fractional Channel Display Scale (003A,0247) is not present, may be present otherwise.

C.10.9.1 Waveform Attribute Descriptions

C.10.9.1.1 Multiplex Group Time Offset

Multiplex Group Time Offset (0018,1068) specifies the offset time in milliseconds from a reference time to the first sample of the multiplex group. The reference time is Acquisition DateTime (0008,002A), if present in the SOP Instance.

In all other cases, the offset is from an arbitrary reference time that is the same for all Multiplex Groups in the SOP Instance; i.e., the Multiplex Group Time Offset allows only relative time synchronization between Multiplex Groups in the SOP Instance. The arbitrary reference time may nominally be assumed to be Content Time (0008,0033).

C.10.9.1.2 Trigger Sample Position

The Trigger Sample Position (0018,106E) specifies the sample that was digitized at the same time as a synchronization trigger. Sample positions are enumerated by channel, with the first sample enumerated 1. This provides a single trigger sample location for all channels of the multiplex group. Although channels may not have been sampled synchronously (as specified by Channel Time Skew or Channel Sample Skew), for the purpose of determining the location of the trigger with an integer value position, all channels are considered to be synchronous.

C.10.9.1.3 Waveform Originality

Waveform Originality (003A,0004) shall have the value ORIGINAL if the Waveform Data samples are the original or source data, and shall have the value DERIVED if the Waveform Data samples have been derived in some manner from the sample data of other waveforms.

Note

1. Waveform Originality (003A,0004) is comparable to Image Type (0008,0008) Value 1 (see Section C.7.6.1.1.2). Within a single Multiplex Group, all channels shall have the same Originality value.

2. Waveform data that has been transcoded from a non-DICOM format may have Waveform Originality value ORIGINAL if the samples are unchanged from the originally acquired waveform samples.

C.10.9.1.4 Channel Definition Sequence

C.10.9.1.4.1 Channel Source and Modifiers

Channel Source Sequence (003A,0208) identifies the metric (quality being measured, e.g., voltage or pressure), the anatomical position of the sensor or probe, the function of the channel (e.g., measurement or stimulus), and any particulars of technique that affect those parameters (e.g., pull-back across multiple anatomic sites, or differential input from two distinct sites). If the full semantics of the source is not carried in a single coded entry (e.g., if it specifies the location but not the metric), additional qualifiers are identified in Channel Source Modifiers Sequence (003A,0209) coded entries.

When a single sensor channel is used to collect a waveform from two (or more) anatomic sites, e.g., in hemodynamic pull-back procedures, multiple Channel Source Modifier Items will identify the sequence of sites, if not encoded in the semantics of the Channel Source Coded Entry. Transition times from one site to another may be indicated with an Annotation, or pull-back rate may be indicated with an Acquisition Context Sequence (0040,0555) Item (see Section C.7.6.14).

The Baseline CIDs are defined by IOD in accordance with Section A.34. Restrictions in the IOD may also determine the pattern of specification of the waveform source, i.e., which Item is to be encoded in the Channel Source Sequence, and the order in which Channel Source Modifier Items are to be encoded. Unless otherwise specified, pattern of specification of the waveform source shall be:

1. If the function of the channel is not measurement, the function (and optionally additional parameters of the channel source) shall be encoded in the Channel Source Item.

2. If the function of the channel is measurement of a waveform originating in the patient (the implicit default function), the metric (and optionally additional parameters of the channel source) shall be encoded in the Channel Source Item.

3. If not encoded in the Channel Source Item, and a particular technique needs to be encoded, that technique shall be encoded in the first Channel Source Modifier Item.

   Note

   For example, an intracardiac measurement of a pressure waveform across the mitral valve by means of a catheter pullback may be encoded in one of the following three ways (using pseudo-coded terminology), depending on the availability of coded terms with sufficient expressive power:

Channel Source	**Channel Source Modifiers**
X-2311 "pressure measurement"	T-7663 "pullback"C-2001 "mitral valve"
X-2123 "pressure measurement, pullback"	C-2001 "mitral valve"
X-1234 "pressure measurement, mitral valve, pullback"	(none required)

C.10.9.1.4.2 Channel Sensitivity and Channel Sensitivity Units

Channel Sensitivity (003A,0210) is the nominal value of one unit (i.e., the least significant bit) of each waveform sample in Waveform Data (5400,1010). It includes both the amplifier gain and the analog-digital converter resolution. It does not relate the vertical scaling of a waveform on a particular display.

Note

A prior edition specified Channel Sensitivity Units Sequence (003A,0211) DCID 3082 “Cardiology Units of Measurement (Retired)”. CID 3082 “Cardiology Units of Measurement (Retired)” was a subset of CID 82 “Units of Measurement”, and has been retired in favor of the more general CID 82 “Units of Measurement”. See PS3.3-2011.

Channel Sensitivity Correction Factor (003A,0212) is the ratio of the actual (calibrated) value to the nominal channel sensitivity specified in Channel Sensitivity (003A,0210). Thus a waveform sample value multiplied by the Channel Sensitivity value provides the nominal measured value in Channel Sensitivity Units, and that nominal value multiplied by the Channel Sensitivity Correction Factor provides the calibrated measured value.

C.10.9.1.4.3 Channel Skew and Channel Offset

Skew is also known as a sub-sample time delay, typically caused by using a multiplexed analog to digital converter that switches from channel to channel. For analysis it may be important to know if the analog channels were all latched simultaneously or sequentially and then digitized. Skew may be represented as time offset in seconds, or a fractional number of samples.

Separate and additional to skew is an offset time adjustment (sometimes called latency) by which one waveform channel is displaced significantly relative to others before sampling.

Note

As an example, a hemodynamic pressure is measured at the external end of a catheter, and thus its measurement is delayed by the time for the pressure wave to propagate down the catheter. With a dual catheter measurement, two signals may be acquired at the same time, but one arrives by a longer distance (e.g., a pulmonary capillary wedge pressure, compared to a left ventricular pressure). To obtain an accurate comparison of the waveforms (e.g., the gradient across the mitral valve), one waveform has to be offset (perhaps as much as 30 ms) to synchronize them.

C.10.9.1.4.4 Waveform Bits Stored

Waveform Bits Stored (003A,021A) specifies the number of significant bits within the Waveform Bits Allocated of each sample, for signed or unsigned integers.

If Waveform Sample Value Representation is MB or AB, Waveform Bits Stored shall be 8.

C.10.9.1.4.5 Channel Minimum and Maximum Value

Channel Minimum Value (5400,0110) and Channel Maximum Value (5400,0112) Attributes may be used to send the analog-to-digital converter limits (i.e., the clipping levels).

Note

These values do not represent the maximum and minimum values in the encoded data, but rather the valid range of values.

C.10.9.1.5 Waveform Bits Allocated and Waveform Sample Interpretation

Waveform Bits Allocated (5400,1004) specifies the number of bits allocated for each sample, and Waveform Sample Interpretation (5400,1006) specifies the data representation of each waveform sample. Waveform Bits Allocated shall be a multiple of 8. These Attributes are related, and their Defined Terms are specified in Table C.10-10.

Table C.10-10. Waveform Bits Allocated and Waveform Sample Interpretation

Waveform Bits Allocated - Defined Terms	Waveform Sample Interpretation - Defined Terms	Waveform Sample Interpretation Meaning
8	SB	signed 8 bit linear
	UB	unsigned 8 bit linear
	MB	8 bit mu-law (in accordance with ITU-T Recommendation G.711)
	AB	8 bit A-law (in accordance with ITU-T Recommendation G.711)
16	SS	signed 16 bit linear
	US	unsigned 16 bit linear
32	SL	signed 32 bit linear
	UL	unsigned 32 bit linear
64	SV	signed 64 bit linear

Waveform Bits Allocated - Defined Terms	Waveform Sample Interpretation - Defined Terms	Waveform Sample Interpretation Meaning
	UV	unsigned 64 bit linear

Note

1. The set of valid values from within this table may be constrained by definition of the IOD (see Section A.34).
2. mu-law and A-law encoding is without the alternate bit inversion used for PCM transmission through the telephone network.

This representation also applies to the Channel Minimum and Maximum Data Values, and Waveform Padding Value.

C.10.9.1.6 Waveform Padding Value

Equipment that produces digitized waveform curves may encode a specific value when the source is disconnected or otherwise invalid. This value is encoded like the Waveform Data (5400,1010) Attribute with one sample only.

The Waveform Padding Value need not be within the range specified by the Channel Minimum and Maximum Data Values.

C.10.9.1.7 Waveform Data

Each sample shall be encoded using the defined Waveform Sample Interpretation (5400,1006), using the defined number of Waveform Bits Stored (003A,021A) right justified in the sample. If the number of Waveform Bits Stored is less than the number of bits in Waveform Bits Allocated, the sign bit shall be extended to the highest order bit of the data sample.

Data values are encoded interleaved, incrementing by channel and then by sample (i.e., C1S1, C2S1,C3S1, … CnS1, C1S2, C2S2, C3S2, … CnSm), with no padding or explicit delimitation between successive samples. Cx denotes the channel defined in the Channel Definition Sequence (003A,0200) Item in Item number x.

Note

1. With 8-bit Waveform Data, there may be an odd number of channels and an odd number of samples; see PS3.5 for rules on encoding.
2. The sign bit extension rule differs from the rules for pixel data, which do not require sign extension.

C.10.9.1.8 Waveform Data Display Scale

Waveform Data Display Scale (003A,0230) specifies the recommended display scale in the time dimension for the waveform data in units of mm/s. The display application needs to know the horizontal pixel scaling of the display device to effectively apply this Attribute. Waveform Data Display Scale (003A,0230), divided by Sampling Frequency (003A,001A), times the display scaling in pixels/mm gives the number of horizontal pixels between subsequent samples.

Note

1. This presumes a conventional waveform display with time in the horizontal dimension, and waveform measured quantity in the vertical dimension.
2. This Attribute is useful for size consistency between softcopy display and classical hardcopy ECG printouts. E.g., for the channels of a multiplex group whose Sampling Frequency is 400 Hz, and whose Waveform Data Display Scale (003A,0230) is 25 mm/s, and that is being displayed on a monitor at 4.1 pixels/mm, the horizontal interval between samples is

   25 / 400 * 4.1 = 0.25625 pixels

How the display application renders samples at fractional pixel spacing is implementation dependent.

C.10.9.1.9 Channel Position

Channel Position (003A,0245) specifies the position of the channel display baseline in the Presentation Group vertical display dimension. The channel position is relative to the top of the display area. Each Presentation Group display area is defined with vertical dimension positions of 0.0 (top of display area) to 1.0 (bottom of display area).

Note

1. This presumes a conventional waveform display with time in the horizontal dimension, and waveform measured quantity in the vertical dimension.

2. Compare Bounding Box Annotation Units (0070,0003) value DISPLAY in Section C.10.5.

Channel sample value 0 maps to the Channel Position (003A,0245) display baseline. The real world value associated with the baseline is specified in Channel Baseline (003A,0213).

Multiple channels may overlap, and may share the same Channel Position (003A,0245).

C.10.9.1.10 Channel Display Scale

Fractional Channel Display Scale (003A,0247) or Absolute Channel Display Scale (003A,0248) specifies the vertical scaling of the channel display. If both Attributes are provided, the selection of which to use for display control is implementation dependent.

Fractional Channel Display Scale (003A,0247) specifies the fraction of the Presentation Group vertical display dimension used to offset each unit of the waveform sample value from the baseline Channel Position (003A,0245). Positive offset values are towards the top of the display area.

Note

E.g., for a channel whose Fractional Channel Display Scale (003A,0247) value is 0.004, and whose Channel Position (003A,0245) value is 0.5, a sample whose value is -37 would be displayed at a position

0.5 - (-37 * 0.004) = 0.648

of the total vertical display dimension below the top of the Presentation Group display area.

Absolute Channel Display Scale (003A,0248) specifies the nominal physical distance on a display device (monitor) used to offset each unit of the waveform sample value from the baseline Channel Position (003A,0245). The display application needs to know the vertical pixel scaling of the display device to effectively apply this Attribute. The Channel Sensitivity (003A,0210) value in Channel Sensitivity Units (003A,0211), divided by Absolute Channel Display Scale (003A,0248) value, gives the real-world scaling of the intended display.

Note

1. This Attribute is useful for size consistency between softcopy display and classical hardcopy waveform printed charts. E.g., a channel whose Channel Sensitivity (003A,0210) value is 44 uV (per least significant bit), and whose Absolute Channel Display Scale (003A,0248) value is 0.44 mm, has a real-world display scale of 0.1 mV/mm.

2. E.g., for a channel whose Absolute Channel Display Scale (003A,0248) value is 0.44 mm, and that is being displayed on a monitor at 4.1 pixels/mm, a sample whose value is 107 would be displayed at a position

   107 * 0.44 * 4 = 193.028

   pixels above the Channel Position (003A,0245) baseline.

Display for waveform samples that would lie outside the Presentation Group display area is unspecified.

Negative values of Fractional Channel Display Scale (003A,0247) and Absolute Channel Display Scale (003A,0248) are allowed.

C.10.9.1.11 Channel Impedance Sequence

The Impedance Value (003A,0313) is stored as a measure (ohm) at a given point in time per electrode. Technically this happens before or after a recording. Recording has to be paused, if impedance testing is done during a recording.

C.10.10 Waveform Annotation Module

The table in this section contains Attributes that identify annotations to the waveform of the current SOP Instance. Each annotation conceptually forms the equivalent of a overlay on a presentation display of the annotated entity. Annotations may represent a measurement or categorization based on the waveform data, identification of regions of interest or particular features of the waveform, or events during the data collection that may affect diagnostic interpretation (e.g., the time at which the subject coughed).

Each Annotation Item shall have the following components:

1. An annotation Text, Coded Name (only), Coded Name/Coded Value pair, or Coded Name/Numeric Measurement pair (mutually exclusive)

2. Temporal coordinates in the Waveform to which the annotation applies

Table C.10-11. Waveform Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Waveform Annotation Sequence	(0040,B020)	1	Sequence of Annotation Items. One or more Items shall be included in this Sequence.
>Unformatted Text Value	(0070,0006)	1C	Text Observation Value (annotation). Mutually exclusive with Concept Name Code Sequence (0040,A043)
>Concept Name Code Sequence	(0040,A043)	1C	Code representing the fully specified name of the NUMERIC measurement or CODED concept. Only a single Item shall be included in this Sequence. Mutually exclusive with Unformatted Text Value (0070,0006).
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Baseline CID may be defined in IOD definition.*
>>Modifier Code Sequence	(0040,A195)	1C	A Sequence of Items modifying or specializing the Concept Name. One or more Items shall be included in this Sequence. Required if the value of Concept Name Code Sequence (0040,A043) does not fully describe the semantics of the measurement or concept.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Baseline CID may be defined in IOD definition.*
>Concept Code Sequence	(0040,A168)	3	A Sequence that conveys the categorical coded nominal value. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Baseline CID may be defined in IOD definition.*
>>Modifier Code Sequence	(0040,A195)	1C	A Sequence of Items modifying or specializing the Concept. One or more Items shall be included in this Sequence. Required if the value of Concept Code Sequence (0040,A168) does not fully describe the semantics of the concept value.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Baseline CID may be defined in IOD definition.*
>Numeric Value	(0040,A30A)	3	Numeric measurement value or values.
>Measurement Units Code Sequence	(0040,08EA)	3	Units of measurement. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 82 “Units of Measurement”.*

Attribute Name	Tag	Type	Attribute Description
>Referenced Waveform Channels	(0040,A0B0)	1	List of channels in waveform to which annotation applies. See Section C.10.10.1.1
>Temporal Range Type	(0040,A130)	1C	See Section C.10.10.1.2 for Enumerated Values. Required if Annotation does not apply to entire Referenced Waveform Channels; shall not be present if Annotation applies to entire temporal extent of referenced channels.
>Referenced Sample Positions	(0040,A132)	1C	List of samples within a multiplex group specifying temporal points for annotation. Position of first sample is 1. Required if Temporal Range Type (0040,A130) is present, and if Referenced Time Offsets (0040,A138) and Referenced DateTime (0040,A13A) are not present. See Section C.10.10.1.3
>Referenced Time Offsets	(0040,A138)	1C	Specifies temporal points for annotation by number of seconds after start of data. Required if Temporal Range Type (0040,A130) is present, and if Referenced Sample Positions (0040,A132) and Referenced DateTime (0040,A13A) are not present.
>Referenced DateTime	(0040,A13A)	1C	Specifies temporal points for annotation by absolute time. Required if Temporal Range Type (0040,A130) is present, and if Referenced Sample Positions (0040,A132) and Referenced Time Offsets (0040,A138) are not present.
>Annotation Group Number	(0040,A180)	3	Number identifying associated annotations (see Section C.10.10.1.4).

C.10.10.1 Waveform Annotation Attribute Descriptions

C.10.10.1.1 Referenced Channels

Referenced Waveform Channels (0040,A0B0) is a multi-value Attribute that lists the channels to which an annotation of a waveform applies. Each channel is specified as a pair of values (M,C), where the first value is the ordinal of the Item of Waveform Sequence (5400,0100) (i.e., the Multiplex Group Number), and the second value is the ordinal of the Item of the Channel Definition Sequence (003A,0200) Attribute (i.e., the Waveform Channel Number) within the multiplex group.

If the specified channel number is 0, the annotation applies to all channels in the multiplex group.

Note

As an example, an annotation that applies to the entire first multiplex group and channels 2 and 3 of the third multiplex group would have Referenced Channels value 0001 0000 0003 0002 0003 0003.

C.10.10.1.2 Temporal Range Type

The Temporal Range Type (0040,A130) Attribute defines the type of temporal extent of the annotated region of interest. A temporal point (or instant of time) may be defined by a waveform sample offset (for a single waveform multiplex group only), time offset, or absolute time.

Enumerated Values:

POINT a single temporal point
MULTIPOINT multiple temporal points
SEGMENT a range between two temporal points
MULTISEGMENT multiple segments, each denoted by two temporal points
BEGIN a range beginning at one temporal point, and extending beyond the end of the acquired data
END a range beginning before the start of the acquired data, and extending to (and including) the identified temporal point

C.10.10.1.3 Referenced Sample Positions

Referenced Sample Positions (0040,A132) may be used only if Referenced Waveform Channels (0040,A0B0) refers to channels within a single multiplex group. The sample position is by channel, and applies to all channels specified in Referenced Channels (0040,A0B0).

C.10.10.1.4 Annotation Group Number

The Annotation Group Number (0040,A180) allows the logical association of multiple annotations within the current SOP Instance. Such linked annotations share an Annotation Group Number, but each annotation is semantically separable. The nature of the association is not defined. The number is not semantically significant.

Note

For instance, the R-wave in several waveform channels may be annotated, and all occurrences of the same R-wave could be linked in an annotation group.

C.10.11 Graphic Group Module

Graphic Group Module provides the label and description for the logical associations made by the Graphic Group ID (0070,0295) of graphic objects.

The grouping concept used in the Graphic Group Module differs from the grouping concept used in the Graphic Layer Module. Graphic Layer Module addresses the rendering order by using the Graphic Layer Order (0070,0062), which specifies which annotations are rendered first. The Graphic Group Module is used to specify which annotations belong together and shall be handled together(e.g., rotate, move) independent of the Graphic Layer to which they are assigned.

Table C.10-12. Graphic Group Module Attributes

Attribute Name	Tag	Type	Attribute Description
Graphic Group Sequence	(0070,0234)	1	Sequence that describes the combined graphic object. One or more Items shall be included in this Sequence.
>Graphic Group ID	(0070,0295)	1	A unique number identifying the Graphic Group, i.e., the combined graphic object.
>Graphic Group Label	(0070,0207)	1	Name used to identify the Graphic Group, i.e., the combined graphic object.
>Graphic Group Description	(0070,0208)	3	Description of the group.

C.11 Look Up Tables and Presentation States

C.11.1 Modality LUT Module

Table C.11-1 specifies the Attributes that describe the Modality LUT.

Either a Modality LUT Sequence containing a single Item or Rescale Slope and Intercept values shall be present but not both.

Note

This requirement for only a single transformation makes it possible to unambiguously define the input of succeeding stages of the grayscale pipeline such as the VOI LUT.

Table C.11-1. Modality LUT Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.11-1b “Modality LUT Macro Attributes”			

Table C.11-1b. Modality LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Modality LUT Sequence	(0028,3000)	1C	Defines a Sequence of Modality LUTs. Only a single Item shall be included in this Sequence. Shall not be present if Rescale Intercept (0028,1052) is present.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.1.1 for further explanation.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>Modality LUT Type	(0028,3004)	1	Specifies the output values of this Modality LUT. See Section C.11.1.1.2 for further explanation.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
Rescale Intercept	(0028,1052)	1C	The value b in relationship between stored values (SV) and the output units specified in Rescale Type (0028,1054). Output units = m*SV + b. Required if Modality LUT Sequence (0028,3000) is not present. Shall not be present otherwise.
Rescale Slope	(0028,1053)	1C	m in the equation specified by Rescale Intercept (0028,1052). Required if Rescale Intercept is present.
Rescale Type	(0028,1054)	1C	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). See Section C.11.1.1.2 for further explanation. Required if Rescale Intercept is present.

C.11.1.1 LUT Attribute Descriptions

C.11.1.1.1 LUT Descriptor

The three values of LUT Descriptor (0028,3002) describe the format of the LUT Data in the corresponding LUT Data (0028,3006) Attribute.

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0.

The second value is the first stored pixel value mapped. The Value Representation of the second value (US or SS) is specified by Pixel Representation (0028,0103). This stored pixel value is mapped to the first entry in the LUT. All stored pixel values less than the first value mapped are also mapped to the first entry in the LUT Data. A stored pixel value one greater than the first value mapped is mapped to the second entry in the LUT Data. Subsequent stored pixel values are mapped to the subsequent entries in the LUT Data up to a stored pixel value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. Stored pixel values greater than or equal to number of entries + first value mapped are also mapped to the last entry in the LUT Data.

The third value specifies the number of bits for each entry in the LUT Data. It shall take the value 8 or 16. The LUT Data shall be stored in a format equivalent to 8 bits allocated when the number of bits for each entry is 8, and 16 bits allocated when the number of bits for each entry is 16, where in both cases the high bit is equal to bits allocated - 1.

Note

Some implementations have encoded 8 bit entries with 16 bits allocated, padding the high bits; this can be detected by comparing the number of entries specified in the LUT Descriptor with the actual value length of the LUT Data entry. The value length in bytes should equal the number of entries if bits allocated is 8, and be twice as long if bits allocated is 16.

The third value also conveys the range of LUT entry values. It shall take the value 8 or 16, corresponding with the LUT entry value range of 256 or 65536.

Note

Since LUT Descriptor (0028,3002) is multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified, even though the first and third values are always by definition interpreted as unsigned. The explicit VR actually used is dictated by the VR needed to represent the second value, which will be consistent with Pixel Representation (0028,0103).

The LUT Data contains the LUT entry values.

The output range of the Modality LUT Module depends on whether or not Rescale Slope (0028,1053) and Rescale Intercept (0028,1052) or the Modality LUT Sequence (0028,3000) are used.

In the case where Rescale Slope and Rescale Intercept are used, the output ranges from (minimum pixel value*Rescale Slope+Rescale Intercept) to (maximum pixel value*Rescale Slope+Rescale Intercept), where the minimum and maximum pixel values are determined by Bits Stored and Pixel Representation.

Note

This range may be signed even if Pixel Representation is unsigned.

In the case where the Modality LUT Sequence is used, the output range is from 0 to 2^n-1 where n is the third value of LUT Descriptor. This range is always unsigned.

C.11.1.1.2 Modality LUT and Rescale Type

Specifies the units of the output of the Modality LUT or rescale operation.

Defined Terms:

OD The number in the LUT represents thousands of optical density. That is, a value of 2140 represents an optical density of 2.140.
HU Hounsfield Units (CT)
US Unspecified
MGML mg/ml
Z_EFF Effective Atomic Number (i.e., Effective-Z)
ED Electron density in 1023 electrons/ml
EDW Electron density normalized to water in units of N/Nw where N is number of electrons per unit volume, and Nw is number of electrons in the same unit of water at standard temperature and pressure.
HU_MOD Modified Hounsfield Unit
PCT Percentage (%)

Other values are permitted, but are not defined by the DICOM Standard.

C.11.1.1.2.1 Recommended Rescale Type Assignments For Multi-energy CT Image

Multi-energy CT Images can have multiple assignments of Rescale Types to Image Type Attributes. These are the recommended assignments for Rescale Type and Real World Value Mapping Attributes.

Table C.11.1.1.2.1-1. Recommended Rescale Type Assignments for Multi-energy CT Image

Multi-energy Image Family	Rec. Rescale Type	Image Type Value 4	Intercept	Slope	RWV First & Last Values Mapped	RWV Intcpt.	RWV Slope	RWV LUT Label	RWV Meas. Units
Objective Image Family									
Virtual Monoenergetic Image	HU	VMI	-1024	1	0/4095	-1024	1	VMI	hnsf'U
Effective AN (Z) Image (see Note 1)	10^-2 Z_EFF	EFF_ATOMIC_NUM	0	1	0/4000	0	0.01	EFF_ATOMIC_NUM	129320
Electron Density Image	10^-2ED	ELECTRON_DENSITY	0	1	0/4000	0	0.01	ELECTRON_DENSITY	10*23/ml
	10^-3EDW	ELECTRON_DENSITY	0	1	0/4000	0	0.001	ELECTRON_DENSITY	ratio
Material Quantification Family									
Material-Specific Image	10^-2MGML	MAT_SPECIFIC	(0) - (-10)	1	0/4000	-3	0.01	MAT_SPECIFIC	mg/cm3
	HU	MAT_SPECIFIC	-1024	1	0/4095	-1024	1	MAT_SPECIFIC	hnsf'U
Material-Removed Image (see Note 2)	HU	MAT_REMOVED	-1024	1	0/4095	-1024	1	MAT_REMOVED	hnsf'U
	HU_MOD	MAT_REMOVED	-1024	1	0/4095	-1024	1	MAT_REMOVED	129321
Fractional Map Image	10^-1 %PCT	MAT_FRACTIONAL	0	1	0/1000	0	0.1	MAT_FRACTIONAL	%
Value-based Map Image	US	MAT_VALUE_BASED	0	1	0/100	0	1	MAT_ VALUE_BASED	US
Material Visualization Family									
Material-Modified Image	HU_MOD	MAT_MODIFIED	-1024	1	0/4095	-1024	1	MAT_MODIFIED	129321

Note

1. This example assumes a scaling of 0.01 for the Effective Atomic Number which would be reasonable for images for which the effective atomic number was not greater than 40 for any pixels.

2. The real-world value mapped pixels in the image may have been adjusted to represent the attenuation as if the pixel was filled with the remaining materials to preserve the relationship between the HU value of the pixel and the materials contained (shown as HU in the first row), or they may have not been adjusted (shown as HU_MOD).

C.11.2 VOI LUT Module

Table C.11-2 specifies the Attributes that describe the VOI LUT.

Table C.11-2. VOI LUT Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.11-2b “VOI LUT Macro Attributes”			

Table C.11-2b. VOI LUT Macro Attributes

Attribute Name	Tag	Type	Attribute Description
VOI LUT Sequence	(0028,3010)	1C	Defines a Sequence of VOI LUTs. One or more Items shall be included in this Sequence. Required if Window Center (0028,1050) is not present. May be present otherwise.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.2.1.1 for further explanation.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
Window Center	(0028,1050)	1C	Window Center for display. See Section C.11.2.1.2 for further explanation. Required if VOI LUT Sequence (0028,3010) is not present. May be present otherwise.
Window Width	(0028,1051)	1C	Window Width for display. See Section C.11.2.1.2 for further explanation. Required if Window Center (0028,1050) is present.
Window Center & Width Explanation	(0028,1055)	3	Free form explanation of the meaning of the Window Center and Width. Multiple values correspond to multiple Window Center and Width values.
VOI LUT Function	(0028,1056)	3	Describes a VOI LUT function to apply to the values of Window Center (0028,1050) and Window Width (0028,1051). See Section C.11.2.1.3 for further explanation. Defined Terms: **LINEAR** **LINEAR_EXACT** **SIGMOID** When this Attribute is not present, the interpretation of the values of Window Center (0028,1050) and Window Width (0028,1051) is linear as in Section C.11.2.1.2.

C.11.2.1 LUT Attribute Descriptions

C.11.2.1.1 LUT Descriptor

The three values of LUT Descriptor (0028,3002) describe the format of the LUT Data in the corresponding LUT Data (0028,3006) Attribute.

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0.

The second value is the first input value mapped. The Value Representation of the second value (US or SS) depends on the source of the input to the VOI LUT, and shall be:

- the same as specified by Pixel Representation (0028,0103), if there is no Modality LUT or Rescale Slope and Intercept specified;
- SS if the possible output range after application of the Rescale Slope and Intercept may be signed;

Note

This is always the case for the CT Image IOD in which the Rescale Type is specified to be Hounsfield Units, which are always signed.

- US otherwise.

This input value is mapped to the first entry in the LUT. All input values less than the first value mapped are also mapped to the first entry in the LUT Data. An input value one greater than the first value mapped is mapped to the second entry in the LUT Data. Subsequent input values are mapped to the subsequent entries in the LUT Data up to an input value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. Input values greater than or equal to number of entries + first value mapped are also mapped to the last entry in the LUT Data.

The third value specifies the number of bits for each entry in the LUT Data. If the VOI LUT is included in an Image IOD, the third value of LUT Descriptor (0028,3002) shall be 8 or 16 bits, unless otherwise specialized. If the VOI LUT is included in a Presentation State IOD, the third value of LUT Descriptor (0028,3002) shall be between 8 and 16 inclusive. The LUT Data shall be stored in a format equivalent to 8 bits allocated when the number of bits for each entry is 8, and 16 bits allocated when the number of bits for each entry is 16, where in both cases the high bit is equal to bits stored - 1, and where bits stored is the third value.

Note

1. Since LUT Descriptor (0028,3002) is multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified, even though the first and third values are always by definition interpreted as unsigned. The explicit VR actually used is dictated by the VR needed to represent the second value.

2. Some implementations have encoded 8 bit entries with 16 bits allocated, padding the high bits; this can be detected by comparing the number of entries specified in the LUT Descriptor with the actual value length of the LUT Data entry. The value length in bytes should equal the number of entries if bits allocated is 8, and be twice as long if bits allocated is 16.

The LUT Data contains the LUT entry values.

The output range is from 0 to 2^n-1 where n is the third value of LUT Descriptor. This range is always unsigned.

C.11.2.1.2 Window Center and Window Width

C.11.2.1.2.1 Default LINEAR Function

If VOI LUT Function (0028,1056) is absent or has a value of LINEAR, Window Center (0028,1050) and Window Width (0028,1051) specify a linear conversion from stored pixel values (after any Modality LUT or Rescale Slope and Intercept specified in the IOD have been applied) to values to be displayed. Window Center contains the input value that is the center of the window. Window Width contains the width of the window.

Note

The terms "window center" and "window width" are not consistently used in practice, nor were they defined in previous editions of the Standard. The definitions here are presented for the purpose of defining consistent meanings for identity and threshold transformations while preserving the common practice of using integer values for center and width.

Window Width (0028,1051) shall always be greater than or equal to 1.

When Window Width (0028,1051) is greater than 1, these Attributes select the range of input values that are to be mapped to the full range of the displayed output.

When Window Width (0028,1051) is equal to 1, they specify a threshold below which input values will be displayed as the minimum output value.

Note

Whether the minimum output value is rendered as black or white may depend on the value of Photometric Interpretation (0028,0004) or the presence of a Presentation LUT Module.

These Attributes are applied according to the following pseudo-code, where x is the input value, y is an output value with a range from y_{min} to y_{max}, c is Window Center (0028,1050) and w is Window Width (0028,1051):

if (x <= c - 0.5 - (w-1) /2), then y = y_{min}

else if (x > c - 0.5 + (w-1) /2), then y = y_{max}

else y = ((x - (c - 0.5)) / (w-1) + 0.5) * (y_{max}- y_{min}) + y_{min}

Note

1. For the purpose of this definition, a floating point calculation without integer truncation is assumed, though the manner of implementation may vary as long as the result is the same.

2. The pseudo-code function computes a continuous value over the output range without any discontinuity at the boundaries. The value of 0 for w is expressly forbidden, and the value of 1 for w does not cause division by zero, since the continuous segment of the function will never be reached for that case.

3. For example, for an output range 0 to 255:

   c=2048, w=4096 becomes:

   if (x <= 0) then y = 0

   else if (x > 4095) then y = 255

   else y = ((x - 2047.5) / 4095 + 0.5) * (255-0) + 0

   c=2048, w=1 becomes:

   if (x <= 2047.5) then y = 0

   else if (x > 2047.5) then y = 255

   else /* not reached */

   c=0, w=100 becomes:

   if (x <= -50) then y = 0

   else if (x > 49) then y = 255

   else y = ((x + 0.5) / 99 + 0.5) * (255-0) + 0

   c=0, w=1 becomes:

   if (x <= -0.5) then y = 0

   else if (x > -0.5) then y = 255

   else /* not reached */

4. A Window Center of 2^{n-1} and a Window Width of 2^n selects the range of input values from 0 to 2^n-1. This represents a mathematical identity VOI LUT transformation over the possible input values (whether used or not) in the case where no Modality LUT is specified and the stored pixel data are n bit unsigned integers.

   In the case where x1 is the lowest input value actually used in the Pixel Data and x2 is the highest, a Window Center of (x1+x2+1)/2 and a Window Width of (x2-x1+1) selects the range of input values from x1 to x2, which represents the full range of input values present as opposed to possible. This is distinct from the mathematical identity VOI LUT transformation, which instead selects the full range of input values possible as opposed to those actually used. The mathematical identity and full input range transformations are the same when x1 = 0 and x2 is 2^n-1 and the input values are n bit unsigned integers. See also Note 7.

5. A Window Width of 1 is typically used to represent a "threshold" operation in which those integer input values less than the Window Center are represented as the minimum displayed value and those greater than or equal to the Window Center are represented as the maximum displayed value. A Window Width of 2 will have the same result for integral input values.

6. The application of Window Center (0028,1050) and Window Width (0028,1051) may select a signed input range. There is no implication that this signed input range is clipped to zero.

7. The selected input range may exceed the actual range of the input values, thus effectively "compressing" the contrast range of the displayed data into a narrower band of the available contrast range, and "flattening" the appearance. There are no limits to the maximum value of the window width, or to the minimum or maximum value of window level, both of which may exceed the actual or possible range of input values.

8. Input values "below" the window are displayed as the minimum output value and input values "above" the window are displayed as the maximum output value. This is the common usage of the window operation in medical imaging. There is no provision for an alternative approach in which all values "outside" the window are displayed as the minimum output value.

9. The output of the Window Center/Width or VOI LUT transformation is either implicitly scaled to the full range of the display device if there is no succeeding transformation defined, or implicitly scaled to the full input range of the succeeding transformation step (such as the Presentation LUT), if present. See Section C.11.6.1.

10. Fractional values of Window Center and Window Width are permitted (since the VR of these Attributes is Decimal String), and though they are not often encountered, applications should be prepared to accept them.

C.11.2.1.2.2 General Requirements for Window Center and Window Width

The Window Center (0028,1050), Window Width (0028,1051) and VOI LUT Function (0028,1056) Attributes shall be used only for Images with Photometric Interpretation (0028,0004) values of MONOCHROME1 and MONOCHROME2. They have no meaning for other Images.

If multiple values are present, both Attributes shall have the same number of values and shall be considered as pairs. Multiple values indicate that multiple alternative views may be presented.

If any VOI LUT Table is included by an Image, a Window Width and Window Center or the VOI LUT Table, but not both, may be applied to the Image for display. Inclusion of both indicates that multiple alternative views may be presented.

If multiple Items are present in VOI LUT Sequence (0028,3010), only one may be applied to the Image for display. Multiple Items indicate that multiple alternative views may be presented.

If the VOI LUT Module is defined in an IOD and if neither a VOI LUT Sequence nor a Window Width and Window Center are present, then the VOI LUT stage of the grayscale pipeline is defined to be an identity transformation.

Note

1. This requirement is specified so that IODs that define a particular output space for the grayscale pipeline, such as P-Values, are not in an undefined state when no VOI LUT Sequence or Window Width and Window Center are present.

2. Despite the Type 3 requirement for VOI LUT Sequence and Window Center, implementations that render images are expected to implement and apply these transformations when they are present in the image, unless overridden by the user, a presentation state, or a hanging protocol, and to allow the user to select which transformation to apply when multiple transformations are present.

C.11.2.1.3 VOI LUT Function

The VOI LUT Function (0028,1056) specifies a potentially non-linear conversion for the output of the (conceptual) Modality LUT values to the input of the (conceptual) Presentation LUT.

The behavior for the value LINEAR is defined in Section C.11.2.1.2.1. For all other values, the VOI LUT Function (0028,1056) shall include a unique descriptor of the LUT function to be used. Each descriptor is associated with a bivariate function of Window Center (0028,1050) and Window Width (0028,1051).

If the VOI LUT Function (0028,1056) is present with a value other than LINEAR, the values provided in Window Center (0028,1050) and Window Width (0028,1051) shall not be interpreted as a linear conversion of the (conceptual) Modality LUT values to the input to the (conceptual) Presentation LUT - but as parameters for the function defined by the VOI LUT Function descriptor in (0028,1056).

When defined, each descriptor must provide the functional relationship between the output of the (conceptual) Modality LUT values to the input of the (conceptual) Presentation LUT.

C.11.2.1.3.1 SIGMOID Function

If the value of VOI LUT Function (0028,1056) is SIGMOID, the function to be used to convert the output of the (conceptual) Modality LUT values to the input of the (conceptual) Presentation LUT is given by

$$y = \frac{(y_{max} - y_{min})}{1 + \exp(-4\frac{x-c}{w})} + y_{min} \qquad \text{(C.11-1)}$$

where

x is the input value of the LUT (i.e., the output of the (conceptual) Modality LUT).

c is the Window Center defined interactively by the user or by using the values provided in (0028,1050).

w is the Window Width defined interactively by the user or by using the values provided in (0028,1051).

y is the output value

$\mathbf{y_{min}}$ is the minimum output value

$\mathbf{y_{max}}$ is the maximum output value

Window Width (0028,1051) shall always be greater than 0.

Note

Window Width (0028,1051) is required to be greater than zero to prevent division by zero (quite apart from being meaningless).

C.11.2.1.3.2 LINEAR_EXACT Function

If the value of VOI LUT Function (0028,1056) is LINEAR_EXACT, the function to be used to convert the output of the (conceptual) Modality LUT values to the input of the (conceptual) Presentation LUT is given by the following pseudo-code, where x is the input value, y is an output value with a range from y_{min} to y_{max}, c is Window Center (0028,1050) and w is Window Width (0028,1051):

if (x <= c - w/2), then y = y_{min}

else if (x > c + w/2), then y = y_{max}

else y = ((x - c) / w + 0.5) * (y_{max}- y_{min}) + y_{min}

Window Width (0028,1051) shall always be greater than 0.

Note

1. For example, given stored unsigned pixel values from 0 to 65535, a Rescale Intercept of 0 and a Rescale Slope of 1.0/65535, a Window Width of 1.0 and a Window Center of 0.5 would specify the entire range of values (the identity transformation for those rescale values).
2. Window Width (0028,1051) is required to be greater than zero to prevent division by zero (quite apart from being meaningless).

C.11.3 LUT Identification Module

This section has been retired. See PS3.3-2006.

C.11.4 Presentation LUT Module

Table C.11-4 specifies the Attributes that describe the Presentation LUT.

Table C.11-4. Presentation LUT Module Attributes

Attribute name	Tag	Description
Presentation LUT Sequence	(2050,0010)	Defines a Sequence of Presentation LUTs. Only a single Item shall be included in this Sequence.
>LUT Descriptor	(0028,3002)	Specifies the format of the LUT Data in this Sequence. Required if Presentation LUT Sequence (2050,0010) is present. See Section C.11.4.1 for further explanation.
>LUT Explanation	(0028,3003)	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	LUT Data in this Sequence.
Presentation LUT Shape	(2050,0020)	Specifies pre-defined Presentation LUT shapes. Enumerated Values: **IDENTITY** input to the Presentation LUT is in P-Values, no further translation is necessary **LIN OD** input to Presentation LUT is in linear optical density over the range of Min Density (2010,0120) and Max Density (2010,1030) Note LIN OD is only defined for hardcopy devices and is not applicable to softcopy devices.

C.11.4.1 LUT Descriptor

The three values of LUT Descriptor (0028,3002) describe the format of the data in LUT Data (0028,3006).

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0. The number of entries shall be equal to the number of possible values in the input. (For 8 bit input will be 256 entries, for 12 bit input it will be 4096 entries)

The second value is the first input value mapped, and shall always be 0. The Value Representation of the second value is always US. This input value is mapped to the first entry in the LUT. Subsequent input values are mapped to the subsequent entries in the LUT Data up to an input value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. There are no input values greater than number of entries - 1.

The third value specifies the number of bits for each entry in the LUT Data. It shall be between 10 and 16 inclusive. The LUT Data shall be stored in a format equivalent to 16 bits allocated where the high bit is equal to bits stored - 1, where bits stored is the third value.

Note

Since LUT Descriptor (0028,3002) is multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified. Since all three values are always by definition interpreted as unsigned, the explicit VR actually used will always be US.

LUT Data (0028,3006) contains the LUT entry values, which are P-Values.

The output range is from 0 to 2^n-1 where n is the third value of LUT Descriptor. This range is always unsigned.

This range specifies the output range of the P-Values.

C.11.5 Image Histogram Module

Table C.11.5-1. Image Histogram Module Attributes

Attribute name	Tag	Type	Description
Histogram Sequence	(0060,3000)	1	Defines a Sequence of Histograms. One or more Items shall be included in this Sequence.
>Histogram Number of Bins	(0060,3002)	1	The number of "bins" (entries) in the histogram.
>Histogram First Bin Value	(0060,3004)	1	The stored pixel value corresponding to the lowest pixel value counted in the first bin. All image pixel values less than this value are not included in the histogram. Note The Value Representation of this Attribute is determined by the value of Pixel Representation (0028,0103).
>Histogram Last Bin Value	(0060,3006)	1	The stored pixel value corresponding to the highest pixel value counted in the last bin. All image pixel values greater than this value are not included in the histogram. Note The Value Representation of this Attribute is determined by the value of Pixel Representation (0028,0103).
>Histogram Bin Width	(0060,3008)	1	The number of consecutive stored pixel values included in a bin. All bins shall be of equal width.
>Histogram Explanation	(0060,3010)	3	Free form text explanation of the meaning of the LUT.
>Histogram Data	(0060,3020)	1	Histogram Data encoded as 32 bit unsigned counts of the number of pixel values in each bin.

C.11.5.1 Image Histogram Attribute Descriptions

The Image Histogram is a Sequence with multiple Items representing a sequential count of binned stored image pixel values in ascending order.

Note

One reason to include a histogram with an image is as an aid to image processing applications. For applications that use them, computations of histograms for very large images can be a significant burden on computer resources and can seriously degrade the response time to the user.

The Image Histogram has multiple Items to support multiple histograms per image. One or more regions of interest or value ranges may be separately computed. A description of the region(s) of interest and value range may be included in Histogram Explanation (0060,3010). The Image Histogram may be related to parts or all of a specific image.

The Attributes describing the parameters of the histogram are in image pixel value space, as stored in Pixel Data (7FE0,0010), before the application of any transformation such as Rescale Slope and Intercept or Modality LUT.

The range of stored image pixel value instances is described by the Histogram First Bin Value (0060,3004) and Histogram Last Bin Value (0060,3006). All values outside of this range shall be ignored. The number of histogram bins shall be large enough to contain all of the pixels in the range from the smallest to the largest stored image pixel value in that region of the image from which the histogram has been derived (which may or may not be the whole image).

The Histogram Bin Width (0060,3008) describes how many consecutive stored image pixel values are counted as one. All bins shall be of equal width.

Note

For example, a Histogram Bin Width (0060,3008) of 8 means that counts of pixel values in ascending groups of 8 are added together. If Histogram First Bin Value (0060,3004) were 0, then the first bin would contain the count of pixel values in the range of 0-7, the second bin the count of pixel values in the range of 8-15, etc. If Histogram Number of Bins (0060,3002) were 32, then the last bin would contain the count of pixel values in the range of 248-255 and Histogram Last Bin Value (0060,3006) would be 255 (not 248).

This example is illustrated in Figure C.11.5-1, in which the vertical axis represents the count within each bin and the horizontal axis represents each bin in ascending order.

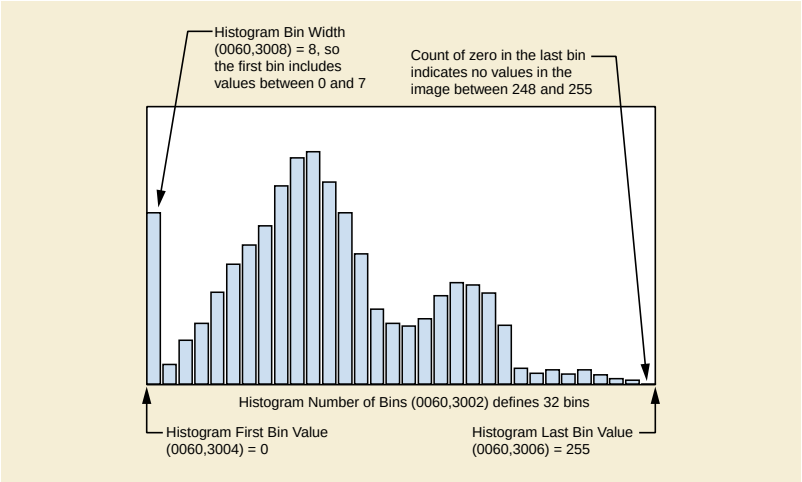


Figure C.11.5-1. Image Histogram Example

C.11.6 Softcopy Presentation LUT Module

Table C.11.6-1 specifies the Attributes that describe the Softcopy Presentation LUT.

Table C.11.6-1. Softcopy Presentation LUT Module Attributes

Attribute name	Tag	Type	Description
Presentation LUT Sequence	(2050,0010)	1C	Defines a Sequence of Presentation LUTs. Only a single Item shall be included in this Sequence. Required if Presentation LUT Shape (2050,0020) is absent.
>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.6.1.1 for further explanation.
>LUT Explanation	(0028,3003)	3	Free form text explanation of the meaning of the LUT.
>LUT Data	(0028,3006)	1	LUT Data in this Sequence.
Presentation LUT Shape	(2050,0020)	1C	Specifies predefined Presentation LUT transformation. Required if Presentation LUT Sequence (2050,0010) is absent. Enumerated Values: **IDENTITY** no further translation necessary, input values are P-Values **INVERSE** output values after inversion are P-Values See Section C.11.6.1.2.

Note

This Module differs from the Presentation LUT Module used in the hardcopy (print) related SOP Classes in that Optical Density is not supported for Presentation LUT Shape (since Optical Density has no meaning for softcopy display devices).

C.11.6.1 Softcopy Presentation LUT Attributes

When the Presentation LUT is specified as a Presentation LUT Sequence, then the input range of values is specified by the LUT Descriptor as the first value mapped and the number of entries (values mapped). However, there is an implicit linear scaling of the output range of the preceding transformation (such as the VOI LUT transformation) so that it is always mapped to the specified input range of the Presentation LUT.

When the Presentation LUT is specified as Presentation LUT Shape, then the input range is implicitly specified to be the output range of the preceding transformation (VOI LUT, or if the VOI LUT is identity or absent, the Modality LUT, or if the Modality LUT and VOI LUT are identity or absent, the stored pixel values). In this case, the full range of the output of the preceding transformation will be mapped to the full input range of the display device that receives the output of the Presentation LUT.

Note

The output of the preceding transformation may be signed. This does not mean that signed P-Values actually need to be generated, only that the output of the preceding transformation is to be interpreted by the display device as perceptually linear over the range from the minimum to the maximum values output by the preceding step, and that the minimum value be mapped to the lowest JND Index (and hence luminance) that the display can generate, and the maximum value be mapped to the highest JND Index (and hence luminance) that the display can generate.

In other words, in both cases, the Presentation LUT Module is always implicitly specified to apply over the full range of output of the preceding transformation, and it never selects a subset or superset of the that range (unlike the VOI LUT).

The output bit precision of the VOI LUT Sequence is not required to match the input range of the Presentation LUT Sequence.

Note

1. For example, if the VOI LUT is specified as a Window Center of 0 and a Window Width of 100, then the range from -50 to +49 is selected to be mapped to the full range of the display or print device (the full range of P-Values) if the Presentation LUT Shape is specified as IDENTITY or INVERSE. This example demonstrates the conventional understanding of the meaning of Window Center and Width to select "values of interest" that are to be displayed across the full range of the output device, without explicitly having to map each choice to P-Values.

2. For example, if the VOI LUT is specified as a Window Center of 0 and a Window Width of 100, and the Presentation LUT Sequence is present with a LUT Descriptor first value of 256 and second value of 0, then the range from -50 to +49 is implicitly linearly scaled from 0 to 255 before selecting values from the LUT Data in the Presentation LUT Sequence. This example demonstrates that it is not necessary to send a different Presentation LUT for different Window Center and Width values.

3. For example, if the VOI LUT is specified as VOI LUT Sequence with a LUT Descriptor with a 3rd Value of 16, then the range from 0 to 2^{16}-1 is selected to be mapped to the full range of the display or print device (the full range of P-Values) if the Presentation LUT Shape is specified as IDENTITY or INVERSE. This example demonstrates that a VOI LUT may be specified with the desired precision, without having to explicitly send a Presentation LUT to rescale that precision to whatever range of P-Values is preferred by the display application.

4. For example, if the VOI LUT is specified as VOI LUT Sequence with a LUT Descriptor with a 3rd Value of 16, and the Presentation LUT Sequence is present with a LUT Descriptor first value of 4096 and second value of 0, then the range from 0 to 2^{16}-1 is implicitly linearly scaled to the range 0 to 4095 before selecting values from the LUT Data in the Presentation LUT Sequence. This example demonstrates the case where, to save space, the Presentation LUT is encoded in a compact form that a display application may choose to interpolate more precisely, yet the VOI LUT output may be encoded with 16 bit precision.

C.11.6.1.1 LUT Descriptor

The three values of LUT Descriptor (0028,3002) describe the format of the LUT Data in the corresponding LUT Data (0028,3006) Attribute.

The first value is the number of entries in the lookup table. When the number of table entries is equal to 2^{16} then this value shall be 0.

The second value is the first implicitly scaled input value mapped, and shall always be 0. The Value Representation of the second value is always US. This implicitly scaled input value is mapped to the first entry in the LUT. There are no implicitly scaled input values less than the first value mapped. An implicitly scaled input value one greater than the first value mapped is mapped to the second entry in the LUT Data. Subsequent implicitly scaled input values are mapped to the subsequent entries in the LUT Data up to an implicitly scaled input value equal to number of entries + first value mapped - 1 that is mapped to the last entry in the LUT Data. There are no implicitly scaled input values greater than number of entries + first value mapped.

The third value specifies the number of bits for each entry in the LUT Data. The third value of LUT Descriptor (0028,3002) shall be between 8 and 16 inclusive. The LUT Data shall be stored in a format equivalent to 8 bits allocated when the number of bits for each entry is 8, and 16 bits allocated when the number of bits for each entry is 16, where the high bit is equal to bits stored - 1, and where bits stored is the third value.

Note

1. Since LUT Descriptor (0028,3002) is multi-valued, in an Explicit VR Transfer Syntax, only one value representation (US or SS) may be specified. Since all three values are always by definition interpreted as unsigned, the explicit VR actually used will always be US.

2. Some implementations have encoded 8 bit entries with 16 bits allocated, padding the high bits; this can be detected by comparing the number of entries specified in the LUT Descriptor with the actual value length of the LUT Data entry. The value length in bytes should equal the number of entries if bits allocated is 8, and be twice as long if bits allocated is 16.

The LUT Data contains the LUT entry values, which are P-Values.

The output range is from 0 to 2^n-1 where n is the third value of LUT Descriptor. This range is always unsigned.

This range specifies the output range of the P-Values.

C.11.6.1.2 Presentation LUT Shape

A value of INVERSE shall mean the same as a value of IDENTITY, except that the minimum output value shall convey the meaning of the maximum available luminance, and the maximum value shall convey the minimum available luminance. In other words:

- P-Value = maximum value - output value

C.11.7 Overlay Activation Module

This Module defines a manner of controlling whether or not bit-mapped overlay and curve information are displayed.

If the corresponding Overlay Group activated is present within the Presentation State, then that Overlay shall be activated and any corresponding Overlay in the referenced image(s) ignored, otherwise the Overlay within the referenced image(s) shall be activated.

An Overlay Group referenced in the Bitmap Display Shutter Module described in Section C.7.6.15 shall not be activated using the Overlay Activation Module.

Table C.11.7-1 specifies the Attributes that describe the Overlay Activation Module.

Table C.11.7-1. Overlay Activation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Overlay Activation Layer	(60xx,1001)	2C	The layer (defined in Graphic Layer (0070,0002) of the Graphic Layer Module in which the Overlay described in group 60xx shall be displayed. If no layer is specified (zero length) then the overlay shall not be displayed. Required if Group 60xx is present in the referenced image(s) or the Presentation State Instance containing this Module.

Note

1. Previously, those bits that are stored in Pixel Data (7FE0,0010) above High Bit (0028,0102) could be used as overlay bit planes if they were referenced by an Overlay Bit Position (60xx,0102). This usage has been retired. See PS3.3-2004. Their contents are unspecified in DICOM and should not be displayed. Usually they will be zero, though if the pixel data is signed, i.e., Pixel Representation (0028,0103) is 0001H, then it is possible that the sign bit may be "extended" through these values. Alternatively, they may have been "masked off" even if the value is signed and negative.

2. Previously, Curve Activation Layer (50xx,1001) was defined in this Module. Its usage has been retired. See PS3.3-2004.

C.11.8 Softcopy VOI LUT Module

Table C.11.8-1 specifies the Attributes that describe the Softcopy VOI LUT. These Attributes have the same meaning and behavior as defined in the Section C.11.2 VOI LUT Module.

Table C.11.8-1. Softcopy VOI LUT Module Attributes

Attribute Name	Tag	Type	Attribute Description
Softcopy VOI LUT Sequence	(0028,3110)	1	Defines a Sequence of VOI LUTs or Window Centers and Widths and to which images and frames they apply. No more than one VOI LUT Sequence containing a single Item or one pair of Window Center/Width values shall be specified for each image or frame. One or more Items shall be included in this Sequence.
>Referenced Image Sequence	(0008,1140)	1C	The subset of images and frames listed in the Presentation State Relationship Module, to which this VOI LUT or Window Center and Width applies. One or more Items shall be included in this Sequence. Required if the VOI LUT transformation in this Item does not apply to all the images and frames listed in the Presentation State Relationship Module.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Include Table C.11-2b “VOI LUT Macro Attributes”			

C.11.9 Presentation Series Module

Table C.11.9-1 contains Attributes that identify and describe a Presentation Series.

Table C.11.9-1. Presentation Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data. Enumerated Values: **PR** Presentation State See Section C.7.3.1.1.1.

Note

This implies that presentation states will be in different Series from the images to which they apply, which will have different values for Modality.

C.11.10 Presentation State Identification Module

Table C.11.10-1 contains Attributes that identify a Presentation State.

Table C.11.10-1. Presentation State Identification Module Attributes

Attribute Name	Tag	Type	Attribute Description
Presentation Creation Date	(0070,0082)	1	Date on which this presentation was created. Note This date may be different from the date that the DICOM SOP Instance was created, since the presentation state information contained may have been recorded earlier.
Presentation Creation Time	(0070,0083)	1	Time at which this presentation was created. Note This time may be different from the time that the DICOM SOP Instance was created, since the presentation state information contained may have been recorded earlier.
Include Table 10-12 “Content Identification Macro Attributes”			Note The Content Label value may be used by an application as a Defined Term in order to imply some grouping of different presentation states, i.e., it may have the same value for different Presentation State Instances that share some common concept.

C.11.11 Presentation State Relationship Module

Table C.11.11-1 contains Attributes that describe the images to which a Presentation State applies.

Table C.11.11-1. Presentation State Relationship Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.11.11-1b “Presentation State Relationship Macro Attributes”			

Table C.11.11-1b. Presentation State Relationship Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Series Sequence	(0008,1115)	1	Sequence of Items where each Item includes the Attributes of one Series to which the Presentation applies. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	1	Unique identifier of a Series that is part of the Study defined by the Study Instance UID (0020,000D) in the enclosing Data Set. Note The Study Instance UID (0020,000D) value will be that of the presentation state itself, unless the Macro is invoked from Blending Sequence (0070,0402) in the Presentation State Blending Module, in which case it will be explicitly specified.

Attribute Name	Tag	Type	Attribute Description
>Referenced Image Sequence	(0008,1140)	1	The set of images and frames to which the Presentation applies. These shall be of the Study defined by Study Instance UID (0020,000D) and the Series defined by Series Instance UID (0020,000E). One or more Items shall be included in this Sequence. The referenced SOP Class shall be the same for all Images in any Item of this Referenced Series Sequence (0008,1115).
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			

C.11.12 Presentation State Shutter Module

Table C.11.12-1 contains Attributes that specialize Attributes in other Modules included in a Presentation State.

Table C.11.12-1. Presentation State Shutter Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shutter Presentation Value	(0018,1622)	1C	A single grayscale unsigned value used to replace those parts of the image occluded by the shutter, when rendered on a monochrome display. The units are specified in P-Values. Required if the Display Shutter Module or Bitmap Display Shutter Module is present. Note The requirement in this Module is type 1C, which overrides the type 3 in the Display Shutter Module.
Shutter Presentation Color CIELab Value	(0018,1624)	1C	A color triplet value used to replace those parts of the image occluded by the shutter, when rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. Required if the Display Shutter Module or Bitmap Display Shutter Module is present and the SOP Class is other than Grayscale Softcopy Presentation State Storage. Note The requirement in this Module is type 1C, which overrides the type 3 in the Display Shutter Module and Bitmap Display Shutter Module.

C.11.13 Presentation State Mask Module

Table C.11.13-1 contains Attributes that specialize the use of masks in a Presentation State.

Table C.11.13-1. Presentation State Mask Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1C	Required if Mask Module is present. Only a single Item shall be included in this Sequence. Applicable Frame Range (0028,6102) shall not be included in the Sequence Item. See Section C.7.6.10 for a complete definition of the Attributes in the Items of this Sequence other than Mask Operation (0028,6101) and Applicable Frame Range (0028,6102). Note 1. This Sequence is replicated here in order to specify one Item, additional conditions on Mask Operation (0028,6101) and to forbid Applicable Frame Range (0028,6102). 2. The role of Applicable Frame Range (0028,6102) is replaced by Referenced Frame Number (0008,1160).
>Mask Operation	(0028,6101)	1	Type of mask operation to be performed Enumerated Values: **AVG_SUB** **TID** See Section C.7.6.10.1 for further explanation. Note The requirement in this Module is for Enumerated Values, which overrides the requirements of the Mask Module.
>Contrast Frame Averaging	(0028,6112)	1C	Specified the number of contrast frames to average together before performing the mask operation. Required if Mask Frame Numbers (0028,6110) specifies more than one frame (i.e., is multi-valued). Note The requirement in this Module is conditional and overrides the optional requirements of the Mask Module.
Recommended Viewing Mode	(0028,1090)	1C	Specifies the recommended viewing protocol(s). Enumerated Values: **SUB** for subtraction with mask images Required if Mask Subtraction Sequence (0028,6100) is present. Note The requirements in this Module are type 1C and a specified Enumerated Value, which override the requirements of the Mask Module.

C.11.14 Presentation State Blending Module

Table C.11.14-1 contains Attributes that describe the identification of two sets of grayscale images and the grayscale transformations to be applied to them, for the purpose of blending.

Table C.11.14-1. Presentation State Blending Module Attributes

Attribute Name	Tag	Type	Attribute Description
Blending Sequence	(0070,0402)	1	A Sequence of Items, one identifying and describing transformations upon a set of underlying grayscale images, and the other identifying and describing transformations upon a set of superimposed grayscale images. Two Items shall be included in this Sequence See Section C.11.14.1.1.
>Blending Position	(0070,0405)	1	Whether or not the contents of the Item represent the superimposed or underlying image set. Enumerated Values: **SUPERIMPOSED** **UNDERLYING**
>Study Instance UID	(0020,000D)	1	Unique identifier for the Study that contains the images, which may differ from the Study in which the presentation state is contained.
>Include Table C.11.11-1b "Presentation State Relationship Macro Attributes"			
>Include Table C.11-1b "Modality LUT Macro Attributes" if a Modality LUT is to be applied to referenced image(s).			
>Softcopy VOI LUT Sequence	(0028,3110)	1C	Defines a Sequence of VOI LUTs or Window Centers and Widths and to which images and frames they apply. No more than one VOI LUT Sequence containing a single Item or one pair of Window Center/Width values shall be specified for each image or frame. One or more Items shall be included in this Sequence. Required if a VOI LUT is to be applied to referenced image(s).
>>Referenced Image Sequence	(0008,1140)	1C	Sequence of Items identifying images that are defined in the enclosing Item of Blending Sequence (0070,0402), to which this VOI LUT or Window Center and Width applies. One or more Items shall be included in this Sequence. Required if the VOI LUT transformation in this Item does not apply to all the images and frames in the enclosing Item of Blending Sequence (0070,0402).
>>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>>Include Table C.11-2b "VOI LUT Macro Attributes"			
Relative Opacity	(0070,0403)	1	A value from 0.0 to 1.0 indicating the relative opacity of the pixels of the superimposed image, where 1.0 means that pixels of the superimposed image completely replace the pixels of the underlying image, and 0.0 means that the pixels of the underlying image completely replace the pixels of the superimposed image. See PS3.4 for a detailed description of the blending operation.

Attribute Name	Tag	Type	Attribute Description
Referenced Spatial Registration Sequence	(0070,0404)	3	A reference to Spatial Registration Instances that may be used to register the underlying and superimposed images. One or more Items are permitted in this Sequence. Note A Spatial Registration Instance may identify registration between frames of reference, or between explicitly identified images. In the latter case, the list of images referenced by the Presentation State, not the list of images referenced by the Spatial Registration Instance, are to be blended.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			

C.11.14.1 Presentation State Blending Module Attributes

C.11.14.1.1 Blending Sequence

Blending Sequence (0070,0402) is used to identify two sets of images, one to be superimposed upon the other.

The sets of images and any subset of the frames therein in the case of multi-frame images are identified by Study, Series, SOP Instance and Frame Number. In the case of a Segmentation image, the subset of segments is identified by the Attribute Referenced Segment Number (0062,000B) in the Referenced Image Sequence (0008,1140) invoked in the Presentation State Relationship Macro.

This Module specifies no explicit relationship (such as pairing or ordering) between the sets of images and frames defined in the first Item for the underlying images, and the second Item for the superimposed images. This Module does not define how the images are spatially related, and what re-sampling, if any, needs to be performed before the images are blended for rendering.

Note

1. The images in the two sets may share the same Frame of Reference, in which case the rendering application can spatially relate the two sets of images based on their Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) Attributes.

   Alternatively, a Spatial Registration SOP Instance may exist that relates either two different Frames of Reference, or two sets of images identified by UID and frame.

   Whilst the two sets of images may already be spatially co-registered and oriented in the same plane, or even be sampled at the same in-plane and between-plane resolution, this will frequently not be the case.

   See PS3.4 for behavioral requirements that apply to Storage SOP Classes using this Module.

2. The underlying image for a superimposed Segmentation image need not be the source image for the segmentation.

C.11.15 ICC Profile Module

Table C.11.15-1 contains Attributes that identify and describe an ICC Profile.

Table C.11.15-1. ICC Profile Module Attributes

Attribute Name	Tag	Type	Attribute Description
ICC Profile	(0028,2000)	1	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values.

Attribute Name	Tag	Type	Attribute Description
Color Space	(0028,2002)	3	A label that identifies the well-known color space of the image. Shall be consistent with any ICC Profile (0028,2000) that is also present. See Section C.11.15.1.2.

C.11.15.1 Attribute Descriptions

C.11.15.1.1 ICC Profile

ICC Profile (0028,2000) encodes an ICC Input Device Profile that encodes the transformation of device-dependent color stored pixel values into PCS-Values.

Note

1. Only Input Device profiles are encoded, since display and output device profiles are not interchanged in DICOM, though they may be used internally within display and output devices, for example when they are calibrated.
2. Since the version of the ICC Profile is encoded within the profile itself, no additional version information is encoded in the ICC Profile Module.

The following constraints on the encoding of the ICC Profile shall be observed:

- The profile shall be of the Input Device class, i.e., header bytes 12 through15, Profile Device/Class Signature, shall be "scnr"
- The color space of the input shall be RGB, i.e., header bytes 16 through 19, Color Space Signature, shall be "RGB", regardless of the Photometric Interpretation of the image pixel data prior to decompression
- PCS shall be CIELab or CIEXYZ, i.e., header bytes 20 through 23, Profile Connection Space, shall be either "Lab" or "XYZ".

Note

1. In the case of a PCS of CIELab, the profile will contain an N-component LUT-based AtoB0Tag, since three-component matrix based transformations are only possible with a PCS of CIEXYZ. A three-component matrix based transformation might be used to define a well-known rather than device-specific profile for such spaces as sRGB.
2. Selection of a PCS of CIELab or CIEXYZ within the ICC profile does not impact the DICOM encoding, since all color management systems support both.

The following constraints on the encoding of the ICC Profile are recommended:

- The Rendering Intent should be Perceptual.

Note

1. The rendering intent specifies how rendering will take place when the ICC Input Profile is linked with another Profile for the purpose of display.
2. A perceptual rendering intent implies that AtoB0Tag and BtoA0Tag tags will be present in the profile. The AtoB0Tag allows mapping from the input values to the PCS. The BtoA0Tag allows mapping from the PCS to the input values, though this is not required for the color rendering pipeline defined in PS3.4.

- All LUTs should be represented as 16 bit values, using tag type lut16Type, for greater precision.
- The chromaticAdaptationTag should be set if the actual illumination source is not D50.

Note

See the discussion of white point in PS3.4.

C.11.15.1.2 Color Space

The Color Space Attribute provides a label that identifies the color space by name, when the ICC Profile (0028, 2000) (if present) describes a well-known color space.

Defined Terms:

SRGB ICC Profile (0028,2000) defines sRGB color space [IEC 61966-2.1]

ADOBERGB ICC Profile (0028,2000) defines Adobe RGB color space [Adobe RGB]

ROMMRGB ICC Profile (0028,2000) defines ROMM RGB color space [ISO 22028-2]

C.11.16 Structured Display Module

Table C.11.16-1 describes the Attributes of the Structured Display Module.

Table C.11.16-1. Structured Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-12 "Content Identification Macro Attributes"			
Presentation Creation Date	(0070,0082)	1	Date on which this structured display was created. Note This date may be different from the date that the DICOM SOP Instance was created, since the structured display information contained may have been recorded earlier.
Presentation Creation Time	(0070,0083)	1	Time at which this structured display was created. Note This time may be different from the time that the DICOM SOP Instance was created, since the structured display information contained may have been recorded earlier.
Number of Screens	(0072,0100)	1	The number of screens for this Structured Display. If SOP Class UID (0008,0016) equals 1.2.840.10008.5.1.4.1.1.131(Basic Structured Display), the value shall be 1.
Nominal Screen Definition Sequence	(0072,0102)	1	Sequence of Items that describes the set of screens for this Structured Display. The number of Items shall equal the value of Number of Screens (0072,0100). One or more Items shall be included in this Sequence. Note The Basic Structured Display IOD limits this Sequence to one Item.
>Include Table C.23.2-2 "Screen Specifications Macro Attributes"			
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the structured display. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*

Attribute Name	Tag	Type	Attribute Description
Structured Display Background CIELab Value	(0072,0420)	3	A value in which it is recommended that Structured Display background (i.e., the area outside of Image Boxes) be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
Empty Image Box CIELab Value	(0072,0421)	3	A value in which it is recommended that empty Image Boxes be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.
Hanging Protocol Name	(0072,0002)	3	Identifies the hanging protocol that was used in the creation of this structured display. See Table OO.1.1-1 “Hanging Protocol Names for Dental Image Layout based on JSOMR classification” in PS3.17 for standard hanging protocols for dentistry.
Hanging Protocol Creator	(0072,0008)	3	Identifies the creator of the Hanging Protocol. See Table OO.1.1-1 “Hanging Protocol Names for Dental Image Layout based on JSOMR classification” in PS3.17 for standard hanging protocols for dentistry.

C.11.17 Structured Display Image Box Module

Table C.11.17-1 describes the Attributes of the Structured Display Image Box Module.

Table C.11.17-1. Structured Display Image Box Module Attributes

Attribute Name	Tag	Type	Attribute Description
Structured Display Image Box Sequence	(0072,0422)	1	The image display boxes defined in the display environment, together with the reference to the image to be displayed in each Image Box. One or more Items shall be included in this Sequence.
>Display Environment Spatial Position	(0072,0108)	1	Exactly four dimensionless floating point values, in the range 0.0 to 1.0, indicating the rectangular coordinate position of the Image Box within the Display Environment. Note For the Basic Structured Display with a single screen, the Display Environment is coextensive with the screen defined in the Nominal Screen Definition Sequence (0072,0102). See Section C.11.17.1.1
>Image Box Number	(0072,0302)	1	An integer that is unique across all Items of the Structured Display Image Box Sequence (0072,0422) that identifies the Image Box.

Attribute Name	Tag	Type	Attribute Description
>Image Box Layout Type	(0072,0304)	1	Type of layout of the Image Box. The types are primarily distinguished by their interaction technique. Defined Terms: **TILED** A scrollable array of rectangles, each containing a single frame of image pixel data. **STACK** A single rectangle containing a steppable single frame, intended for user-controlled stepping through the image set, usually via continuous device interaction (e.g., mouse scrolling) or by single stepping (mouse or button click). **CINE** A single rectangle, intended for animation where the user controls are play sequence, rate of play, and direction. **VOLUME_VIEW** A single rectangle, intended for volumetric display. **VOLUME_CINE** A single rectangle, intended for animation of a volumetric view. **SINGLE** A single rectangle, intended for images and objects with no defined methods of interaction. Note This value may also be used for non-image objects, such as waveforms and SR documents.
>Image Box Tile Horizontal Dimension	(0072,0306)	1C	Positive integer defining the horizontal Image Box tile dimension; the number of columns. Required if the value of Image Box Layout Type (0072,0304) is TILED.
>Image Box Tile Vertical Dimension	(0072,0308)	1C	Positive integer defining the vertical Image Box tile dimension; the number of rows. Required if the value of Image Box Layout Type (0072,0304) is TILED.
>Image Box Overlap Priority	(0072,0320)	3	If this Image Box overlaps in spatial position with others, this Attribute indicates the layer of this Image Box in relation to the others. The value shall be a positive integer in the range 1 to 100, where 1 = top and 100 = bottom. If this Attribute is not present, then the expected behavior is not defined.
>Display Set Horizontal Justification	(0072,0717)	3	Indicates direction in which to horizontally justify the image within an Image Box that is not the same shape (aspect ratio) as the image. Enumerated Values: **LEFT** **CENTER** **RIGHT** Note Typically used in mammography display applications in which images from the patient's left and right are displayed "back to back", rather than centered.
>Display Set Vertical Justification	(0072,0718)	3	Indicates direction in which to vertically justify the image within an Image Box that is not the same shape (aspect ratio) as the image. Enumerated Values: **TOP** **CENTER** **BOTTOM**

Attribute Name	Tag	Type	Attribute Description
>Preferred Playback Sequencing	(0018,1244)	1C	Describes the preferred playback sequencing for the Image Box. Overrides any Preferred Playback Sequencing (0018,1244) value in the image objects being displayed. Required if the value of Image Box Layout Type (0072,0304) is CINE. Enumerated Values: **0** Looping (1,2…n,1,2,…n,1,2,….n,…) **1** Sweeping (1,2,…n,n-1,…2,1,2,…n,…) **2** Stop (1,2…n)
>Recommended Display Frame Rate	(0008,2144)	1C	Recommended rate at which the frames of a multi-frame image shall be displayed, in frames/second. Shall have a value greater than zero. Overrides any Recommended Display Frame Rate (0008,2144) value in the image objects being displayed. Required if the value of Image Box Layout Type (0072,0304) is CINE and if Cine Relative to Real-Time (0072,0330) is not present.
>Cine Relative to Real-Time	(0072,0330)	1C	A positive dimensionless floating point numeric factor equal to playback rate divided by acquisition rate. Required if the value of Image Box Layout Type (0072,0304) is CINE and if Recommended Display Frame Rate (0008,2144) is not present. Note The acquisition rate may change within the image object, as specified in Frame Time Vector (0018,1065).
>Initial Cine Run State	(0018,0042)	1C	Defined Terms: **STOPPED** **RUNNING** Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Start Trim	(0008,2142)	2C	The frame number of the first frame of the multi-frame image to be displayed in a CINE Image Box. Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Stop Trim	(0008,2143)	2C	The Frame Number of the last frame of the multi-frame image to be displayed in a CINE Image Box. Required if the value of Image Box Layout Type (0072,0304) is CINE.
>Referenced First Frame Sequence	(0072,0427)	2C	Reference to the initial frame in a stack to be displayed in this image box. If value is not present, the first image frame to be displayed is not defined by the Standard. Zero or one Item shall be included in this Sequence. Required if the value of Image Box Layout Type (0072,0304) is STACK.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Referenced Image Sequence	(0008,1140)	2C	Reference to the Image SOP Instances, or frames from multi-frame Image SOP Instances, to be displayed in this Image Box. Zero or more Items shall be included in this Sequence. Required if Referenced Presentation State Sequence (0008,9237), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Instance Sequence (0008,114A) are not present. See Section C.11.17.1.2.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			Note The order of frames identified in the Referenced Frame Number (0008,1160) Attribute affects ordering in STACK Image Box Layout. See Section C.11.17.1.2.
>>Referenced Presentation State Sequence	(0008,9237)	1C	Reference to a Softcopy Presentation State SOP Instance to be applied to the referenced image. Only a single Item shall be permitted in this sequence. Required if presentation controls are to be applied to the image or image frame before rendering in the Structured Display.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Presentation State Sequence	(0008,9237)	1C	Reference to a Softcopy Presentation State SOP Instance or a Volumetric Presentation State SOP Instance whose referenced images are to be displayed in the Image Box using the presentation controls of the referenced SOP Instance. One or more Items shall be included in this Sequence. Multiple items are only permitted if the Image Box Layout Type (0072,0304) has a value of VOLUME_CINE. Required if Referenced Image Sequence (0008,1140), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Instance Sequence (0008,114A) are not present. See Section C.11.17.1.2.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Instance Sequence	(0008,114A)	1C	Reference to a non-image SOP Instance (e.g., waveform, SR, encapsulated document) whose content is to be displayed in the Image Box. Only a single Item shall be included in this Sequence. Required if Referenced Presentation State Sequence (0008,9237), Referenced Stereometric Instance Sequence (0008,1134), and Referenced Image Sequence (0008,1140) are not present. See Section C.11.17.1.3.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Referenced Stereometric Instance Sequence	(0008,1134)	1C	Reference to a Stereometric SOP Instance whose referenced images are to be displayed in the Image Box. Only a single Item shall be included in this Sequence. Required if Referenced Presentation State Sequence (0008,9237), Referenced Instance Sequence (0008,114A), and Referenced Image Sequence (0008,1140) are not present. See Section C.11.17.1.4.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Image Box Synchronization Sequence	(0072,0430)	1C	Description of synchronized display between two or more Image Boxes. Required if synchronized display is specified between Image Boxes. One or more Items shall be included in this Sequence.
>Synchronized Image Box List	(0072,0432)	1	Multi-valued list of two or more Image Box Number (0072,0302) values. Indicates that the display of multiple image frames within the specified Image Boxes are synchronized. Referenced Image Boxes shall be of same Image Box Layout Type (0072,0304). An Image Box Number value may appear in only one Image Box Synchronization Sequence (0072,0430) Item.
>Type of Synchronization	(0072,0434)	1	Type of synchronization between Image Boxes. Defined Terms: **FRAME** **POSITION** **TIME** **PHASE** See Section C.11.17.1.5.

C.11.17.1 Structured Display Image Box Attribute Descriptions

C.11.17.1.1 Display Environment Spatial Position

The Display Environment Spatial Position (0072,0108) specifies the corners of the Image Box relative to the vertical and horizontal dimensions of the Display Environment, specified as Number of Vertical Pixels (0072,0104) and Number of Horizontal Pixels (0072,0106) in the Nominal Screen Definition Sequence (0072,0102).

See also Section C.23.2.1.1.

Within the Image Box, the image (or the area of the image selected for display by the associated Presentation State SOP Instance) shall be scaled to fit the display area under the constraint that the aspect ratio of the image is maintained.

In rendering the Image Box, the Application Entity may render display controls (such as cine speed control, or stack position indication) either within or outside the specified Display Environment Spatial Position (0072,0108).

C.11.17.1.2 Referenced Image Sequence and Referenced Presentation State Sequence

Image SOP Instances, or frames from multi-frame SOP Instances, to be displayed in an Image Box may be identified either directly by the Referenced Image Sequence (0008,1140), or indirectly through the Referenced Presentation State Sequence (0008,9237).

Referenced Image Sequence (0008,1140) is permitted to be zero length, indicating an empty Image Box.

Note

1. The recommended display color for an empty Image Box is specified by Empty Image Box CIELab Value (0072,0421).

2. When displaying a standard template such as a dental full mouth series, an empty image box may be used to indicate that the corresponding view was not taken.

If images are identified indirectly through the Referenced Presentation State Sequence (0008,9237), all of the image frames identified in the top level Referenced Series Sequence (0008,1115) Attribute shall be displayed. For images identified indirectly through a Blending Presentation State SOP Instance, all the image frames for which the Blending Position (0070,0405) value is UNDERLYING shall be displayed, with the relevant SUPERIMPOSED images blended as necessary.

If images are to be displayed, the number of frames referenced for display shall be consistent with the value of Image Box Layout Type (0072,0304). If the value of Image Box Layout Type is SINGLE, only a single frame shall be referenced, either directly or indirectly; if the value is CINE, only a single multi-frame SOP Instance shall be referenced.

If the value of Image Box Layout Type is STACK, more than one SOP Instance or frame may be referenced, and the frames constitute a stack to be displayed in the Image Box. For frames identified by the Referenced Image Sequence, the order of stepping through the stack shall be the order of Image SOP Instance references in that Sequence. If multiple frames are selected in Referenced Frame Number (0008,1160), those frames shall be stepped through in the order of their listing in that Attribute, within the order of display of their Image SOP Instance.

For a stack whose frames are selected indirectly through an Item of the Referenced Presentation State Sequence, the order of stepping through the stack shall be the order of SOP Instance references in the Referenced Series Sequence (0008,1115) of the referenced Presentation State. For a referenced Blending Softcopy Presentation State, this shall be the Referenced Series Sequence within the Blending Sequence (0070,0402) Item for which the Blending Position (0070,0405) value is UNDERLYING.

Note

1. Display of images using Blending Softcopy Presentation State must use indirect SOP Instance reference through the Referenced Presentation State Sequence (0008,9237) at the top level of Structured Display Image Box Sequence (0072,0422) Item, and cannot use the Referenced Presentation State Sequence within an Item of the Referenced Image Sequence (0008,1140).

2. A Blending Presentation State that references a blending of a single underlying frame and a single superimposed frame may be associated with a SINGLE Image Box Layout.

3. A reference to a single display frame, either directly through Referenced Image Sequence or indirectly through Referenced Presentation State Sequence, may be associated with either a STACK or a CINE Image Box Layout as a degenerate case.

4. There is no requirement for the pixel matrix sizes of the images in the stack, or the image display area as selected by referenced Presentation State SOP Instances, to be identical, nor for the referenced images to be of the same SOP Class.

5. Referenced Presentation States are an initial presentation control. The rendering Application Entity might allow a user to interactively enable/disable graphic layers, or change the zoom, rotation, window width / window level, or other presentation controls. Any such Application Entity functionality is beyond the scope of the Standard.

C.11.17.1.3 Referenced Instance Sequence

The Referenced Instance Sequence (0008,114A) references a non-Image SOP Instance, e.g., a Structured Report, Waveform, or Encapsulated Document SOP Instance, to be displayed in the image box. For such object references, the value of Image Box Layout Type (0072,0304) shall be SINGLE, even if displaying the object will require scrolling or paging (e.g., a multi-page encapsulated document).

C.11.17.1.4 Referenced Stereometric Instance Sequence

The Referenced Stereometric Instance Sequence (0008,1134) references a Stereometric SOP Instance, whose Stereo Pairs Sequence (0022,0020) references image pairs to be displayed in the Image Box. The number of image pairs referenced for display shall be consistent with the value of Image Box Layout Type (0072,0304). If the value of Image Box Layout Type is SINGLE, only a single pair of frames shall be referenced by the Stereo Pairs Sequence in the referenced Stereometric Instance; if the value is CINE, only

a single pair of multi-frame SOP Instances shall be referenced; if the value is STACK, one or more pairs may be referenced constituting a stack to be displayed in the Image Box, and the order of stepping through the stack shall be the order of Items in the Stereo Pairs Sequence. The manner in which a stereo pair is rendered is unspecified.

Note

1. While the Stereometric IOD allows reference to multiple pairs of multi-frame cine Instances, the CINE Image Box Layout does not support the display of more than one (a "stack" of cines).

2. Display of stereo pairs typically requires specialized hardware (e.g., polarizing filters and shutter glasses).

C.11.17.1.5 Type of Synchronization

Type of Synchronization (0072,0434) specifies the method for synchronizing the display of images in two or more Image Boxes linked through the Synchronized Image Box List (0072,0432).

FRAME Stepping of frames in one Image Box is synchronized by the stepping of an identical number of frames in the other Image Boxes.

POSITION Stepping of frames in one Image Box is synchronized by the stepping of frames in the other Image Boxes to effect an identical relative positional offset within the Patient-Based Coordinate System. This presumes that the referenced images includes Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) Attributes, and that the stacks have approximately the same orientation relative to the Patient-Based Coordinate System.

TIME Playback of frames in one Image Box is synchronized by the playback of frames in the other Image Boxes to effect an identical temporal offset from the original displayed frame. This presumes that the referenced images include Frame Time (0018,1063), Frame Time Vector (0018,1065), or Frame Reference DateTime (0018,9151). It also presumes that if the Image Box Layout Type (0072,0304) is STACK, the frames are referenced in a monotonically increasing time order in the stack.

PHASE Playback of frames in one Image Box is synchronized by the playback of frames in the other Image Boxes to effect an identical phase offset. This presumes that the referenced frames within each referenced Image Box constitute a uniform sampling across a single "cycle", and that relative position within that cycle is synchronized across all the referenced Image Boxes. For Image Boxes with Image Box Layout Type (0072,0304) value CINE, the set of frames to be displayed as one cycle may be specified either using the Referenced Frame Number (0008,1160) Attribute within the Referenced Image Sequence (0008,1140), or if that Attribute is not present, using the values of Attributes Start Trim (0008,2142) and Stop Trim (0008,2143).

Note

1. PHASE may be used, for instance, to synchronize display of images representing a single cardiac cycle.

2. Synchronization of Image Boxes is an initial presentation control. The rendering Application Entity might allow a user to unlink the synchronization, e.g., to navigate to cine frames before the Start Trim (0008,2142) frame or after the Stop Trim (0008,2143) frame. Any such Application Entity functionality is beyond the scope of the Standard.

C.11.18 Structured Display Annotation Module

This Module defines Attributes of text annotation that shall be applied to a Structured Display. The text is defined in position and size relative to the Display Environment.

Note

1. The text bounding box is specified using the same Attribute, Display Environment Spatial Position (0072,0108), which is used for Image Boxes in the Structured Display Module. This Attribute uses the coordinates (0.0,0.0) as the bottom left hand corner and (1.0,1.0) as the top right hand corner. In contrast, the image-related text annotations defined in the Graphic Annotation Module in image Presentation State IODs use the Attributes Bounding Box Top Left Hand Corner (0070,0010) and Bounding Box Bottom Right Hand Corner (0070,0011), which use the coordinates (0.0,0.0) as the top left hand corner and (1.0,1.0) as the bottom right hand corner.

2. Annotation of regions of interest in images included in the Structured Display, e.g., circling of a feature of interest, may be done with a Presentation State applied to the image in the Structured Display Image Box Sequence (0072,0422) in

the Structured Display Image Box Module. This Structured Display Annotation Module provides only for text annotations, typically as used for captions for the Image Boxes or for the Structured Display as a whole.

Table C.11.18-1 describes the Attributes of the Structured Display Annotation Module.

Table C.11.18-1. Structured Display Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Structured Display Text Box Sequence	(0072,0424)	1	Sequence that describes a text annotation. One or more Items shall be included in this Sequence.
>Unformatted Text Value	(0070,0006)	1	Text data that is unformatted and whose manner of display within the defined bounding box is implementation dependent. See Section C.11.18.1.1. The text value may contain spaces, as well as multiple lines separated by CR LF, but otherwise no format control characters (such as horizontal or vertical tab and form feed) shall be present, even if permitted by the Value Representation of ST. The text shall be interpreted as specified by Specific Character Set (0008,0005) if present in the SOP Instance. Note The text may contain single or multi-byte characters and use code extension techniques as described in PS3.5 if permitted by the values of Specific Character Set (0008,0005).
>Display Environment Spatial Position	(0072,0108)	1	Exactly four dimensionless floating point values, in the range 0.0 to 1.0, indicating the rectangular coordinate position within the Display Environment of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed. Note For the Basic Structured Display with a single screen, the Display Environment is coextensive with thescreen defined in the Nominal Screen Definition Sequence (0072,0102). See Section C.11.16.
>Bounding Box Text Horizontal Justification	(0070,0012)	1	Location of the text relative to the vertical edges of the bounding box. Enumerated Values: **LEFT** closest to left edge **RIGHT** closest to right edge **CENTER** centered
>Graphic Layer Recommended Display CIELab Value	(0070,0401)	3	A value in which it is recommended that Unformatted Text Value (0070,0006) be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

C.11.18.1 Structured Display Annotation Attribute Descriptions

C.11.18.1.1 Unformatted Text Value and Display Environment Spatial Position

The Unformatted Text Value (0070,0006) rendered in Display Environment Spatial Position (0072,0108) need not be confined to the specified bounding box.

Note

1. An implementation may render text outside the confines of the bounding box if necessary to display all the specified text.

2. Alternatively, an implementation may choose to render the text in a scrolling box, or a link to another fixed or popup window as appropriate.

When the text bounding box overlaps an Image Box (from the Structured Display Image Box Module), the text box has a higher display priority (i.e., it is on top of the image box). The background color of the bounding box is undefined.

Note

1. Commonly, the background region of the bounding box around the text will be rendered "transparently", i.e., the image will be visible, though some implementations may choose to opacify the bounding box behind the text to improve its readability.

2. With a transparent background, for example, an implementation may choose an "exclusive or" style opacification to be sure that the text is discernible over light and dark portions of the image.

The size, font, and rotation of the individual rendered text characters are unspecified.

C.11.19 XA/XRF Presentation State Mask Module

Table C.11.19-1 specifies the Attributes that describe mask operations for a XA/XRF Multi-frame image.

Table C.11.19-1. XA/XRF Presentation State Mask Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mask Subtraction Sequence	(0028,6100)	1	Defines a Sequence that describes mask subtraction operations for Multi-frame Images. One or more Items shall be included in this Sequence.
>Referenced Image Sequence	(0008,1140)	1C	A reference to a selected Image. Required if Presentation State Relationship Module references more than one SOP Instance. Only a single Item shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Mask Operation	(0028,6101)	1	Defined Term identifying the type of mask operation to be performed. See Section C.7.6.10.1 for further explanation.
>Applicable Frame Range	(0028,6102)	1C	Each pair of numbers in this multi-valued Attribute specifies a beginning and ending frame number inclusive of a range where this particular mask operation is valid. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. If this Attribute is missing in this particular Sequence Item, then the mask operation is applicable throughout the entire Multi-frame Image, subject to certain limits as described in Section C.7.6.10.1.1. Each frame shall only be associated with a single Item of this Sequence. Required if Mask Operation (0028,6101) equals REV_TID. May be present otherwise.
>Mask Frame Numbers	(0028,6110)	1C	Specifies the frame numbers of the pixel data used to generate this mask. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. Required if the Mask Operation (0028,6101) is AVG_SUB.
>Contrast Frame Averaging	(0028,6112)	3	Specifies the number of contrast frames to average together before performing the mask operation. If the Attribute is missing, no averaging is performed.

Attribute Name	Tag	Type	Attribute Description
>TID Offset	(0028,6120)	2C	If Mask Operation is TID, specifies the offset to be subtracted from the current frame number in order to locate the mask frame in TID mode. If Mask Operation is REV_TID, specifies the initial offset to be subtracted from the first contrast frame number. See Section C.7.6.10.1.1. If zero length, TID Offset defaults to 1. Required if Mask Operation (0028,6101) is TID or REV_TID.
>Pixel Intensity Relationship LUT Sequence	(0028,9422)	1C	A Sequence of Pixel Intensity Relationship LUTs that specifies a transformation to logarithmic space. One or more Items shall be included in this Sequence. Required if Pixel Intensity Relationship (0028,1040) is not LOG for frames included in this Item of the Mask Subtraction Sequence (0028,6100).
>>LUT Frame Range	(0028,9507)	1	Each pair of numbers in this multi-valued Attribute specifies a beginning and ending frame number inclusive of a range where this LUT operation is specified. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. Note The specified frame numbers must be a part of the frames where this mask operation is valid.
>>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data in this Sequence. See Section C.11.1.1 and Section C.7.6.16.2.13.1 for further explanation.
>>LUT Data	(0028,3006)	1	LUT Data in this Sequence
>>LUT Function	(0028,9474)	1	The transformation function this LUT applies to the stored pixel values. Enumerated Values: **TO_LOG**
>Pixel Shift Sequence	(0028,9501)	1	Sequence containing the pixel shift values for the masks of the specified frame range(s) in the specified region(s). One or more Items shall be included in this Sequence.
>>Pixel Shift Frame Range	(0028,9506)	1	Each pair of numbers in this multi-valued Attribute specify a beginning and ending contrast frame number inclusive of a range where this pixel shift is specified. Discontinuous ranges are represented by multiple pairs of numbers. Frames in a Multi-frame Image are specified by sequentially increasing number values beginning with 1. Overlapping frame ranges are not permitted. Note The specified frame numbers must be a part of the frames where this mask operation is valid.

Attribute Name	Tag	Type	Attribute Description
>>Region Pixel Shift Sequence	(0028,9502)	1	Sequence containing the pixel shifts for this frame(s). Only one sub region of this frame(s) shall be specified when the pixel shift is applicable for the full size or a single region of the frame(s). More than one sub region of this frame(s) may be specified when pixel shift is different in different regions. The order of Items in this Sequence is significant, see Section C.11.19.1.2. One or more Items shall be included in this Sequence.
>>>Mask Sub-pixel Shift	(0028,6114)	1	A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the region of the frame numbers specified by Pixel Shift Frame Range (0028,9506) of this Pixel Shift Sequence (0028,9501) Item. The region is specified by the polygon defined by the Vertices of the Region (0028,9503) Attribute. The pixels on the line of the polygon belong to the region. Note If no pixel shift has to be applied a pair of zero Attribute values (0.0\0.0) should be specified. See Section C.11.19.1.1.
>>>Vertices of the Region	(0028,9503)	1C	Multiple Values where the first set of two values are: row of the origin vertexcolumn of the origin vertex Two or more pairs of values follow and are the row and column coordinates of the other vertices of the polygon region. Each polygon region is implicitly closed from the last vertex to the origin vertex and all edges shall be non-intersecting except at the vertices. See Section C.11.19.1.2. The upper left pixel of the image has the coordinate 1\1. Required if the pixel shift does not apply to the entire set of pixels of the frames.

C.11.19.1 XA/XRF Presentation State Mask Attributes

C.11.19.1.1 Mask Sub-pixel Shift

A pair of floating point numbers specifying the fractional vertical [adjacent row spacing] and horizontal [adjacent column spacing] pixel shift applied to the mask before subtracting it from the specified region of the contrast frame. The row offset results in a shift of the pixels along the column axis. The column offset results in a shift of the pixels along the row axis. A positive row offset is a shift toward the pixels of the lower row of the pixel plane. A positive column offset is a shift toward the pixels of the left hand side column of the pixel plane.

C.11.19.1.2 Vertices of the Region

Each Item of the Region Pixel Shift Sequence (0028,9502) specifies both a region of the contrast frame and a mask pixel shift to be applied during the subtraction of that region.

When the Region Pixel Shift Sequence (0028,9502) contains more than one Item, each region of the contrast frame is subtracted by applying the corresponding pixel shift specified in that Item.

When an Item of the Sequence does not contain the Attribute Vertices of the Region (0028,9503), the applicable region for that Item is the whole contrast frame.

The union of all the regions defined in the Region Pixel Shift Sequence (0028,9502) does not cover necessarily the whole contrast frame, in which case the pixels outside the union of all the regions shall be subtracted with no pixel shift.

If a set of pixels of the contrast frame is contained in more than one region, the applicable pixel shift is the one of the last Item with the region that contains this set of pixels, as shown in Figure C.11.19-1.

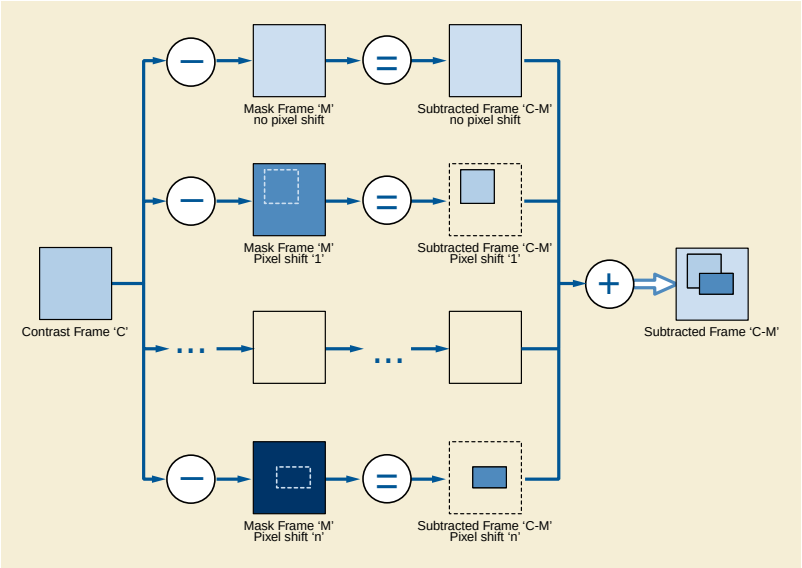


Figure C.11.19-1. Applicable pixel shift in case of multiple pixel shift regions

Note

For example, the contrast frames 4 to 10 of a SOP Instance "A" are subtracted to the mask frame 1, the subtraction of the frames 4 to 7 being performed with three different values of mask pixel shift on overlapping rectangular regions: The (row,column) coordinates of the top-left and bottom-right vertices of the regions are 1: (1,1) to (30,60), 2: (10,40) to (50,120) and 3: (20,20) to (70,80). The mask pixel shift to be applied to the pixel (25,50) corresponds to the region 3 because this pixel is contained in the intersection of the three regions (see Figure C.11.19-2 and Figure C.11.19-3).

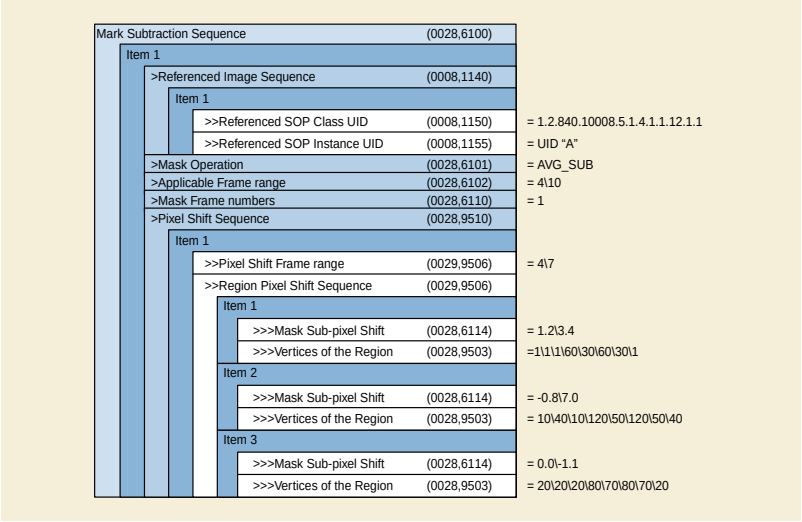


Figure C.11.19-2. Example of Contents of Mask Subtraction Sequence

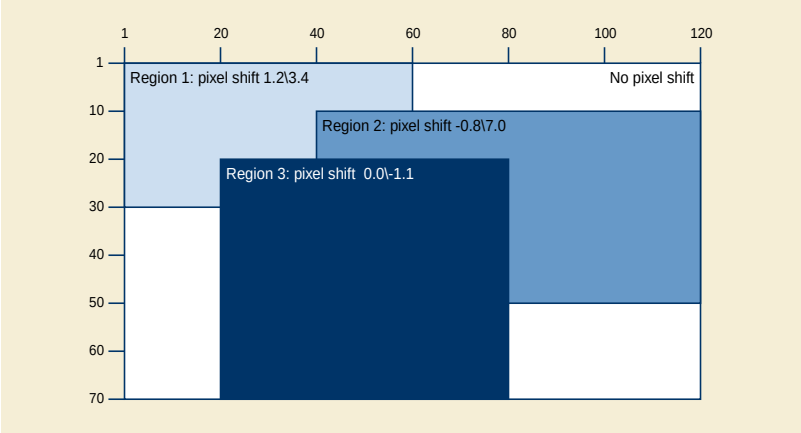


Figure C.11.19-3. Example of three different pixel shift regions

C.11.20 XA/XRF Presentation State Shutter Module

Table C.11.19-1 specifies the Attributes that describe shutter operations for a XA/XRF Multi-frame image.

Table C.11.20-1. XA/XRF Presentation State Shutter Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Display Shutter Sequence	(0018,9472)	1	Sequence of shutter specifications to be applied to groups of frames. One or more Items shall be included in this Sequence.
>Referenced Image Sequence	(0008,1140)	1C	Sequence of Items where each Item provides reference to a selected set of Image SOP Class/SOP Instance pairs that are defined in the Presentation State Relationship Module. One or more Items shall be included in this Sequence. Required if shutters in this Item do not apply to all the images and frames listed in the Presentation State Relationship Module.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Include Table C.7-17a “Display Shutter Macro Attributes”			

C.11.21 XA/XRF Presentation State Presentation Module

Table C.11.21-1 specifies the Attributes of a XA/XRF Presentation State Presentation Module.

Table C.11.21-1. XA/XRF Presentation State Presentation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-frame Presentation Sequence	(0028,9505)	1	Describes for one or more SOP Instances the recommended playback and display preferences. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Referenced Image Sequence	(0008,1140)	1C	Sequence of Items where each Item provides reference to a selected set of Image SOP Class/SOP Instance pairs that are defined in the Presentation State Relationship Module. One or more Items shall be included in this Sequence. Required if display sequences in this Item do not apply to all the images listed in the Presentation State Relationship Module.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Preferred Playback Sequencing	(0018,1244)	3	Describes the preferred playback sequencing for a multi-frame image. Enumerated Values: **0** Looping (1,2…n,1,2,…n,1,2,….n,…) **1** Sweeping (1,2,…n,n -1,…2,1,2,…n,…)
>Frame Display Sequence	(0008,9458)	3	Sequence that specifies the display frame rate of a selected set of frames. The Items are ordered in increasing frame number. The range of the frames may not overlap and the ranges shall be adjacent. One or more Items are permitted in this Sequence.
>>Start Trim	(0008,2142)	1	The Frame Number of the first frame of the set of frames to be displayed in this Item.
>>Stop Trim	(0008,2143)	1	The Frame Number of the last frame of the set of frames to be displayed in this Item.
>>Skip Frame Range Flag	(0008,9460)	1	A flag indicating that the range of frames in this Item may be skipped. Defined Terms: **DISPLAY** **SKIP**
>>Recommended Display Frame Rate in Float	(0008,9459)	1	Recommended rate at which the frames of this Item should be displayed in frames/second.
>>Recommended Viewing Mode	(0028,1090)	2	Specifies the recommended viewing protocol(s). Defined Terms: **SUB** subtraction with mask images **NAT** native viewing of image as stored Note If an implementation does not recognize the Defined Term for Recommended Viewing Mode (0028,1090), reverting to native display mode is recommended.
>>Display Filter Percentage	(0028,9411)	2	Edge enhancement filter percentage that is recommended by the pixel data creator as filter presetting for display purposes. The value of 100 corresponds to the maximum filter strength that can be applied by a specific application displaying the image.

Attribute Name	Tag	Type	Attribute Description
>>Mask Visibility Percentage	(0028,9478)	1C	The percentage of visibility of the mask frame during a subtracted display. A value of 0 corresponds to subtracted display, a value of 100 corresponds to un-subtracted display (native). See Section C.8.19.7.1. Note The value of 100 is equivalent to Recommended Viewing Mode (0028,1090) having a value of NAT. Required if Recommended Viewing Mode (0028,1090) equals SUB.

C.11.22 Volumetric Presentation State Identification Module

Table C.11.22-1 contains Attributes that describe the volume view type of this Presentation State.

Table C.11.22-1. Volumetric Presentation State Identification Module Attributes

Attribute Name	Tag	Type	Attribute Description
Presentation Creation Date	(0070,0082)	1	Date on which this presentation was created. Note This date may be different from the date that the DICOM SOP Instance was created, since the Presentation State information contained may have been recorded earlier.
Presentation Creation Time	(0070,0083)	1	Time at which this presentation was created. Note This time may be different from the time that the DICOM SOP Instance was created, since the Presentation State information contained may have been recorded earlier.
Include Table 10-12 “Content Identification Macro Attributes”			Note The Content Label value may be used by an application as a Defined Term in order to imply some grouping of different Presentation States, i.e., it may have the same value for different Presentation State Instances that share some common concept.
Rendered Image Reference Sequence	(0070,1104)	3	A rendered representation of the view described by this Presentation State. Only one Item shall be present in this Sequence. See Section XXX.2 “Volumetric Presentation States vs. Static Derived Images” in PS3.17.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Presentation Display Collection UID	(0070,1101)	3	Unique identifier of a collection of Presentation State Instances that are intended by the Presentation State creator to be processed or displayed together. See Section C.11.22.1. Note A Key Object Selection Document with a Document Title of (113022, DCM, "Collection of Presentation States") could be used to reference all Volumetric Presentation States in a particular spatial collection.
Presentation Sequence Collection UID	(0070,1102)	1C	Unique identifier of a collection of Presentation State Instances that are sequentially related. See Section C.11.22.2. Required if Presentation Animation Style (0070,1A01) is present with a value of PRESENTATION_SEQ. May be present otherwise. Note A Key Object Selection Document with a Document Title of (113022, DCM, "Collection of Presentation States") could be used to reference all Volumetric Presentation States in a particular Presentation Sequence Collection.
Presentation Sequence Position Index	(0070,1103)	1C	Ordinal position of this Presentation State within a Presentation Sequence Collection. Shall be a monotonically increasing integer, starting from 1, incrementing by 1, unique within the Instances sharing the same value of Presentation Sequence Collection UID (0070,1102). See Section C.11.22.2. Required if Presentation Sequence Collection UID (0070,1102) is present.

C.11.22.1 Presentation Display Collection UID

Views that are intended to be displayed together can be associated by assigning them to a common Presentation Display Collection UID (0070,1101).

Note

Examples of a display collection include:

- a set of mutually-orthogonal views that are intended to be displayed together
- a set of slices that are intended to be displayed in a "light-box" format

Display applications applying a Presentation State that contains a Presentation Display Collection UID (0070,1101) may look for other Presentation States that share the same value of Presentation Display Collection UID (0070,1101) and choose to process or present them together.

See Section XXX.3.1 “Simple Planar MPR View” in PS3.17 for an example of the use of this Attribute.

C.11.22.2 Presentation Sequence Collection UID

A set of Presentation States with the same value of Presentation Sequence Collection UID (0070,1102) defines a sequence of views. The Presentation Sequence Position Index (0070,1103) specifies the order of Presentation States within this Presentation Sequence.

Presentation States in such a collection may be used in an animation. In this form of animation, Presentation States in the set are applied in sequential order to produce a moving view. Typically, the same input(s) are used in each Presentation State of the set. See the PRESENTATION_SEQ animation style in Section C.11.29.

Note

Examples include:

- animation of a sequence of MPRs depicting the left ventricle of the heart at each point in a cardiac cycle with slightly different geometries
- animation of a sequence of views throughout the cardiac cycle in which a stent appears stationary in the middle of the view
- a sequence of parallel slices of an anatomical structure (that aren't necessarily going to be animated)

Presentation States in such a collection that are not used in an animation leave the style of presentation to the discretion of the display application, such as by display of all related presentations in a "light-box" format or in a single display frame with manual scrolling of the views.

All Presentation States with the same value of Presentation Sequence Collection UID (0070,1102) shall share the same Volumetric Presentation State Reference Coordinate System.

C.11.23 Volumetric Presentation State Relationship Module

Table C.11.23-1 contains Attributes that describe sets of inputs to a Presentation State and how each input is to be displayed in the presentation.

Table C.11.23-1. Volumetric Presentation State Relationship Module Attributes

Attribute Name	Tag	Type	Attribute Description
Volumetric Presentation Input Set Sequence	(0070,120A)	1	Input sets specified for use by this Volumetric Presentation State
>Volumetric Presentation Input Set UID	(0070,1209)	1	Unique identifier of this input specification. See Section C.11.23.4.
>Presentation Input Type	(0070,1202)	1	Type of input. See Section C.11.23.1. Enumerated Values: **VOLUME**
>Referenced Image Sequence	(0008,1140)	1C	The set of images comprising this input volume. One or more Items shall be included in this Sequence. See Section C.11.23.1 for constraints on objects referenced by this Sequence. Required if Presentation Input Type (0070,1202) has a value of VOLUME.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Referenced Spatial Registration Sequence	(0070,0404)	1C	A reference to a Spatial Registration Instance that is used to register the referenced inputs. Only one Item shall be included in this Sequence. All images referenced by the Referenced Image Sequence (0008,1140) of this Item of the Volumetric Presentation State Input Sequence (0070,1201) shall be referenced by the Spatial Registration Instance. See Section C.11.23.3. Required if the Frame of Reference UID (0020,0052) value of the Images referenced by the Referenced Image Sequence (0008,1140) of this Item of the Volumetric Presentation State Input Sequence (0070,1201) does not match the Frame of Reference UID (0020,0052) value of this Presentation State Instance. May be present otherwise.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Volumetric Presentation State Input Sequence	(0070,1201)	1	Inputs to the Presentation State. Each Item represents one input. One or more Items shall be included in this Sequence.
>Volumetric Presentation Input Number	(0070,1207)	1	Identification number of the input. Values shall be ordinal numbers starting from 1 and monotonically increasing by 1 within the Volumetric Presentation State Instance.
>Volumetric Presentation Input Set UID	(0070,1209)	1	Unique identifier of this input in Volumetric Presentation Input Set Sequence (0070,120A). The UID may be shared among multiple Volumetric Presentation State Input Sequence (0070,1201) Items. See Section C.11.23.4.
>Input Sequence Position Index	(0070,1203)	1C	Position of this input data within a set of sequential inputs. Multiple inputs may share the same value. Note For example, CT and PET inputs. Distinct values shall be ordinal numbers starting from 1 and monotonically increasing by 1 within the Volumetric Presentation State Instance. See Section C.11.23.2. Required if Presentation Animation Style (0070,1A01) is present with a value of INPUT_SEQ. Note The inputs of the sequence are typically temporally related.
>Include Table C.11-2b "VOI LUT Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Crop	(0070,1204)	1	Specifies whether to apply per-input cropping to this input. Enumerated Values: **YES** **NO** See Section C.11.23.5.
>Cropping Specification Index	(0070,1205)	1C	Values of Cropping Specification Number (0070,1309) of the Item in the Volume Cropping Sequence (0070,1301) specifying the cropping methods to be applied to this input. Required if Crop (0070,1204) has a value of YES.
>Rendering Method	(0070,120D)	1C	The rendering method for this input. Enumerated Values: **AVERAGE_IP** A method that projects the mean intensity of all interpolated samples that fall in the path of each ray traced from the viewpoint to the plane of projection. **MAXIMUM_IP** A method that projects the interpolated sample with maximum intensity that fall in the path of each ray traced from the viewpoint to the plane of projection. **MINIMUM_IP** A method that projects the interpolated sample with minimum intensity that fall in the path of each ray traced from the viewpoint to the plane of projection. Required if MPR Thickness Type (0070,1502) is present with a value of SLAB.
Global Crop	(0070,120B)	1	Specifies whether to apply the cropping specified by Global Cropping Specification Index (0070,120C) to every input of the Volumetric Presentation State. Enumerated Values: **YES** **NO** See Section C.11.23.5.
Global Cropping Specification Index	(0070,120C)	1C	Values of Cropping Specification Number (0070,1309) of one or more Items in the Volume Cropping Sequence (0070,1301) specifying the cropping methods to be applied to every input. Volume Cropping Method (0070,1302) shall include only BOUNDING_BOX or OBLIQUE_PLANE values. Required if Global Crop (0070,120B) has a value of YES.

C.11.23.1 Presentation Input Type Volume Input Requirements

SOP Instances with Presentation Input Type (0070,1202) value of VOLUME referenced by one Item in Volumetric Presentation Input Set Sequence (0070,1209) are a collection of Image Instances or frames within Image Instances that conforms to the following requirements:

- All Image Instances shall have the same values of
  - SOP Class UID(0008,0016)
  - Series Instance UID (0020,000E)

  - Frame of Reference UID (0020,0052) or Volume Frame of Reference UID (0020,9312)
- All Instances or frames shall have the following Attributes of the same value:
  - Samples per Pixel (0028,0002)
  - Photometric Interpretation (0028,0004)
  - Rows (0028,0010)
  - Columns (0028,0011)
  - Bits Allocated (0028,0100)
  - Bits Stored (0028,0101)
  - High Bit (0028,0102)
  - Pixel Representation (0028,0103)
  - Pixel Spacing (0028,0030)
- Photometric Interpretation (0028,0004) shall be MONOCHROME2
- Pixel Data (7FE0,0010) is present.
- All Instances or Frames have orthogonal row and column vectors
- A VOLUME input shall have more than one frame.
- No two Instances or Frames share the same Image Position (Patient) (0020,0032) or Image Position (Volume) (0020,9301). Two Instances or Frames should be treated as sharing the same position if the differences between their positions is sufficiently small.
- All Instances or Frames shall be parallel. Instances or Frames may be treated as parallel if the differences in their Image Orientation (Patient) (0020,0037) or Image Orientation (Volume) (0020,9302) are sufficiently small.
- All Instances or Frames shall be sufficiently aligned such that a single ray can pass through the upper-left hand corner of all Instances or Frames. That ray shall be orthogonal to the plane of the frame (i.e., normal to the input frames). Instances or Frames may be treated as aligned if the degree of misalignment between frames or relative to the normal is sufficiently small.
- A VOLUME input may have:
  - Variable spacing between slices
  - Overlapping slice thicknesses
  - Gaps between slice thicknesses

  Note

  The degree of tolerance for discrepancies in position and orientation may vary between applications.

C.11.23.2 Input Sequence Position Index

A sequence of inputs may be used in an animation. In this form of animation, the Presentation State is applied to each input in a sequence of inputs to produce a moving view. The inputs belonging to the input sequence are identified by the inclusion of an Input Sequence Position Index (0070,1203) value for each included input. See the INPUT_SEQ animation style in Section C.11.29.

Note

Examples include:

- a sequence of cardiac volume acquisitions acquired through a heart cycle

- a sequence of volume acquisitions during multiple phases of passage of a contrast agent

There is another animation method "Presentation Sequence Animation" that may be used. See Section C.11.22.2 “Presentation Sequence Collection UID”.

C.11.23.3 Volumetric Presentation State Reference Coordinate System

The Volumetric Presentation State Reference Coordinate System (VPS-RCS) is identified by the Section C.7.4.1 “Frame of Reference Module”.

All SOP Instances specified in the Volumetric Presentation State Relationship Module shall be implicitly or explicitly registered to the Volumetric Presentation State Reference Coordinate System. Registration is implicit if the Frame of Reference of a particular input SOP Instance is chosen as the VPS-RCS. Explicit registration is required if the Frame of Reference UID value of one or more input SOP Instances are different from the Frame of Reference UID value of the Presentation State.

Note

1. If the Presentation State has a single source object, it is recommended that the Presentation State use the same Frame of Reference UID as the source object and not require explicit Spatial Registration.

2. It should be recognized that not all objects with the same Frame of Reference UID values are precisely registered to the Frame of Reference implied by that UID (for example, successive scans of a patient by a CT/PET scanner where the patient may have moved somewhat between scans). In such a case, explicit registration may be necessary to achieve the precision of registration required by the clinical application.

C.11.23.4 Volumetric Presentation Input Set UID

Each set of Instances and/or frames used as input to the Volumetric Presentation State specified by one Item in Volumetric Presentation State Input Set Sequence (0070,120A) is identified by Volumetric Presentation Input Set UID (0070,1209). The Volumetric Presentation State Input Sequence (0070,1201) references Items in Volumetric Presentation Input Set Sequence (0070,120A) by their UID and specifies the particular processing to be performed prior to compositing with other inputs to build the final presentation view.

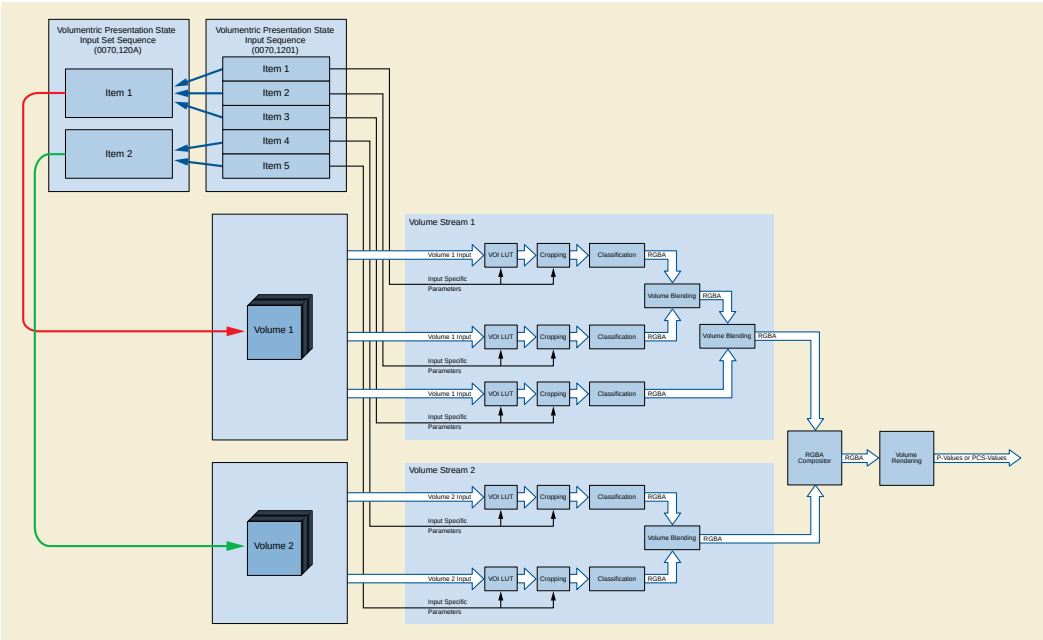


Figure C.11.23.4-1. Role of Volumetric Presentation Input Set Sequence (0070,120A)

Volumetric Presentation Input Set UID (0070,1209) may be shared among multiple Volumetric Presentation State Instances using the same input data.

C.11.23.5 Cropping

Cropping is an operation in which a portion of the source volume is ignored during subsequent volumetric processing. Cropping shall be specified as follows:

- If Global Crop (0070,120B) is YES, Global Crop Specification Index (0070,120C) specifies cropping which shall be applied to every input of the Volumetric Presentation State.
- If Crop (0070,1204) is YES for a particular input, Cropping Specification Index (0070,1205) specifies cropping which shall be applied to that input of the Volumetric Presentation State.

Each value in Global Crop Specification Index (0070,120C) and Cropping Specification Index (0070,1205) shall match a Cropping Specification Number (0070,1302) in Volume Cropping Sequence (0070,1301).

C.11.24 Volume Cropping Module

Table C.11.24-1 contains the Attributes of the Volume Cropping Module. This Module limits the spatial extent of inputs in Volumetric Presentation State Input Sequence (0070,1201) that are used.

Table C.11.24-1. Volume Cropping Module Attributes

Attribute Name	Tag	Type	Attribute Description
Volume Cropping Sequence	(0070,1301)	1	Regions cropped from volumetric presentation inputs. One or more Items shall be included in this Sequence.
>Cropping Specification Number	(0070,1309)	1	Identification number of the cropping specification, as an ordinal number starting from 1 and monotonically increasing by 1 within the Volumetric Presentation State Instance.
>Volume Cropping Method	(0070,1302)	1	Method of volume cropping applied. Enumerated Values: **BOUNDING_BOX** **OBLIQUE_PLANES** **INCLUDE_SEG** **EXCLUDE_SEG** See Section C.11.24.1 for description of terms.
>Bounding Box Crop	(0070,1303)	1C	A cuboid containing the source volume data to be included. The axes of the cuboid are aligned to the axes of encoded source volume. The bounding box is defined by the (x,y,z) coordinates in mm of two opposite corners in the Volumetric Presentation State Reference Coordinate System. Note If the source volume consists of gantry tilted slices (e.g., CT) then the bounding box will be a cuboid in the encoded image space, but a parallelepiped in the VPS-RCS. Required if Volume Cropping Method (0070,1302) has a value of BOUNDING_BOX.
>Oblique Cropping Plane Sequence	(0070,1304)	1C	Oblique cropping planes that contain the source volume data to be included. One or more Items shall be included in this Sequence. Required if Volume Cropping Method (0070,1302) has a value of OBLIQUE.
>>Plane	(0070,1305)	1	A plane described by a four-tuple (A,B,C,D) describing coordinates in mm of the plane equation Ax+By+Cz+D=0 relative to the Volumetric Presentation State Reference Coordinate System.

Attribute Name	Tag	Type	Attribute Description
>>Plane Normal	(0070,1306)	1	Vector of the normal to the plane pointing outside of the volume to be included, encoded as x, y and z values of a unit vector (direction cosine) in the Volumetric Presentation State Reference Coordinate System.
>Referenced Image Sequence	(0008,1140)	1C	Instances of the Segmentation Storage SOP Class (1.2.840.10008.5.1.4.1.1.66.4) containing segments specifying the included or excluded source volume data. Each referenced Segmentation Instance shall have Segmentation Type (0062,0001) value of BINARY and shall share a Frame of Reference with one or more Input Volumes. One or more Items shall be included in this Sequence. Required if Volume Cropping Method (0070,1302) has a value of INCLUDE_SEG or EXCLUDE_SEG. Note Surface Segmentation Instances are not referenced by this element.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			

C.11.24.1 Volume Cropping

Cropping is an operation in which a portion of the source volume is ignored during subsequent volumetric processing, using one of the methods specified by Volume Cropping Method (0070,1302) :

BOUNDING_BOX The source volume data within a bounding box are included in the View

OBLIQUE_PLANES The source volume data within a closed surface described by a set of arbitrarily-oriented planes are included in the View

INCLUDE_SEG Source volume data should be included in the View if and only if the data is within any of the referenced Segments that share its value of Input Sequence Position Index (0070,1203) (if specified)

EXCLUDE_SEG Source volume data should be included in the View if and only if the data is not within any of the referenced Segments that share its value of Input Sequence Position Index (0070,1203) (if specified)

C.11.25 Presentation View Description Module

Table C.11.25-1 contains Attributes that describe the view of this presentation in anatomical terms.

Note: For example, a Volumetric Presentation State derived from a whole-body CT source volume could be restricted to the left leg.

Table C.11.25-1. Presentation View Description Module Attributes

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table 10-6 "General Anatomy Required Macro Attributes"~~			~~*No Baseline CID is defined.*~~
Include Table 10-6 "General Anatomy Required Macro Attributes"			*No Baseline CID is defined.*
View Code Sequence	(0054,0220)	2	Describes this view of the patient anatomy. No more than one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes" .			*BCID 501 "Volumetric View Description".*
>View Modifier Code Sequence	(0054,0222)	2	View modifier. Zero or more Items shall be included in this Sequence.
>> Include Table 8.8-1 "Code Sequence Macro Attributes" .			*BCID 502 "Volumetric View Modifier".*

Attribute Name	Tag	Type	Attribute Description
Image Laterality	(0020,0062)	2	Laterality of (possibly paired) body part (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), if present.

C.11.26 Multi-Planar Reconstruction Geometry Module

Table C.11.26-1 contains Attributes that describe the geometry of this Multi-Planar Reconstruction view.

Table C.11.26-1. Multi-Planar Reconstruction Geometry Module Attributes

Attribute Name	Tag	Type	Attribute Description
Multi-Planar Reconstruction Style	(0070,1501)	1	Style of the MPR view. Enumerated Values: **PLANAR** by a Euclidean plane
MPR Thickness Type	(0070,1502)	1	Specifies whether the Multi-Planar Reconstruction surface has thickness. Enumerated Values: **THIN** a rendering of nominally minimal but unspecified thickness **SLAB** an orthographic rendering of a volume with a defined thickness See Section C.11.26.1.
MPR Slab Thickness	(0070,1503)	1C	Thickness of the Multi-Planar Reconstruction slab as a value greater than zero, in mm. See Section C.11.26.1. Required if MPR Thickness Type (0070,1502) has a value of SLAB.
MPR View Width Direction	(0070,1507)	1C	Direction cosine (x,y,z) indicating the direction within the VPS RCS of the top row of the MPR view. See Section C.11.26.1. Required if Multi Planar Reconstruction Style (0070,1501) is PLANAR.
MPR View Width	(0070,1508)	1C	Width of the MPR view, in mm. See Section C.11.26.1. Required if Multi Planar Reconstruction Style (0070,1501) is PLANAR.
MPR View Height Direction	(0070,1511)	1C	Direction cosine (x,y,z) indicating the direction within the VPS RCS of the leftmost column of the MPR view. See Section C.11.26.1. Required if Multi Planar Reconstruction Style (0070,1501) is PLANAR.

Attribute Name	Tag	Type	Attribute Description
MPR View Height	(0070,1512)	1C	Height of the MPR view, in mm. See Section C.11.26.1. Required if Multi Planar Reconstruction Style (0070,1501) is PLANAR.
MPR Top Left Hand Corner	(0070,1505)	1C	The 3D location in the Volumetric Presentation State - Reference Coordinate System of the upper left hand corner of the MPR View rectangle, in mm. See Section C.11.26.1.1. Required if Multi-Planar Reconstruction Style (0070,1501) has a value of PLANAR.

C.11.26.1 Multi-Planar Reconstruction Styles

A Multi-Planar Reconstruction (or MPR) is one of the styles described in this section.

C.11.26.1.1 Planar Style

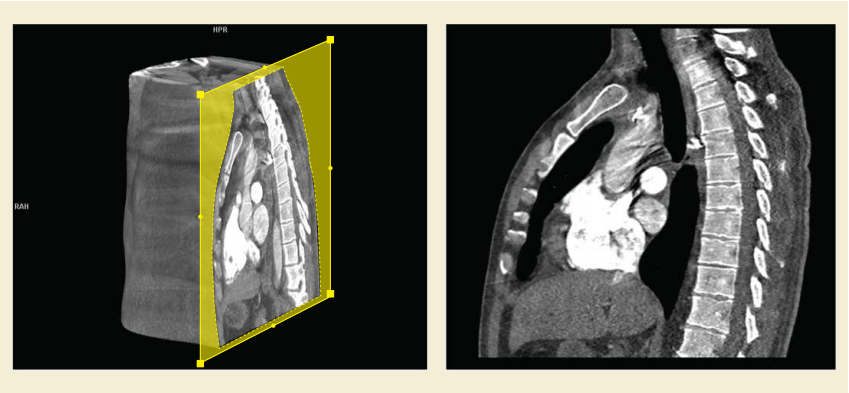


Figure C.11.26-1. Volume Rendering with visualization of MPR plane orientation and resulting PLANAR MPR rendering

A PLANAR MPR is a thin slice or thick slab of the input volume defined by a geometric plane as illustrated by Figure C.11.26-1. Figure C.11.26-2 and Figure C.11.26-3 depict the relationships between MPR Geometry Module Attributes and Thin and Slab MPR views, respectively.

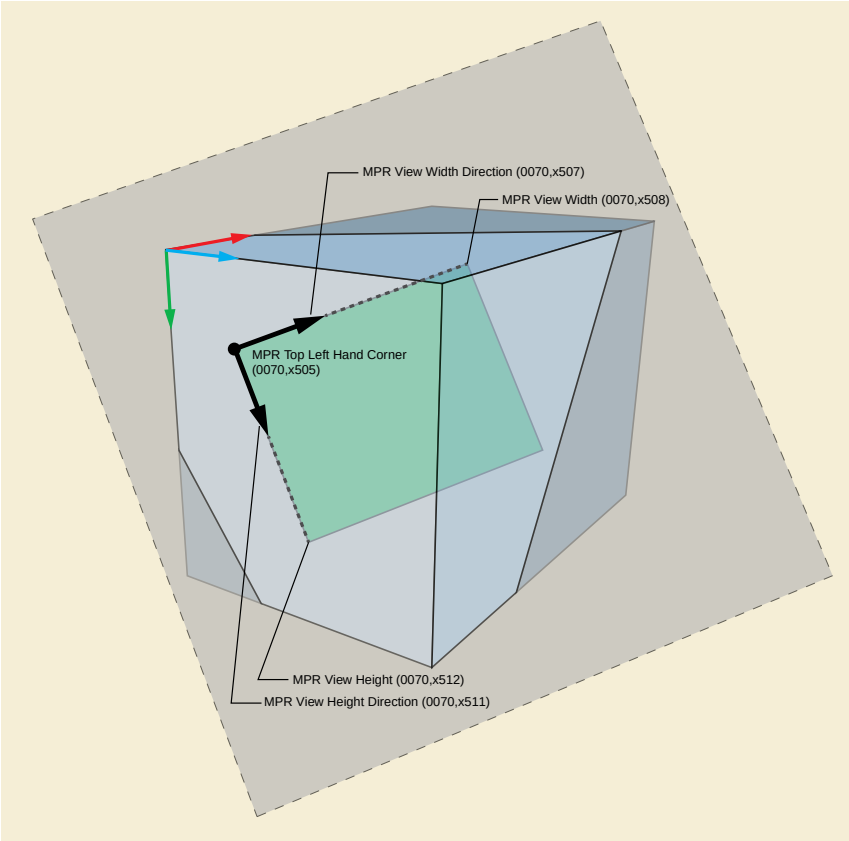


Figure C.11.26-2. Planar MPR THIN Geometry

The following Attributes describe the PLANAR MPR:

- MPR View Width Direction (0070,1507) and MPR View Height Direction (0070,1511) specify the orientation of the MPR view rectangle in the Volumetric Presentation State Reference Coordinate System
- MPR View Width (0070,1508) and MPR View Height (0070,1512) specify the size of the MPR view rectangle in the Volumetric Presentation State Reference Coordinate System
- MPR Top Left Hand Corner (0070,1505) species the position of the upper-left corner of the MPR view rectangle in the Volumetric Presentation State Reference Coordinate System
- MPR Thickness Type (0070,1502) specifies whether the MPR is created by taking a single sample for each pixel (THIN) or by creating an orthographic rendering of a slab volume with a defined thickness using the method defined by Rendering Method (0070,120D) (SLAB). If the specified thickness is below an application-determined limit the resulting view shall be treated as a THIN MPR.
- MPR Slab Thickness (0070,1503) specifies the thickness of the slab if MPR Thickness Type (0070,1502) is SLAB. The slab volume is positioned such that the MPR view defined by MPR View Width Direction (0070,1507), MPR View Width (0070,1508), MPR View Height Direction (0070,1511), MPR View Height (0070,1512), and MPR Top Left Hand Corner (0070,1505) is at the midpoint of the slab thickness.

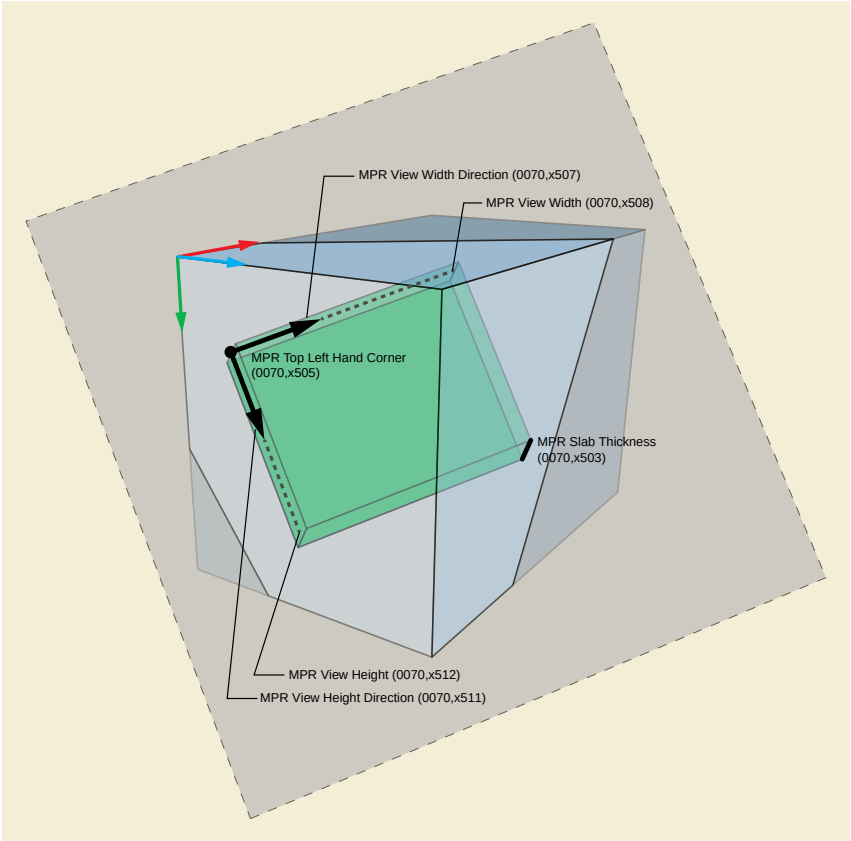


Figure C.11.26-3. Planar MPR SLAB Geometry

C.11.27 MPR Volumetric Presentation State Display Module

Table C.11.27-1 specifies the Attributes that define the transformations of the processed MPR Volumetric Presentation State inputs into a single VPS display space, as described in the Volumetric Presentation State pipeline in Section FF.2.1 “Volumetric Transformations” in PS3.4.

Table C.11.27-1. MPR Volumetric Presentation State Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Presentation	(0008,9205)	1	Grayscale or color space of the Presentation State output. Enumerated Values: **MONOCHROME** Output consists of P-Values **TRUE_COLOR** Output consists of PCS-Values
Presentation State Classification Component Sequence	(0070,1801)	2C	Sequence of classification components in which the order of Items is significant. Each classification component converts one or two processed inputs into a single RGB output. One or more Items shall be included in this Sequence. See Section C.11.27.2. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.

Attribute Name	Tag	Type	Attribute Description
>Component Type	(0070,1802)	1	Type of component. Enumerated Values: **ONE_TO_RGBA** **TWO_TO_RGBA** See Section C.11.27.2.
>Component Input Sequence	(0070,1803)	1	Description of the input or inputs to this component. One Item shall be present in this Sequence if Component Type (0070,1802) has a value of ONE_TO_RGBA. Two Items shall be present in this Sequence if Component Type (0070,1802) has a value of TWO_TO_RGBA.
>>Volumetric Presentation Input Index	(0070,1804)	1	Value of Volumetric Presentation Input Number (0070,1207) for this input in the Volumetric Presentation State Input Sequence (0070,1201)
>>Bits Mapped to Color Lookup Table	(0028,1403)	3	The number of most significant bits of each value of Pixel Data (7FE0,0010) from this frame contributing to the Palette Color Lookup Table input. If absent, Bits Stored (0028,0101) bits of each value of Pixel Data (7FE0,0010) from this frame contributes to the Palette Color Lookup Table input. See Section C.7.6.23.3 for usage.
>RGB LUT Transfer Function	(0028,140F)	1	Specifies the mapping that takes place between the input value and RGB output. Enumerated Values: **EQUAL_RGB** Output is R=G=B = input value **TABLE** Output is RGB LUT values See Section C.11.27.1.
>Alpha LUT Transfer Function	(0028,1410)	1C	Specifies the transformation that is used to create the Alpha input a compositor component. Enumerated Values: **NONE** Output = 1 (opaque) for all input values **IDENTITY** Output = input value **TABLE** Output = output of the Alpha LUT Required if the number of Items in Presentation State Classification Component Sequence (0070,1801) is greater than 1. Note When this condition is true, there will be one or more compositor components to follow this classification component.
>Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.

Attribute Name	Tag	Type	Attribute Description
>Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.
>Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.
>Alpha Palette Color Lookup Table Descriptor	(0028,1104)	1C	Specifies the format of the Alpha Palette Color Lookup Table Data. The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE.
>Palette Color Lookup Table UID	(0028,1199)	3	Palette Color Lookup Table UID. See Section C.7.9.1. Note Including the UID in Presentation States that comprise a presentation collection is helpful to the display application that is rendering several related presentations together. The palettes and UIDs do not need to be the same in such a case.
>Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE and Segmented Red Palette Color Lookup Table Data (0028,1221) is not present.
>Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if Red Palette Color Lookup Table Data (0028,1201) is present.
>Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if Red Palette Color Lookup Table Data (0028,1201) is present.
>Alpha Palette Color Lookup Table Data	(0028,1204)	1C	Alpha LUT contains the blending values for the data frames. See Section C.7.6.3.1.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE and Segmented Alpha Palette Color Lookup Table Data (0028,1224) is not present.

Attribute Name	Tag	Type	Attribute Description
>Segmented Red Palette Color Lookup Table Data	(0028,1221)	1C	Segmented Red Palette Color Lookup Table Data. See Section C.11.27.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE and Red Palette Color Lookup Table Data (0028,1201) is not present.
>Segmented Green Palette Color Lookup Table Data	(0028,1222)	1C	Segmented Green Palette Color Lookup Table Data. See Section C.11.27.5. Required if Segmented Red Palette Color Lookup Table Data (0028,1221) is present.
>Segmented Blue Palette Color Lookup Table Data	(0028,1223)	1C	Segmented Blue Palette Color Lookup Table Data. See Section C.11.27.5. Required if Segmented Red Palette Color Lookup Table Data (0028,1221) is present.
>Segmented Alpha Palette Color Lookup Table Data	(0028,1224)	1C	Segmented Alpha Palette Color Lookup Table Data. See Section C.11.27.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE and Alpha Palette Color Lookup Table Data (0028,1204) is not present.
Presentation State Compositor Component Sequence	(0070,1805)	2C	RGB Compositor components. Each RGB Compositor component combines pairs of RGB values to produce a single RGB value. The order of Items is significant. If there is more than one compositor component, the components are chained such that the output of one compositor component is an input to the next compositor component. The number of Items in this Sequence shall be one less than the number of Items in Presentation State Classification Component Sequence (0070,1801). See Section C.11.27.3. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.
>Weighting Transfer Function Sequence	(0070,1806)	1	Transfer functions used to derive the weighting factors for each of the two RGB inputs from both input Alphas. Each function is represented by the formula $f(Alpha_1,Alpha_2) = WeightingFactor$ The function is specified in the form of a table. Two Items shall be included in this Sequence. The order is significant. The first Item specifies the weighting factor for RGB1 and the second Item specifies the weighting factor for RGB2. See Section C.11.27.4.

Attribute Name	Tag	Type	Attribute Description
>>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data (0028,3006) in this Sequence. The first value (number of entries in the LUT) shall be an even power of two or zero indicating 2^{16}, so that there are an even number of bits in the LUT input. The third value (number of bits in the LUT Data) shall be 8. See Section C.11.1.1.
>>LUT Data	(0028,3006)	1	LUT Data.
Presentation LUT Shape	(2050,0020)	1C	Presentation LUT transformation. Enumerated Values: **IDENTITY** No further translation necessary; input values are P-Values **INVERSE** Output values after inversion are P-Values See Section C.11.6.1.2. Required if Pixel Presentation (0008,9205) has a value of MONOCHROME.
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Volumetric Presentation State. See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.
Color Space	(0028,2002)	1C	A label that identifies the well-known color space of the view. Shall be consistent with the ICC Profile (0028,2000) that is present. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR and a standard color space described by one of the Enumerated Values in Section C.11.15.1.2 is used.

C.11.27.1 RGB LUT Transfer Function

If the value of RGB LUT Transfer Function (0028,140F) is "TABLE" then each input scalar value will be mapped to an RGB value specified by the specified red, green, and blue palette color lookup tables.

If the value of RGB LUT Transfer Function (0028,140F) is "EQUAL_RGB" then each input scalar value will used as the red, green and blue values of the output (i.e., the output will be grayscale).

C.11.27.2 Classification Component Usage

If Pixel Presentation (0008,9205) is TRUE_COLOR, the Presentation State Classification Component Sequence (0070,1801) defines the transformations of processed VPS inputs into RGB data streams, a process known as "classification".

Each Item of Presentation State Classification Component Sequence (0070,1801) describes one "classification component" in the Volumetric Presentation State Display Pipeline, as described in Section FF.2.3.2.1 “Classification Component Components” in PS3.4. At least one Item is required in order for the Presentation State to generate a PCS-Value output. If there is more than one Item in this Sequence, the outputs of the multiple classification components are composited as described in Section C.11.27.3 “Compositor Component Usage”.

Two types of classification components are defined:

- Component Type (0070,1802) value of ONE_TO_RGBA specifies that of one processed input value is transformed into the RGBA output value
- Component Type (0070,1802) value of TWO_TO_RGBA specifies that of two processed input values are transformed into the RGBA output value.

The internal structure of each classification component is described in Section FF.2.3.3 “Internal Structure of Components” in PS3.4.

C.11.27.3 Compositor Component Usage

If Pixel Presentation (0008,9205) is TRUE_COLOR and there are more than one Item in the Presentation State Classification Component Sequence (0070,1801), the Presentation State Compositor Component Sequence (0070,1805) defines the transformations of the multiple RGB data streams produced by the Classification components into one RGB output stream, a process known as "compositing".

Note

If there is only one Item in Presentation State Classification Sequence (0070,1801), Presentation State Compositor Sequence (0070,1801) is empty since there is only one RGB data stream so there is no need to composite.

Each Item in Presentation State Compositor Component Sequence (0070,1805) describes one two-input "compositing component" in which two RGBA inputs are composited into one RGB output. The first compositor component in the Sequence combines the outputs of the first two classification components to produce one RGB output. Subsequent compositor components combine the output of the previous compositor component with the output of the next classification component to produce one RGB output. This process continues until the RGB outputs of all classification components are composited into a single RGB output.

Each classification component produces a RGBA output, while each compositor component has two RGBA inputs to produce a RGB output. This means that all compositor components after the first in the Sequence have only one Alpha input available, that is the Alpha value from the next classification component output to be composited. In this case, (1-Alpha) is used in place of the Alpha input missing from the previous compositing component.

Note

Through the use of (1-Alpha $_2$) as Alpha $_1$for the input from the previous Compositor, the Compositor performs standard Porter-Duff "A over B" compositing in all but the first compositor [Porter and Duff 1984].

The internal structure and usage of the Compositor component is described in Section FF.2.3.3.2 “Internal Structure of RGB and RGBA Compositor Components” in PS3.4.

C.11.27.4 Weighting Transfer Function

In some situations, it is desirable to consider both Alpha inputs to the compositor in determining the weight to be given to each of the two RGB inputs to the compositing operation. This is accomplished by providing two weighting transfer functions

$f(Alpha_1,Alpha_2) = WeightingFactor_n$

one for each of the two RGB inputs to the compositor.

In the degenerate (and common) case where simple additive compositing $(RGB_1*Alpha_1)+(RGB_2* (1-Alpha_1))$ is desired, identity weighting transfer functions can be specified to just pass through the Alpha $_1$and (1-Alpha $_1$) values (or Alpha $_1$and Alpha $_2$values) to be the weighing factors for the RGB inputs.

For ease of specification of these transfer functions and for maximum flexibility, each of these weighting transfer functions is defined as a look-up table with inputs $Alpha_1$ and $Alpha_2$. Each LUT contains 8-bit integer values which are then normalized to the range 0.0 to 1.0 by dividing by 255 (2^8-1).

See Section FF.2.3.3.2 “Internal Structure of RGB and RGBA Compositor Components” in PS3.4 for details on the use of these weighting transfer functions, and see Section XXX.5 “Compositing and the Use of Weighting Transfer Functions” in PS3.17 for clinical applications.

C.11.27.5 Use of Segmented Palette Color Lookup Tables

Segmented Palette Color Lookup Tables provide a means for specifying lookup tables in a parametric manner rather than as a set of discrete mapping values.

Note

Specifying tables using the segmented method may be preferred by color mapping implementations based on control points.

The value of Segmented Alpha Palette Color Lookup Table (0028,1224) is structured in the same manner as Segmented Red Palette Color Lookup Table Data (0028,1221), Segmented Green Palette Color Lookup Table Data (0028,1222), and Segmented Blue Palette Color Lookup Table Data (0028,1221) described in Section C.7.9.2 “Segmented Palette Color Lookup Table Data”.

C.11.28 Volumetric Graphic Annotation Module

Table C.11.28-1 contains Attributes that specify graphic annotation placed in the Volumetric Presentation State Reference Coordinate System coordinate space.

Note

This Module specifies literal text and/or graphic annotation only. Provision is made to reference external measurement Structured Report Instances to provide context for the annotation, if desired.

Table C.11.28-1. Volumetric Graphic Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Volumetric Annotation Sequence	(0070,1901)	1C	Graphic annotations described by coordinates in the Volumetric Presentation State Reference Coordinate System. One or more Items shall be included in this Sequence. Required if Volumetric Presentation Input Annotation Sequence (0070,1905) is not present. May be present otherwise.
>Graphic Data	(0070,0022)	1	An ordered set of (x,y,z) triplets (in mm and may be negative) that define a region of interest in the Volumetric Presentation State Reference Coordinate System defined by Frame of Reference UID (0020,0052). See Section C.18.9.1.1.
>Graphic Type	(0070,0023)	1	See Section C.18.9.1.2 for Enumerated Values.
>Graphic Layer	(0070,0002)	1	The layer defined in the Section C.10.7 “Graphic Layer Module” in which the graphics or text is to be rendered.
>Annotation Clipping	(0070,1907)	1	Specifies whether the volumetric annotation should be displayed only when it intersects with the presentation view. Enumerated Values: **YES** **NO** See Section C.11.28.1.
>Text Object Sequence	(0070,0008)	3	Sequence that describes a text annotation. One Item shall be included in this Sequence.
>>Unformatted Text Value	(0070,0006)	1	Displayed text associated with the input Instance. See Section C.10.5.1.1.

Attribute Name	Tag	Type	Attribute Description
>>Bounding Box Top Left Hand Corner	(0070,0010)	3	Recommended location of the Top Left Hand Corner (TLHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be placed within a Volumetric Presentation View, specified as fractions of the view width and view height. Each value shall be within the range 0.0 to 1.0.
>>Bounding Box Bottom Right Hand Corner	(0070,0011)	1C	Recommended location of the Bottom Right Hand Corner (BRHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be placed within a Volumetric Presentation View, specified as fractions of the view width and view height. Each value shall be within the range 0.0 to 1.0. Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>>Bounding Box Text Horizontal Justification	(0070,0012)	1C	Location of the Unformatted Test Value (0070,0006) relative to the vertical edges of the bounding box. Enumerated Values: **LEFT** Closest to the left edge **RIGHT** Closest to the right edge **CENTER** Centered Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>Referenced Structured Context Sequence	(0070,1903)	3	Reference to a node in a Structured Report Instance providing context for this annotation. Only one Item shall be present in this Sequence. See Section C.11.28.2.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>>Referenced Content Item	(0070,1904)	1	Reference to a Content Item in the referenced Structured Report specified as the Observation UID (0040,A171) of the Content Item.
Volumetric Presentation Input Annotation Sequence	(0070,1905)	1C	Annotations of inputs in Volumetric Presentation State Input Sequence (0070,1201). One or more Items shall be included in this Sequence. Required if Volumetric Annotation Sequence (0070,1901) is not present. May be present otherwise.
> Volumetric Presentation Input Index	(0070,1804)	1	Value of Volumetric Presentation Input Number (0070,1207) for this input in the Volumetric Presentation State Input Sequence (0070,1201). Note The annotation is intended to refer to a cropped input volume.
>Graphic Layer	(0070,0002)	1	The layer defined in the Graphic Layer Module C.10.7 in which the graphic or text is to be rendered.
>Text Object Sequence	(0070,0008)	1	Sequence that describes a text annotation. One Item shall be included in this Sequence.
>>Unformatted Text Value	(0070,0006)	1	Displayed text associated with the input. See Section C.10.5.1.1.

Attribute Name	Tag	Type	Attribute Description
>>Bounding Box Top Left Hand Corner	(0070,0010)	3	Recommended location of the Top Left Hand Corner (TLHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed, as fractions of the specified presentation view width and height. Each value shall be within the range 0.0 to 1.0. See Section C.10.5.1.1.
>>Bounding Box Bottom Right Hand Corner	(0070,0011)	1C	Recommended location of the Bottom Right Hand Corner (BRHC) of the bounding box in which Unformatted Text Value (0070,0006) is to be displayed, as fractions of the specified presentation view width and height. Each value shall be within the range 0.0 to 1.0. See Section C.10.5.1.1. Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>>Bounding Box Text Horizontal Justification	(0070,0012)	1C	Location of the Unformatted Test Value (0070,0006) relative to the vertical edges of the bounding box. Enumerated Values: **LEFT** Closest to the left edge **RIGHT** Closest to the right edge **CENTER** Centered See Section C.10.5.1.1. Required if Bounding Box Top Left Hand Corner (0070,0010) is present.
>Referenced Structured Context Sequence	(0070,1903)	3	Reference to a node in a Structured Report Instance providing context for this annotation. Only one Item shall be present in this Sequence. See Section C.11.28.2.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Referenced Content Item	(0070,1904)	1	Reference to a Content Item in the referenced Structured Report specified as the Observation UID (0040,A171) of the Content Item.

C.11.28.1 Annotation Clipping

A graphic defined by the Volumetric Annotation Sequence (0070,1901) may contain data that falls outside the view defined by the Volumetric Presentation State geometry.

If the Volumetric Presentation State intends that an annotation be clipped where it falls outside the defined view, Annotation Clipping (0070,1907) shall have a value of YES.

If the Volumetric Presentation State intends that an annotation be displayed in its entirely even where it does not intersect the volume of interest then Annotation Clipping (0070,1907) shall have a value of NO.

Any visual clues used to indicate where the annotation does and does not intersect the volume of interest are not specified by the Volumetric Presentation State.

Note

For example, the projection of a 3D curve onto a plane could be done such that the curve would be a rendered differently depending on if it is above, below or on the defined plane.

C.11.28.2 Referenced Structured Content Sequence

A volume annotation provides graphics and text to include in the presentation, but doesn't provide any context for the annotation. Context may be provided through an optional reference to a Structured Report concept. The structured concept could be in the form of a finding concept code or measurement from the Structured Report. It is an application-specific decision on whether to use this reference and how to make use of the information it provides.

C.11.29 Presentation Animation Module

Table C.11.29-1 contains Attributes that describe animation of the presentation.

Table C.11.29-1. Presentation Animation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Presentation Animation Style	(0070,1A01)	1	Animation style intended by the source. Enumerated Values: **INPUT_SEQ** **PRESENTATION_SEQ** **CROSSCURVE** **FLYTHROUGH** **SWIVEL** See Section C.11.29.1.
Recommended Animation Rate	(0070,1A03)	3	Recommended rate at which the inputs shall be displayed. Shall have a value greater than zero. See Section C.11.29.1.
Animation Curve Sequence	(0070,1A04)	1C	Curve describing the trajectory of a fly-through animation. Only a single Item shall be included in this Sequence. Required if Presentation Animation Style (0070,1A01) has a value of CROSSCURVE or FLYTHROUGH.
>Number of Volumetric Curve Points	(0070,150C)	1	Number of (x,y,z) points in Volumetric Curve Points (0070,150D).
>Volumetric Curve Points	(0070,150D)	1	Coordinates of points on the curve in the Volumetric Presentation State Reference Coordinate System, in mm. One triplet (x,y,z) shall be present for each point in the curve. See Section C.11.29.1. Note The points on the curve are samples. It is an implementation decision how the points are connected.
>Volumetric Curve Up Directions	(0070,1A07)	1C	Direction cosines (x_d,y_d,z_d) in the Volumetric Presentation State Reference Coordinate System defining the viewpoint up direction at each point in Volumetric Curve Points (0070,150D). See Section C.11.29.1. Required if Presentation Animation Style (0070,1A01) has a value of FLYTHROUGH.
Animation Step Size	(0070,1A05)	1C	Distance in mm along the curve the display moves in one step. Required if Presentation Animation Style (0070,1A01) has a value of CROSSCURVE or FLYTHROUGH.

Attribute Name	Tag	Type	Attribute Description
Swivel Range	(0070,1A06)	1C	Range in which a volume rotates back-and-forth around the swivel axis, in degrees. The initial position is at the midpoint of the swivel range. See Section C.11.29.1. Required if Presentation Animation Style (0070,1A01) is SWIVEL.

C.11.29.1 Presentation Animation Style

The presence of Presentation Animation Style (0070,1A01) indicates that a form of view animation is intended by the creator of the Presentation State, and the value of the Attribute indicates the nature of such animation. See Section FF.2.4.2 “Volumetric Animation” in PS3.4 for further description of the various presentation animation styles.

Values of Presentation Animation Style (0070,1A01) are:

INPUT_SEQ A number of inputs are displayed sequentially using the same Presentation State. The inputs are described by Items in Volumetric Presentation State Input Sequence (0070,1201) with values of Input Sequence Position Index (0070,1203). If Recommended Animation Rate (0070,1A03) is present, the animation occurs as values of the sequence position index are incremented at a rate specified by Recommended Animation Rate (0070,1A03) in units of steps per second. If Recommended Animation Rate (0070,1A03) is not present, the use of manual scrolling or animation rate is at the discretion of the display application. Inputs with the same Input Sequence Position Index (0070,1203) value are displayed simultaneously. If all values of Input Sequence Position Index (0070,1203) are the same, the presented view is not animated.

PRESENTATION_SEQ The animation is determined by two or more Presentation States sharing the same value of Presentation Sequence Collection UID (0070,1102). The Presentation States shall be applied sequentially in the order of Presentation Sequence Position Index (0070,1103) values as the index is varied at a rate specified by Recommended Animation Rate (0070,1A03) in units of steps per second, if present; otherwise, the use of manual scrolling or animation rate is at the discretion of the display application.

CROSSCURVE Indicates that the designated Planar MPR view shall be stepped along the curve defined in Animation Curve Sequence (0070,1A04) at the interval specified by Animation Step Size (0070,1A05). The rate is specified by Recommended Animation Rate (0070,1A03) in units of steps per second, if present; otherwise, the use of manual scrolling or animation rate is at the discretion of the display application.

FLYTHROUGH Indicates that the field of view defined by Render Field of View (0070,1606) be stepped along the curve defined in Animation Curve Sequence (0070,1A04) at the rate specified by Recommended Animation Rate (0070,1A03) steps per second. Presentation Animation Style (00070,1A01) value of FLYTHROUGH shall be present only if Render Projection (0070,1602) is present.

Viewpoint LookAt Point (0070,1604) shall coincide with the first point in Volumetric Curve Points (0070,150D, the direction from the Viewpoint Position (0070,1603) to the Viewpoint LookAt Point(0070,1604) shall be tangent to the curve at that point, and the Viewpoint Up Direction (0070,1605) shall be parallel to the first direction cosine in Volumetric Curve Up Directions (0070,1A07).

Note

These conditions ensure the view defined by the Volumetric Presentation State matches the initial view of the animation.

Spacing of curve points in Volumetric Curve Points (0070,150D) shall be chosen such that the angular change between any two consecutive direction cosines in Volumetric Curve Up Directions (0070,1A07) is always less than 90 ~~degress~~degrees in 3D space, and should be chosen such that the change in curve direction at each point is reasonably small.

Note

This condition and recommendation ensure that the up direction interpolated between points in Volumetric Curve Points (0070,150D) and the direction along the tangent from viewpoint to lookAt point at each step are always unambiguous.

The animation consists of a sequence of dynamically repositioned views that are successively rendered to produce a moving view along a curve through the volume. The curve is specified by the set of discrete points defined by Volumetric Curve Points (0070,150D). The views are at points along the curve determined by Animation Step Size (0070,1A04) and may or may not correspond to Volumetric Curve Points (0070,150D). At each step in the sequence, the viewpoint position, lookAt, and up direction changes as follows:

- The distance D_{lookAt} is the distance between Viewpoint Position (0070,1603) and Viewpoint LookAt Point (0070,1604), which is a constant throughout the animation.
- The view lookAt point is initially the first point in Volumetric Curve Points (0070,150D). At each step in the animation, the lookAt point moves on the curve a distance defined by Animation Step Size (0070,1A04) from the previous lookAt point in the direction towards the last point in Volumetric Curve Points (0070,150D).
- At each lookAt point position:
  - There is a line L_{tan} tangent to the curve at the ~~currentLookAt~~current LookAt point.
  - The viewpoint is a point on L_{tan} at a distance D_{lookAt} from the lookAt point. The direction from viewpoint to lookAt point is looking forward along the curve, generally toward the next point in Volumetric Curve Points (0070,150D).
  - If the current lookAt point is coincident with a point in Volumetric Curve Points (0070,150D), the up direction is the direction cosine in Volumetric Curve Up Direction (0070,1A07) corresponding to that point. Otherwise, the up direction is the direction interpolated between the two direction cosines in Volumetric Curve Up Directions (0070,1A07) corresponding to the neighboring points in Volumetric Curve Points (0070,150D).
  - The field of view is defined by Render Field of View (0070,1606) relative to the viewpoint coordinate system determined by the current viewpoint, lookAt point, and up direction.

SWIVEL Indicates that the rendered volume rotates around the “swivel axis”, which is defined as the axis parallel to the Viewpoint Up Direction (0070,1605) intersecting the Viewpoint LookAt Point (0070,1604). The rendered volume rotates back and forth in the angular range specified by Swivel Range (0070,1A06) at a rotational frequency specified by Recommended Animation Rate (0070,1A03) in degrees per second. The display application should provide for smooth (rather than abrupt) changes in direction as the swivel approaches the limits of the swivel range. Shall not be used unless Render Projection (0070,1602) is present.

Note

There are no constraints on the value of Swivel Range (0070,1A06). If this value is greater than 360 degrees, it implies that the rendered volume rotates more than one full rotation before changing direction. There is no significance given to negative rather than positive values of Swivel Range (0070,1A06).

CROSSCURVE is permitted only if the following conditions are met:

- Multi-Planar Reconstruction Style (0070,1501) is present with a value of PLANAR
- The curve specified by Animation Curve Sequence (0070,1A04) intersects the MPR view defined by MPR View Width Direction (0070,1507), MPR View Width (0070,1508), MPR View Height Direction (0070,1511), MPR View Height (0070,1512), and MPR Top Left Hand Corner (0070,1505) and is approximately normal to it at the point of intersection.

The original MPR Geometry parameters determine the view orientation and extent throughout the animation as follows:

- The same point on the MPR plane intersects the curve at each step of the animation
- The MPR x-directional vector remains unchanged from the initial MPR geometry throughout the animation
- The cross-product of the x-direction vector and y-direction vector is the tangent to the curve at each point.

See Section XXX.3.2 “Spatially Related Views (e.g., Orthogonal)” in PS3.17 for an application of CROSSCURVE.

C.11.30 Volume Render Geometry Module

Table C.11.30-1 contains Attributes that describe the geometry of the volume rendered view.

Table C.11.30-1. Volume Render Geometry Module Attributes

Attribute Name	Tag	Type	Attribute Description
Render Projection	(0070,1602)	1	Projection style. Enumerated Values: **ORTHOGRAPHIC** **PERSPECTIVE**
Viewpoint Position	(0070,1603)	1	Position of the viewpoint in volume space. A point (x,y,z) in the Volumetric Presentation State Reference Coordinate System.
Viewpoint LookAt Point	(0070,1604)	1	Point the viewpoint is looking at. A point (x,y,z) in the Volumetric Presentation State Reference Coordinate System.
Viewpoint Up Direction	(0070,1605)	1	Vertical orientation of the view. A vector (x,y,z) in the Volumetric Presentation State Reference Coordinate System.
Render Field of View	(0070,1606)	1	The field of view specified as a 6-tuple of values (X_{left}, X_{right}, Y_{top}, Y_{bottom}, $Distance_{near}$, $Distance_{far}$) in the Viewpoint Coordinate System, in mm. See Section C.11.30.1.
Rendering Method	(0070,120D)	1	The rendering method used during the ray casting compositing operation. Enumerated values: Enumerated Values: **MAXIMUM_IP** A method that projects the interpolated sample with maximum intensity that falls in the path of each ray traced from the viewpoint to the plane of projection. **MINIMUM_IP** A method that projects the interpolated sample with minimum intensity that falls in the path of each ray traced from the viewpoint to the plane of projection. **VOLUME_RENDERED** A method where each XY pixel of the rendered view is determined by accumulating the set of non-transparent voxel samples along a ray.
Sampling Step Size	(0070,1607)	3	Spacing in mm between samples along each ray in the original volume rendering operation. See Section C.11.30.2.

C.11.30.1 Render Field of View

The Render Field of View (0070,1606) defines the region of the volume data that is displayed.

The viewpoint is positioned and oriented within the Volumetric Presentation State Reference Coordinate System (VPS-RCS) by Viewpoint Position (0070,1603), Viewpoint LookAt Point (0070,1604) and Viewpoint Up Direction (0070,1605). This position and orientation establish a Viewpoint Coordinate System (VCS), which is a right-hand coordinate system in which the viewpoint is positioned at (0,0,0) and is looking at a point at (0,0,-z) and the up direction is along the +y axis.

Render Field of View (0070,1606) is specified by the following coordinate values in the Viewpoint Coordinate System:

- $Distance_{near}$, $Distance_{far}$ specify the distances from Viewpoint Position (0070,1603) to the near and far depth clipping planes. Both distances shall be positive, and $Distance_{near}$ shall be less than $Distance_{far}$.
- X_{left}, X_{right} specify the coordinates of the left and right vertical clipping planes at $Distance_{far}$. X_{left} shall be less than X_{right}.
- Y_{top}, Y_{bottom} specify the coordinates for the top and bottom horizontal clipping planes at $Distance_{far}$. X_{left} shall be less than X_{right}.

  Note

  Positive values of $Distance_{near}$ and $Distance_{far}$ place the near and far rectangles of the field of view on the negative Z axis at Z values of -$Distance_{near}$ and -$Distance_{far}$, respectively.

In the case of a Render Projection (0070,1602) value of ORTHOGRAPHIC, Render Field of View (0070,1606) defines a rectangular cuboid with dimensions (X_{right} minus X_{left}) by (Y_{top} minus Y_{bottom}) by ($Distance_{far}$ minus $Distance_{near}$), in mm, as shown in Figure C.11.30-1:

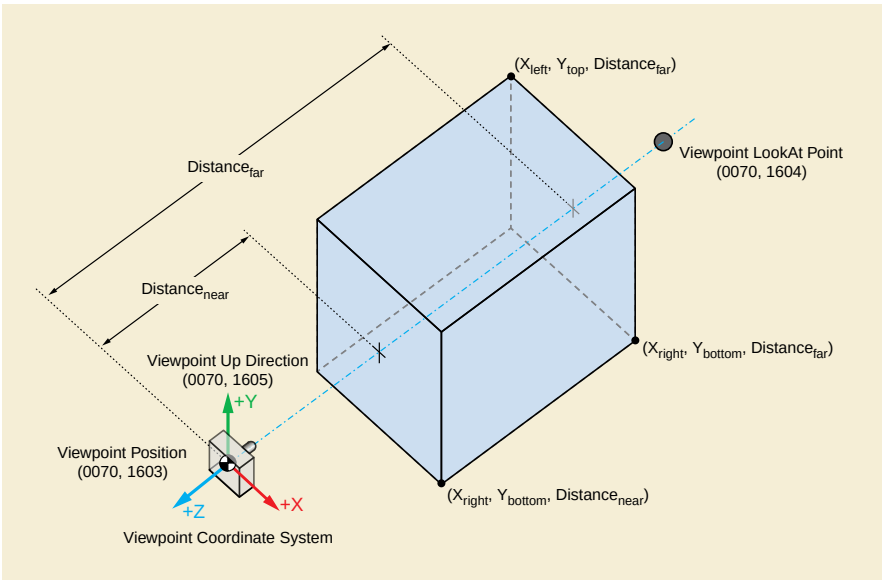


Figure C.11.30-1. ORTHOGRAPHIC Field of View Geometry

In the case of a Render Projection (0070,1602) value of PERSPECTIVE, Render Field of View (0070,1606) defines a frustum in which the far rectangle is larger than the near rectangle. The extent of the far rectangle is established by the points (X_{left}, Y_{top}) and (X_{right}, Y_{bottom}) at $Distance_{far}$. The extent of the near rectangle is established by the four points where rays originating at the viewpoint position to the corners of the far rectangle intersect the plane that is located at $Distance_{near}$ from the viewpoint, as shown in Figure C.11.30-2.

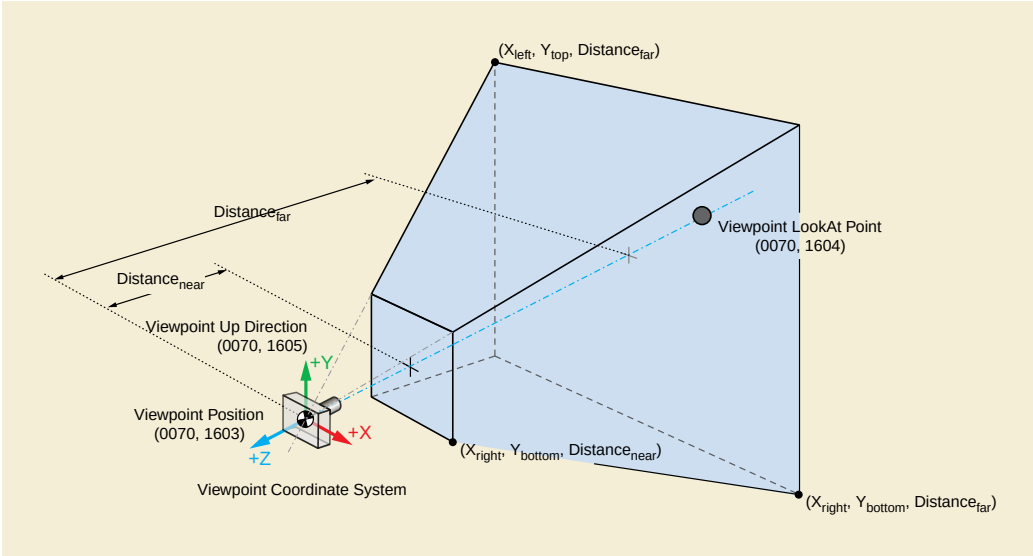


Figure C.11.30-2. PERSPECTIVE Field of View Geometry

C.11.30.2 Sampling Step Size

Sampling Step Size (0070,1607) specifies the spacing in mm between samples along each ray that was used in the original view by the creator of the Presentation State. A display application may choose to use a different step size, but this will usually require an adjustment to the Alpha LUTs found in the Presentation State Classification Component Sequence (0070,1801) to compensate the change in opacity accumulation caused by the different step size.

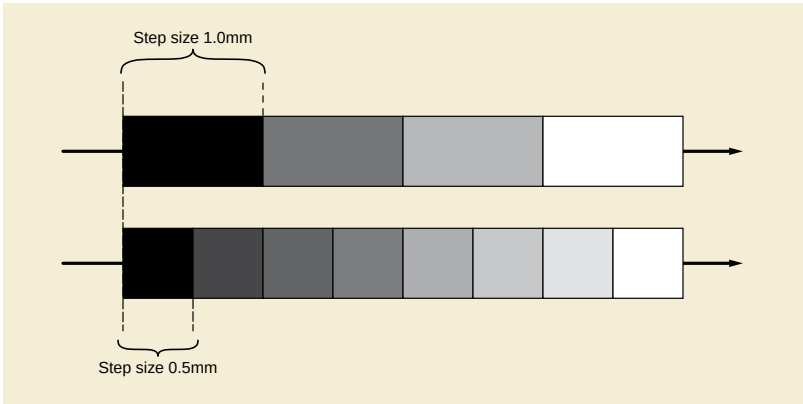


Figure C.11.30-3. Sampling Step Size

C.11.31 Render Shading Module

Shading enhances the visual perception of a volume by adding reflection characteristics.

Table C.11.31-1 contains Attributes that describe the shading used in a rendered view.

Note

This Module assumes a Phong shading model [Phong 1975]. An implementation may use any appropriate shading model, translating these parameters into a similar meaning in the chosen shading ~~model. The~~model. The generation mechanism for the surface normals that are required for the Phong shading model is not specified by DICOM.

Table C.11.31-1. Render Shading Module Attributes

Attribute Name	Tag	Type	Attribute Description
Shading Style	(0070,1701)	1	The style of shading. See Section C.11.31.1.
Ambient Reflection Intensity	(0070,1702)	1	Intensity of the ambient reflection in the relative range 0.0 to 1.0, inclusive.
Light Direction	(0070,1703)	1C	The direction light is traveling from a single white light source at infinity. Represented as a unit vector encoded as three coordinates (x,y,z) in the VPS-RCS. Required if Diffuse Reflection Intensity (0070,1704) or Specular Reflection Intensity (0070,1705) is present.
Diffuse Reflection Intensity	(0070,1704)	3	Intensity of the diffuse reflection in the relative range 0.0 to 1.0, inclusive. If absent, a value of zero is assumed.
Specular Reflection Intensity	(0070,1705)	3	Intensity of the specular reflection in the relative range 0.0 to 1.0, inclusive. If absent, a value of zero is assumed.
Shininess	(0070,1706)	3	Specifies the roughness of the rendered surfaces, in the relative range 0.0 to 1.0, inclusive. A value of 0.0 represents a rough surface and a value of 1.0 represents the smoothest surface which can be generated by the implementation. Note In theory, the range of shininess is from 0 to infinity. However, in practice each implementation has a finite upper limit for shininess. The implementation is expected to multiply this value by its upper limit value and use the result in its shading algorithm for shininess. If absent, the shininess is an implementation decision.

C.11.31.1 Shading Style

The Shading Style (0070,1701) determines if the shading calculations are performed for all voxels, based on the facing of the surface normal which has been generated for that voxel:

Enumerated Values for Shading Style (0070,1701):

SINGLESIDED Only "front-facing" voxels are shaded.
DOUBLESIDED "Front-facing" and "back-facing" voxels are shaded.

Note

"Front-facing" voxels are those with a negative dot product between the surface normal which has been generated for that voxel and the vector between the Viewpoint Position (0070,1603) and the ~~ViewPoint~~Viewpoint LookAt Point (0070,1604). "Back-facing" voxels are those with a positive dot product.

C.11.32 Render Display Module

Table C.11.32-1 specifies the Attributes that define the transformations of the processed Volumetric Presentation State inputs into a single VPS display space, as described in the Volumetric Presentation State pipelines in Section FF.2.2 “Volumetric Inputs, Registration and Cropping” in PS3.4.

Table C.11.32-1. Render Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Presentation	(0008,9205)	1	Grayscale or color space of the Presentation State output. Enumerated Values: **TRUE_COLOR** Output consists of PCS-Values.
Volume Stream Sequence	(0070,1A08)	1	Volumetric source input streams combined through Volume Blending. One or more Items shall be included in this Sequence.
>Volumetric Presentation Input Set UID	(0070,1209)	1	Unique identifier of the input set processed in this volume stream. Corresponds to the Item in Volume Presentation Input Set Sequence (0070,120A) with this UID. See Section C.11.23.4.
>Presentation State Classification Component Sequence	(0070,1801)	1	Classification components in which the order of Items is significant. Each classification component converts one or two processed inputs into a single RGB output. One or more Items shall be included in this Sequence. See Section C.11.27.2.
>>RGBA Transfer Function Description	(0070,1A09)	3	Label describing the clinical significance of the RGBA transfer function.
>>Component Type	(0070,1802)	1	Type of component. Enumerated Values: **ONE_TO_RGBA** **TWO_TO_RGBA** See Section C.11.27.2.
>>Component Input Sequence	(0070,1803)	1	Specification of the input or inputs to this component. One Item shall be present in this Sequence if Component Type (0070,1802) has a value of ONE_TO_RGBA. Two Items shall be present in this Sequence if Component Type (0070,1802) has a value of TWO_TO_RGBA.
>>> Volumetric Presentation Input Index	(0070,1804)	1	Volumetric Presentation Input Number (0070,1207) for this input in the Volumetric Presentation State Input Sequence (0070,1201).
>>>Bits Mapped to Color Lookup Table	(0028,1403)	3	The number of most significant bits of each value of Pixel Data (7FE0,0010) from this frame contributing to the Palette Color Lookup Table input. If absent, Bits Stored (0028,0101) bits of each value of Pixel Data (7FE0,0010) from this frame contributes to the Palette Color Lookup Table input. See Section C.7.6.23.3.
>>RGB LUT Transfer Function	(0028,140F)	1	Specifies the mapping that takes place between the input value and RGB output. Enumerated Values: **EQUAL_RGB** Output is R=G=B = input value **TABLE** Output is RGB LUT values See Section C.11.27.1.

Attribute Name	Tag	Type	Attribute Description
>>Alpha LUT Transfer Function	(0028,1410)	1	Specifies the transformation that is used to create the Alpha input to a compositor component (if present) and the opacity value for use in the Volume Rendering compositor. Enumerated Values: **NONE** Output = 1 (opaque) for all input values. **IDENTITY** Output = input value. **TABLE** Output = output of the Alpha LUT.
>>Red Palette Color Lookup Table Descriptor	(0028,1101)	1C	Specifies the format of the Red Palette Color Lookup Table Data (0028,1201). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.
>>Green Palette Color Lookup Table Descriptor	(0028,1102)	1C	Specifies the format of the Green Palette Color Lookup Table Data (0028,1202). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.
>>Blue Palette Color Lookup Table Descriptor	(0028,1103)	1C	Specifies the format of the Blue Palette Color Lookup Table Data (0028,1203). The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE.
>>Alpha Palette Color Lookup Table Descriptor	(0028,1104)	1C	Specifies the format of the Alpha Palette Color Lookup Table Data. The second value (first stored pixel value mapped) shall be zero. See Section C.7.6.3.1.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE.
>>Palette Color Lookup Table UID	(0028,1199)	3	Palette Color Lookup Table UID. See Section C.7.9.1. Note Including the Palette Color Lookup Table UID in Presentation States that use the same palette is helpful to the display application that is rendering several related presentations together.
>>Red Palette Color Lookup Table Data	(0028,1201)	1C	Red Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE and Segmented Red Palette Color Lookup Table Data (0028,1221) is not present.

Attribute Name	Tag	Type	Attribute Description
>>Green Palette Color Lookup Table Data	(0028,1202)	1C	Green Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if Red Palette Color Lookup Table Data (0028,1201) is present.
>>Blue Palette Color Lookup Table Data	(0028,1203)	1C	Blue Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if Red Palette Color Lookup Table Data (0028,1201) is present.
>>Alpha Palette Color Lookup Table Data	(0028,1204)	1C	Alpha Palette Color Lookup Table Data. See Section C.7.6.3.1.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE and Segmented Alpha Palette Color Lookup Table Data (0028,1224) is not present.
>>Segmented Red Palette Color Lookup Table Data	(0028,1221)	1C	Segmented Red Palette Color Lookup Table Data. See Section C.11.27.5. Required if RGB LUT Transfer Function (0028,140F) has a value of TABLE and Red Palette Color Lookup Table Data (0028,1201) is not present.
>>Segmented Green Palette Color Lookup Table Data	(0028,1222)	1C	Segmented Green Palette Color Lookup Table Data. See Section C.11.27.5. Required if Segmented Red Palette Color Lookup Table Data (0028,1221) is present.
>>Segmented Blue Palette Color Lookup Table Data	(0028,1223)	1C	Segmented Blue Palette Color Lookup Table Data. See Section C.11.27.5. Required if Segmented Red Palette Color Lookup Table Data (0028,1221) is present.
>>Segmented Alpha Palette Color Lookup Table Data	(0028,1224)	1C	Segmented Alpha Palette Color Lookup Table Data. See Section C.11.27.5. Required if Alpha LUT Transfer Function (0028,1410) has a value of TABLE and Alpha Palette Color Lookup Table Data (0028,1204) is not present.
Presentation State Compositor Component Sequence	(0070,1805)	2	RGBA Compositor components. Each RGBA Compositor component combines pairs of RGBA values to produce a single RGBA value. The order of Items is significant. If there are more than one compositor component, the components are chained such that the output of one compositor component is an input to the next compositor component. The number of Items in this Sequence shall be the one less than the number of Items in Volume Stream Sequence (0070,1A08). See Section C.11.27.3.

Attribute Name	Tag	Type	Attribute Description
>Weighting Transfer Function Sequence	(0070,1806)	1	Transfer functions used to derive the weighting factors for each of the two RGB inputs from both input Alphas. Each function is represented by the formula $f(Alpha_1, Alpha_2) = Weighting\ Factor$ The function is specified in the form of a table. Two Items shall be included in this Sequence. The order is significant. The first Item specifies the weighting factor for RGB1 and the second Item specifies the weighting factor for RGB2. See Section C.11.27.4.
>>LUT Descriptor	(0028,3002)	1	Specifies the format of the LUT Data (0028,3006) in this Sequence. The first value (number of entries in the LUT) shall be an even power of two or zero indicating 2^{16}, so that there are an even number of bits in the LUT input. The third value (number of bits in the LUT Data) shall be 8. See Section C.11.1.1.
>>LUT Data	(0028,3006)	1	LUT Data
ICC Profile	(0028,2000)	1C	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. When present, defines the color space of the output of the Volumetric Presentation State. See Section C.11.15.1.1. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR.
Color Space	(0028,2002)	1C	A label that identifies the well-known color space of the view. Shall be consistent with the ICC Profile (0028,2000) that is present. Required if Pixel Presentation (0008,9205) has a value of TRUE_COLOR and a standard color space described by one of the Enumerated Values in Section C.11.15.1.2 is used.

C.11.33 Advanced Blending Presentation State Module

C.11.33.1 Advanced Blending Presentation State Module Attributes

Table C.11.33-1 contains Attributes that describe one or more inputs optionally one or more sets of registration objects, and the color and thresholds to be applied to them, for the purpose of blending.

Table C.11.33-1. Advanced Blending Presentation State Module Attributes

Attribute Name	Tag	Type	Attribute Description
Advanced Blending Sequence	(0070,1B01)	1	A Sequence of Items identifying the inputs and describing transformations of them. One or more Items shall be included in this Sequence. See Section C.11.33.1.1.

Attribute Name	Tag	Type	Attribute Description
>Blending Input Number	(0070,1B02)	1	Identification number of the input. Values shall be ordinal numbers starting from 1 and monotonically increasing by 1 within the Advanced Blending Presentation State Instance.
>Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
>Series Instance UID	(0020,000E)	1	Unique identifier of a Series that is part of the Study defined by the Study Instance UID (0020,000D)
>Referenced Image Sequence	(0008,1140)	1C	The set of images comprising this input. One or more Items shall be included in this Sequence. Required if the input is not the entire set of Instances in the Series.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Referenced Spatial Registration Sequence	(0070,0404)	1C	A reference to a Spatial Registration Instance that is used to register the referenced inputs. Only one Item shall be included in this Sequence. Required if the Frame of Reference UID (0020,0052) value of the Images referenced by the Referenced Image Sequence (0008,1140) of this Item does not match the Frame of Reference UID (0020,0052) value of this Presentation State Instance. May be present otherwise.
>>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
>Include Table C.11.33.1-1 "Threshold Sequence Macro Attributes"			
>Time Series Blending	(0070,1B07)	1C	Whether this Series is a time series and every time point in this Series will be blended with the single volumes in the other Series specified in the Advanced Blending Sequence (0070,1B01). Enumerated Values: **TRUE** **FALSE** Only a single Item in the Sequence may have the value TRUE Required if the input is a Time Series and all time points need to be blended with the other Series. May be present otherwise
>Geometry for Display	(0070,1B08)	1C	Whether the geometry of this Series is used as the geometry for the blending operation. See Section C.11.33.1.1. Enumerated Values: **TRUE** **FALSE** Only a single Item in the Sequence may have the value TRUE Required if the geometry of this input is to be used as the geometry for the blending operation. May be present otherwise.

C.11.33.1.1 Advanced Blending Sequence

The images to be blended are specified in the Advanced Blending Sequence (0070,1B01).

Geometry refers to the following Attributes:

- Number of Frames (0028,0008)
- Rows (0028,0010)
- Columns (0028,0011)
- Pixel Aspect Ratio (0028,0034)
- Imager Pixel Spacing (0018,1164) (if applicable)
- Nominal Scanned Pixel Spacing (0018,2010) (if applicable)
- Slice Thickness (0018,0050)
- Spacing Between Slices (0018,0088)

The geometry of the output images shall match the geometry of the input specified as having the Geometry for Display (0070,1B08) as TRUE. If no input has Geometry for Display (0070,1B08) equal TRUE then the application shall choose which geometry to use.

If all inputs do not have the same frames, resolution, etc., the application determines the appropriate pixels to be blended. This implies that the blending result may vary between different applications. If consistent blending results are desired the inputs should be resampled in advance such that they have the same frames, resolution, etc.

This Module specifies no explicit relationship (such as pairing or ordering) between the sets of images and frames defined in the Sequence Attributes. This Module does not define how the images are spatially related, and what re-sampling, if any, needs to be performed before the images are blended for rendering.

It is expected that blending takes place between pixels at the same position in space.

The images in the image sets may share the same Frame of Reference, in which case the rendering application can spatially relate the image sets based on their Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) Attributes.

If a spatial registration object is included in the Advanced Blending Sequence (0070,1B01) it shall be applied to the referenced input even if the Frame of Reference is the same, as small corrections might have taken place during post-processing.

If they are both missing the application will decide how to blend the inputs.

Note

The underlying image for a superimposed segmentation image need not be the source image for the segmentation.

C.11.33.1.2 Threshold Sequence Macro

The Threshold Sequence is defining the values of the image that are used or ignored.

Table C.11.33.1-1. Threshold Sequence Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Threshold Sequence	(0070,1B11)	1C	Threshold specification for the image One or more Items shall be included in this Sequence. Required if Threshold needs to be applied.
>Threshold Type	(0070,1B13)	1	Type of threshold comparison used to determine the presence of a pixel value in the output. See Section C.11.33.1.2.1.

Attribute Name	Tag	Type	Attribute Description
>Threshold Value Sequence	(0070,1B12)	1	Values for thresholding. If the Threshold Type (0070,1B13) is GREATER_OR_EQUAL, LESS_OR_EQUAL, GREATER_THAN or LESS_THAN only a single Item shall be included in this Sequence. If the Threshold Type (0070,1B13) is RANGE_INCL or RANGE_EXCL, exactly two Items shall be included in this Sequence, the first of which is less than or equal to the second.
>>Threshold Value	(0070,1B14)	1	Value for the threshold. See Section C.11.33.1.2.1. Note VR of Threshold Value is FD and if this is different than the VR of the pixels then format conversion is needed.

C.11.33.1.2.1 Threshold

The Threshold Type (0070,1B13) defines the pixel values that will be shown. Values that are not inside any of the specified Threshold Sequence (0070,1B11) Items shall be treated as padding pixels.

To describe a threshold that consists of more than one range, multiple Items are specified in the Threshold Sequence (0070,1B11) Items.

When more than one Item is specified in the Threshold Sequence (0070,1B11) the pixel shall be shown if any Item specifies that the pixel shall be shown.

The number of Items in the Threshold Value Sequence (0070,1B12) and the use of Threshold Value (0070,1B14) depends on the value of the Threshold Type (0070,1B13) as follows:

Enumerated Values for Threshold Type (0070,1B13):

RANGE_INCL A pixel value shall be shown when the value lies between the specified values or is equal to one of the specified values.
RANGE_EXCL A pixel value shall be shown when the value lies outside (i.e. not between) the specified values.
GREATER_OR_EQUAL A pixel value shall be shown when the value is greater than or equal to the specified value.
LESS_OR_EQUAL A pixel value shall be shown when the value is less than or equal to the specified value.
GREATER_THAN A pixel value shall be shown when the value is greater than the specified value.
LESS_THAN A pixel value shall be shown when the value is less than the specified value.

C.11.34 Advanced Blending Presentation State Display Module

The Advanced Blending Presentation State Display Module specifies the input and the method used for each blending step.

Table C.11.34.1-1. Advanced Blending Presentation State Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Presentation	(0008,9205)	1	Grayscale or color space of the Presentation State output. Enumerated Values: **TRUE_COLOR** Output consists of PCS-Values

Attribute Name	Tag	Type	Attribute Description
Blending Display Sequence	(0070,1B04)	1	The blending operations and the input series to be used. Each Item results in a single RGB output that may be reused in a following step. One or more Items shall be included in this Sequence. Note The order of operations is determined by the specified Blending Input Number (0070,1B02) for each blending step. The displayed output will be the result of the blending step that is not assigned a Blending Input Number (0070,1B02)
>Blending Display Input Sequence	(0070,1B03)	1	Each Item is an input series that will be used in the blending operation. The order of Items is significant Two Items shall be included if the blending mode is FOREGROUND. One or more Items shall be included if the blending mode is EQUAL.
>>Blending Input Number	(0070,1B02)	1	Identification number of the input series to which the Blending information must be applied.
>Relative Opacity	(0070,0403)	1C	Specifies Relative Opacity for the visible pixels of the set referenced by the first Blending Input Number (0070,1B02) Required if Blending Mode (0070,1B06) is equal to FOREGROUND
>Blending Mode	(0070,1B06)	1	Describes the method for weighting the different input images during the blending operation: Enumerated Values: **EQUAL** **FOREGROUND** See Section N.2.6 in PS3.4.
>Blending Input Number	(0070,1B02)	1C	Identification of the result as input for a subsequent blending operation. Required if the result is used for further Blending. Note If this Attribute is not present the Item describes the final output of the blending process.

C.12 General Modules

The SOP Common Module shall be mandatory for all DICOM IODs.

C.12.1 SOP Common Module

Table C.12-1 defines the Attributes that are required for proper functioning and identification of the associated SOP Instances. They do not specify any semantics about the Real-World Object represented by the IOD.

Table C.12-1. SOP Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
SOP Class UID	(0008,0016)	1	Uniquely identifies the SOP Class. See Section C.12.1.1.1 for further explanation. See also PS3.4.

Attribute Name	Tag	Type	Attribute Description
SOP Instance UID	(0008,0018)	1	Uniquely identifies the SOP Instance. See Section C.12.1.1.1 for further explanation. See also PS3.4.
Specific Character Set	(0008,0005)	1C	Character Set that expands or replaces the Basic Graphic Set. Required if an expanded or replacement character set is used. See Section C.12.1.1.2 for Defined Terms.
Instance Creation Date	(0008,0012)	3	Date the SOP Instance was created. This is the date that the SOP Instance UID was assigned, and does not change during subsequent coercion of the Instance.
Instance Creation Time	(0008,0013)	3	Time the SOP Instance was created. This is the time that the SOP Instance UID was assigned, and does not change during subsequent coercion of the Instance.
Instance Coercion DateTime	(0008,0015)	3	Date and time that the SOP Instance was last coerced by a Storage SCP (see PS3.4).
Instance Creator UID	(0008,0014)	3	Uniquely identifies device that created the SOP Instance. Note There is no requirement that the Instance Creator UID (0008,0014) be the same as the Device UID (0018,1002) in the General Equipment Module, though they may be.
Related General SOP Class UID	(0008,001A)	3	Uniquely identifies a Related General SOP Class for the SOP Class of this Instance. See PS3.4.
Original Specialized SOP Class UID	(0008,001B)	3	The SOP Class in which the Instance was originally encoded that has been replaced during a fall-back conversion to the current Related General SOP Class. See PS3.4.
Coding Scheme Identification Sequence	(0008,0110)	3	Sequence of Items that map values of Coding Scheme Designator (0008,0102) to an external coding system registration, or to a private or local coding scheme. One or more Items are permitted in this Sequence.
>Coding Scheme Designator	(0008,0102)	1	The value of a Coding Scheme Designator, used in this SOP Instance, which is being mapped.
>Coding Scheme Registry	(0008,0112)	1C	The name of the external registry where further definition of the identified coding scheme may be obtained. Required if coding scheme is registered. Defined Terms: **HL7**
>Coding Scheme UID	(0008,010C)	1C	The coding scheme UID identifier. Required if coding scheme is identified by an ISO 8824 object identifier compatible with the UI VR.
>Coding Scheme External ID	(0008,0114)	2C	The coding scheme identifier as defined in an external registry. Required if coding scheme is registered and Coding Scheme UID (0008,010C) is not present.
>Coding Scheme Name	(0008,0115)	3	The coding scheme full common name
>Coding Scheme Version	(0008,0103)	3	The coding scheme version associated with the Coding Scheme Designator (0008,0102).
>Coding Scheme Responsible Organization	(0008,0116)	3	Name of the organization responsible for the Coding Scheme. May include organizational contact information.

Attribute Name	Tag	Type	Attribute Description
>Coding Scheme Resources Sequence	(0008,0109)	3	Resources related to the coding scheme. One or more Items are permitted in this Sequence.
>>Coding Scheme URL Type	(0008,010A)	1	The type of the resource related to the coding scheme at the Coding Scheme URL (0008,010E). Defined Terms: **DOC** The resource is human-readable information describing the coding scheme. **OWL** The resource contains an OWL file that contains a representation of the coding scheme. **CSV** The resource contains a comma separated value text file that contains a representation of the coding scheme.
>>Coding Scheme URL	(0008,010E)	1	A resource related to the coding scheme.
Context Group Identification Sequence	(0008,0123)	3	Sequence of Items that map values of Context Identifier (0008,010F) to an external, private or local Context Group. One or more Items are permitted in this Sequence.
>Context Identifier	(0008,010F)	1	The identifier of the Context Group. See Section 8.6.
>Context UID	(0008,0117)	3	The unique identifier of the Context Group. See Section 8.6.
>Mapping Resource	(0008,0105)	1	The identifier of the Mapping Resource that defines the Context Group. See Section 8.4.
>Context Group Version	(0008,0106)	1	The identifier of the version of the Context Group. See Section 8.5.
Mapping Resource Identification Sequence	(0008,0124)	3	Sequence of Items that map values of Mapping Resource (0008,0105) to an external, private or local Mapping Resource. One or more Items are permitted in this Sequence.
>Mapping Resource	(0008,0105)	1	The identifier of the Mapping Resource. See Section 8.4.
>Mapping Resource UID	(0008,0118)	3	The unique identifier of the Mapping Resource
>Mapping Resource Name	(0008,0122)	3	The name of the Mapping Resource. See Section 8.4.
Timezone Offset From UTC	(0008,0201)	3	Contains the offset from UTC to the timezone for all DA and TM Attributes present in this SOP Instance, and for all DT Attributes present in this SOP Instance that do not contain an explicitly encoded timezone offset. See Section C.12.1.1.8 The local timezone offset is undefined if this Attribute is absent.

Attribute Name	Tag	Type	Attribute Description
Contributing Equipment Sequence	(0018,A001)	3	Sequence of Items containing descriptive Attributes of related equipment that has contributed to the acquisition, creation or modification of the Composite Instance. One or more Items are permitted in this Sequence. See Section C.12.1.1.5 for further explanation.
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the related equipment is being referenced. Only a single Item shall be included in this Sequence. See Section C.12.1.1.5 for further explanation.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7005 "Contributing Equipment Purposes of Reference".*
>Manufacturer	(0008,0070)	1	Manufacturer of the equipment that contributed to the Composite Instance.
>Institution Name	(0008,0080)	3	Institution where the equipment that contributed to the Composite Instance is located.
>Institution Address	(0008,0081)	3	Address of the institution where the equipment that contributed to the Composite Instance is located.
>Station Name	(0008,1010)	3	User defined name identifying the machine that contributed to the Composite Instance.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment that contributed to the Composite Instance is located.
>Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7030 "Institutional Departments, Units and Services".*
>Operators' Name	(0008,1070)	3	Name(s) of the operator(s) of the contributing equipment.
>Operator Identification Sequence	(0008,1072)	3	Identification of the operator(s) of the contributing equipment. One or more Items are permitted in this Sequence. The number and order of Items shall correspond to the number and order of values of Operators' Name (0008,1070), if present.
>>Include Table 10-1 "Person Identification Macro Attributes Description"			
>Manufacturer's Model Name	(0008,1090)	3	Manufacturer's model name of the equipment that contributed to the Composite Instance.
>Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the equipment that contributed to the Composite Instance.
>Software Versions	(0018,1020)	3	Manufacturer's designation of the software version of the equipment that contributed to the Composite Instance. See Section C.7.5.1.1.3.
>Spatial Resolution	(0018,1050)	3	The inherent limiting resolution in mm of the acquisition equipment for high contrast objects for the data gathering and reconstruction technique chosen. If variable across the images of the Series, the value at the image center.
>Date of Last Calibration	(0018,1200)	3	Date when the image acquisition device calibration was last changed in any way. Multiple entries may be used for additional calibrations at other times. See Section C.7.5.1.1.1 for further explanation.
>Time of Last Calibration	(0018,1201)	3	Time when the image acquisition device calibration was last changed in any way. Multiple entries may be used. See Section C.7.5.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Contribution DateTime	(0018,A002)	3	The Date & Time when the equipment contributed to the Composite Instance.
>Contribution Description	(0018,A003)	3	Description of the contribution the equipment made to the Composite Instance.
Instance Number	(0020,0013)	3	A number that identifies this Composite Instance.
SOP Instance Status	(0100,0410)	3	A flag that indicates the storage status of the SOP Instance. Enumerated Values: **NS** Not Specified; implies that this SOP Instance has no special storage status, and hence no special actions need be taken **OR** Original; implies that this is the primary SOP Instance for the purpose of storage, but that it has not yet been authorized for diagnostic use **AO** Authorized Original; implies that this is the primary SOP Instance for the purpose of storage, which has been authorized for diagnostic use **AC** Authorized Copy; implies that this is a copy of an Authorized Original SOP Instance; any copies of an Authorized Original should be given the status of Authorized Copy Note Proper use of these flags is specified in Security Profiles. Implementations that do not conform to such Security Profiles may not necessarily handle these flags properly.
SOP Authorization DateTime	(0100,0420)	3	The date and time when the SOP Instance Status (0100,0410) was set to AO.
SOP Authorization Comment	(0100,0424)	3	Any comments associated with the setting of the SOP Instance Status (0100,0410) to AO.
Authorization Equipment Certification Number	(0100,0426)	3	The certification number issued to the Application Entity that set the SOP Instance Status (0100,0410) to AO.
Include Table C.12-6 “Digital Signatures Macro Attributes”			
Encrypted Attributes Sequence	(0400,0500)	1C	Sequence of Items containing encrypted DICOM data. One or more Items shall be included in this Sequence. Required if application level confidentiality is needed and certain recipients are allowed to decrypt all or portions of the Encrypted Attributes Data Set. See Section C.12.1.1.4.1.
>Encrypted Content Transfer Syntax UID	(0400,0510)	1	Transfer Syntax used to encode the encrypted content. Only Transfer Syntaxes that explicitly include the VR and use Little Endian encoding shall be used.
>Encrypted Content	(0400,0520)	1	Encrypted data. See Section C.12.1.1.4.2.
Original Attributes Sequence	(0400,0561)	3	Sequence of Items containing all Attributes that were removed or replaced by other values in the top level Data Set. See Section C.12.1.1.9. One or more Items are permitted in this Sequence.
>Source of Previous Values	(0400,0564)	2	The source that provided the SOP Instance prior to the removal or replacement of the values. For example, this might be the Institution from which imported SOP Instances were received.
>Attribute Modification DateTime	(0400,0562)	1	Date and time the Attributes were removed and/or replaced.

Attribute Name	Tag	Type	Attribute Description
>Modifying System	(0400,0563)	1	Identification of the system that removed and/or replaced the Attributes.
>Reason for the Attribute Modification	(0400,0565)	1	Reason for the Attribute modification. Defined Terms: **COERCE** Replace values of Attributes such as Patient Name, ID, Accession Number, for example, during import of media from an external institution, or reconciliation against a master patient index. **CORRECT** Replace incorrect values, such as Patient Name or ID, for example, when incorrect worklist item was chosen or operator input error.
>Modified Attributes Sequence	(0400,0550)	1	Sequence that contains all the Attributes, with their previous values, that were modified or removed from the top level Data Set. See Section C.12.1.1.9. Only a single Item shall be included in this Sequence.
>>Any Attribute from the top level Data Set that was modified or removed.		2	May include Sequence Attributes and their Items.
>Nonconforming Modified Attributes Sequence	(0400,0551)	3	Attributes that were modified or removed from the Data Set because the values were not conformant to the Attribute's Value Representation or Value Multiplicity. See Section C.12.1.1.9.2. One or more Items are permitted in this Sequence, one Item for each nonconforming Attribute.
>>Include Table 10-20 “Selector Attribute Macro Attributes”			Pointer to Attribute in Modified Attributes Sequence that had a nonconforming value.
>>Nonconforming Data Element Value	(0400,0552)	1	The original Value of the nonconforming Attribute.
HL7 Structured Document Reference Sequence	(0040,A390)	1C	Sequence of Items defining mapping between HL7 Instance Identifiers of unencapsulated HL7 Structured Documents referenced from the current SOP Instance as if they were DICOM Composite SOP Instances defined by SOP Class and Instance UID pairs. May also define a means of accessing the Documents. One or more Items shall be included in this Sequence. See Section C.12.1.1.6. Required if unencapsulated HL7 Structured Documents are referenced within the Instance. Every such document so referenced is required to have a corresponding Item in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>HL7 Instance Identifier	(0040,E001)	1	Instance Identifier of the referenced HL7 Structured Document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier).
>Retrieve URI	(0040,E010)	3	Retrieval access path to HL7 Structured Document. Includes fully specified scheme, authority, path, and query in accordance with[RFC3986]. Note The VR of this Data Element has changed from UT to UR.

Attribute Name	Tag	Type	Attribute Description
Longitudinal Temporal Information Modified	(0028,0303)	3	Indicates whether or not the date and time Attributes in the Instance have been modified during de-identification. Enumerated Values: **UNMODIFIED** **MODIFIED** **REMOVED** See PS3.15.
Query/Retrieve View	(0008,0053)	1C	The view requested during the C-MOVE operation that resulted in the transfer of this Instance. Enumerated Values: **CLASSIC** **ENHANCED** Required if the Instance has ever been converted from its source form as the result of a C-MOVE operation with a specific view.
Conversion Source Attributes Sequence	(0020,9172)	1C	The set of images or other composite SOP Instances that were converted to this Instance. If this Instance was converted from a specific frame in the source Instance, the reference shall include the Frame Number. One or more Items shall be included in this Sequence. Required if this Instance was created by conversion from a DICOM source, and Conversion Source Attributes Sequence (0020,9172) is not present in an Item of Shared Functional Groups Sequence (5200,9229) or Per-Frame Functional Groups Sequence (5200,9230).
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
Content Qualification	(0018,9004)	3	Content Qualification Indicator Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.8.13.2.1.1 for further explanation.
Private Data Element Characteristics Sequence	(0008,0300)	3	Characteristics of Private Data Elements within or referenced in the current SOP Instance. See Section C.12.1.1.7. One or more Items are permitted in this Sequence.
>Private Group Reference	(0008,0301)	1	Odd group number within which the Private Data Element block is reserved.

Attribute Name	Tag	Type	Attribute Description
>Private Creator Reference	(0008,0302)	1	The value of the Private Creator Data Element value used to reserve the block of Private Data Elements whose characteristics are described in this Item. Note Private blocks are identified by their Private Creator Data Element value, rather than their numeric block number, since instances may be modified and numeric block numbers reassigned but the Private Creator Data Element value, which is required to be unique within a Group of Private Data Elements, will be preserved.
>Private Data Element Definition Sequence	(0008,0310)	3	Description of individual Private Data Elements. One or more Items are permitted in this Sequence.
>>Private Data Element	(0008,0308)	1	Element Number used to identify the Data Element within the reserved block. The value of this Attribute represents the last two digits of the Data Element Tag; i.e., the value of xx in (gggg,00xx) where gggg is the Private Group Reference (0008,0301).
>>Private Data Element Value Multiplicity	(0008,0309)	1	Value Multiplicity (VM) of the Data Element. See Section C.12.1.1.7.1.
>>Private Data Element Value Representation	(0008,030A)	1	Value Representation (VR) of the Data Element.
>>Private Data Element Number of Items	(0008,030B)	1C	Number of Items allowed in a Sequence Data Element. Required if the value of Private Data Element Value Representation (0008,030A) is SQ. See Section C.12.1.1.7.2.
>>Private Data Element Keyword	(0008,030D)	1	Keyword for the Data Element (in the sense of the keywords provided in PS3.6).
>>Private Data Element Name	(0008,030C)	1	Name for referring to the Data Element.
>>Private Data Element Description	(0008,030E)	3	Description of the purpose and/or proper usage of the Data Element.
>>Private Data Element Encoding	(0008,030F)	3	Description of how the Data Element value contents are encoded.
>>Retrieve URI	(0040,E010)	3	Retrieval access path to associated documentation. Includes fully specified scheme, authority, path, and query in accordance with [RFC3986].

Attribute Name	Tag	Type	Attribute Description
>Block Identifying Information Status	(0008,0303)	1	Specifies whether some or all of the Private Data Elements in the block are safe from identity leakage as defined by PS3.15 Section E.3.10 Retain Safe Private Option. Enumerated Values: **SAFE** no Data Elements within the block contain identifying information **UNSAFE** all Data Elements within the block may contain identifying information **MIXED** some Data Elements within the block may contain identifying information
>Nonidentifying Private Elements	(0008,0304)	1C	List of Private Data Elements in block that do not contain identifying information (are safe from identity leakage). Elements are identified by the lowest 8-bits of the Date Element Tag (i.e., with a value from 0000H to 00FFH) within the block, stored as an unsigned short integer. Multiple values shall be in increasing order and a given value shall be listed at most once. Required if Block Identifying Information Status (0008,0303) equals MIXED.
>Deidentification Action Sequence	(0008,0305)	3	Actions to be performed on element within the block that are not safe from identify leakage. One or more Items are permitted in this Sequence.
>>Identifying Private Elements	(0008,0306)	1	List of Private Data Elements in block that may contain identifying information (are unsafe from identity leakage). Elements are identified by the lowest 8-bits of the Data Element Tag (i.e., with a value from 0000H to 00FFH) within the block, stored as an unsigned short integer. Multiple values shall be in increasing order and a given value shall be listed at most once.

Attribute Name	Tag	Type	Attribute Description
>>Deidentification Action	(0008,0307)	1	Recommended action to be performed during de-identification on elements listed in Identifying Private Elements (0008,0306) within this Item. Note A specific type of action is suggested in order to minimize the impact of de-identification on the behavior of recipients that use the Private Data Elements. Enumerated Values: **D** replace with a non-zero length value that may be a dummy value and consistent with the VR **Z** replace with a zero length value, or a non-zero length value that may be a dummy value and consistent with the VR **X** remove **U** replace with a non-zero length UID that is internally consistent within a set of Instance Note 1. No C (clean) action is specified, since replacement with values of similar meaning known not to contain identifying information and consistent with the VR requires an understanding of the meaning of the value of the element. Whether or not to clean rather than remove or replace values is at the discretion of the implementer. 2. No suggested dummy value is provided, since the encoding of the value would depend on the VR of the Data Element. 3. Further explanation of these actions can be found in PS3.15 Section E.3.1 Clean Pixel Data Option.

Attribute Name	Tag	Type	Attribute Description
Instance Origin Status	(0400,0600)	3	

Attribute Name	Tag	Type	Attribute Description
			Categorizes the locality of the entity from whence the Instance originated. Enumerated Values: **LOCAL** Acquired or created in the local entity. **IMPORTED** Imported from an external entity. Note 1. The interpretation of the meaning of local and imported are user-specific. The purpose of this Attribute is to provide a means of communicating a user-specific decision, not to attempt to achieve uniformity with respect to any particular organizational or geographical boundary around any particular organizational or geographical entity, be it an entity that is a device, system, facility, office, department, site, enterprise, region, nation, etc. 2. A typical pattern would be for an archive to set a value of LOCAL when receiving Instances on the network from a modality within the hospital but to set a value of IMPORTED when receiving Instances from an interchange media reader or an external network Instance sharing gateway. Displaying the value of this Attribute in a viewer then makes it apparent to a user whether or not an Instance is "one of their own". How a receiver determines whether or not the sender is local is not specified, but could, for example, be determined from the sender's AE Title. 3. When Instances are transported from one entity to another and then imported, it is expected that this Attribute be set to an appropriate value for the new context, overwriting any previous value. E.g., a value of LOCAL used within an archive at the site where the Instances were acquired would be coerced to a value of IMPORTED when those Instances were received by another site to which the patient had been transferred. Whether or not previous values of this Attribute are copied into Original Attributes Sequence (0400,0561) after coercion is not specified. 4. It is not expected (but nor is it prohibited) that this Attribute will be removed by an exporting entity, since it may be useful to a recipient to know whether or not the Instance was local to the previous entity or not. Similarly, a modality may populate this Attribute with a value of LOCAL after creating the images, but is not required to. 5. The round-trip case, e.g., when an image is acquired locally, exported, locally deleted and then re-imported may be challenging unless a local record is maintained. I.e., after acquisition, in the local archive it would be expected to be LOCAL. After re-importation without any local state, it may be hard to determine that it once was LOCAL. Other Attributes such as Institution Name may not be sufficient to reliably detect this. 6. A new SOP Instance UID (0008,0018) is not required when adding or coercing this Attribute, since a derived Instance is not being created. See Section C.12.4.1.1 Derivation

Attribute Name	Tag	Type	Attribute Description
			Description and Section B.4.1.3 Coercion of Attributes in PS3.4. 7. A more detailed history of the handling of an Instance may be recorded in Contributing Equipment Sequence (0018,A001). 8. This Attribute may need to be removed during de-identification. See Annex E “Attribute Confidentiality Profiles” in PS3.15.
Barcode Value	(2200,0005)	3	Barcode interpreted from a scanned label. Note 1. In the case of a scanned patient label, this may be the same as Patient ID (0010,0020), but it is included in an Instance level Module rather than a Patient level Module since barcodes may also be used to identify lower level entities. This might be obtained by scanning the patient's wrist band, request form, or extracting a burned-in label from the image pixel data, for example. 2. In the case of a scanned slide label, this may be the same as Container Identifier (0040,0512) in the Specimen Module.

Note

If Issuer of Patient ID (0010,0021) is included in the Modified Attribute Sequence, the context of the prior Patient ID (0010,0020) can be more precisely identified.

C.12.1.1 SOP Common Attribute Descriptions

C.12.1.1.1 SOP Class UID, SOP Instance UID

The SOP Class UID and SOP Instance UID Attributes are defined for all DICOM IODs. However, they are only encoded in Composite IODs with the Type equal to 1. See Section C.1.2.3. When encoded they shall be equal to their respective Attributes in the DIMSE Services and the File Meta Information header (see PS3.10 Media Storage).

C.12.1.1.2 Specific Character Set

Specific Character Set (0008,0005) identifies the Character Set that expands or replaces the Basic Graphic Set (ISO 646) for values of Data Elements that have Value Representation of SH, LO, ST, PN, LT, UC or UT. See PS3.5.

If the Attribute Specific Character Set (0008,0005) is not present or has only a single value, Code Extension techniques are not used. Defined Terms for the Attribute Specific Character Set (0008,0005), when single valued, are derived from the International Registration Number as per ISO 2375 (e.g., ISO_IR 100 for Latin alphabet No. 1). See Table C.12-2.

Table C.12-2. Defined Terms for Single-Byte Character Sets Without Code Extensions

Character Set Description	Defined Term	ISO Registration Number	Number of Characters	Code Element	Character Set
Default repertoire	none	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 1	ISO_IR 100	ISO-IR 100	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 2	ISO_IR 101	ISO-IR 101	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646

Character Set Description	Defined Term	ISO Registration Number	Number of Characters	Code Element	Character Set
Latin alphabet No. 3	ISO_IR 109	ISO-IR 109	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 4	ISO_IR 110	ISO-IR 110	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Cyrillic	ISO_IR 144	ISO-IR 144	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Arabic	ISO_IR 127	ISO-IR 127	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Greek	ISO_IR 126	ISO-IR 126	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Hebrew	ISO_IR 138	ISO-IR 138	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 5	ISO_IR 148	ISO-IR 148	96	G1	Supplementary set of ISO 8859
		ISO-IR 6	94	G0	ISO 646
Japanese	ISO_IR 13	ISO-IR 13	94	G1	JIS X 0201: Katakana
		ISO-IR 14	94	G0	JIS X 0201: Romaji
Thai	ISO_IR 166	ISO-IR 166	88	G1	TIS 620-2533 (1990)
		ISO-IR 6	94	G0	ISO 646

Note

To use the single-byte code table of JIS X0201, the value of Attribute Specific Character Set (0008,0005), value 1 should be ISO_IR 13. This means that ISO-IR 13 is designated as the G1 code element, which is invoked in the GR area. It should be understood that, in addition, ISO-IR 14 is designated as the G0 code element and this is invoked in the GL area.

If the Attribute Specific Character Set (0008,0005) has more than one value, Code Extension techniques are used and Escape Sequences may be encountered in all character sets. Requirements for the use of Code Extension techniques are specified in PS3.5. In order to indicate the presence of Code Extension, the Defined Terms for the repertoires have the prefix "ISO 2022", e.g., ISO 2022 IR 100 for the Latin Alphabet No. 1. See Table C.12-3 and Table C.12-4. Table C.12-3 describes single-byte character sets for value 1 to value n of the Attribute Specific Character Set (0008,0005), and Table C.12-4 describes multi-byte character sets for value 2 to value n of the Attribute Specific Character Set (0008,0005).

Note

A prefix other than "ISO 2022" may be needed in the future if other Code Extension techniques are adopted.

The same character set shall not be used more than once in Specific Character Set (0008,0005).

Note

For example, the values "ISO 2022 IR 100\ISO 2022 IR 100" or "ISO_IR 100\ISO 2022 IR 100" are redundant and not permitted.

Table C.12-3. Defined Terms for Single-Byte Character Sets with Code Extensions

Character Set Description	Defined Term	Standard for Code Extension	ESC Sequence	ISO Registration Number	Number of Characters	Code Element	Character Set
Default repertoire	ISO 2022 IR 6	ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646

Character Set Description	Defined Term	Standard for Code Extension	ESC Sequence	ISO Registration Number	Number of Characters	Code Element	Character Set
Latin alphabet No. 1	ISO 2022 IR 100	ISO 2022	ESC 02/13 04/01	ISO-IR 100	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 2	ISO 2022 IR 101	ISO 2022	ESC 02/13 04/02	ISO-IR 101	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 3	ISO 2022 IR 109	ISO 2022	ESC 02/13 04/03	ISO-IR 109	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 4	ISO 2022 IR 110	ISO 2022	ESC 02/13 04/04	ISO-IR 110	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Cyrillic	ISO 2022 IR 144	ISO 2022	ESC 02/13 04/12	ISO-IR 144	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Arabic	ISO 2022 IR 127	ISO 2022	ESC 02/13 04/07	ISO-IR 127	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Greek	ISO 2022 IR 126	ISO 2022	ESC 02/13 04/06	ISO-IR 126	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Hebrew	ISO 2022 IR 138	ISO 2022	ESC 02/13 04/08	ISO-IR 138	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Latin alphabet No. 5	ISO 2022 IR 148	ISO 2022	ESC 02/13 04/13	ISO-IR 148	96	G1	Supplementary set of ISO 8859
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646
Japanese	ISO 2022 IR 13	ISO 2022	ESC 02/09 04/09	ISO-IR 13	94	G1	JIS X 0201: Katakana
		ISO 2022	ESC 02/08 04/10	ISO-IR 14	94	G0	JIS X 0201: Romaji
Thai	ISO 2022 IR 166	ISO 2022	ESC 02/13 05/04	ISO-IR 166	88	G1	TIS 620-2533 (1990)
		ISO 2022	ESC 02/08 04/02	ISO-IR 6	94	G0	ISO 646

Note

If the Attribute Specific Character Set (0008,0005) has more than one value and value 1 is empty, it is assumed that value 1 is ISO 2022 IR 6.

Table C.12-4. Defined Terms for Multi-Byte Character Sets with Code Extensions

Character Set Description	Defined Term	Standard for Code Extension	ESC Sequence	ISO Registration Number	Number of Characters	Code Element	Character Set
Japanese	ISO 2022 IR 87	ISO 2022	ESC 02/04 04/02	ISO-IR 87	942	G0	JIS X 0208:Kanji
	ISO 2022 IR 159	ISO 2022	ESC 02/04 02/08 04/04	ISO-IR 159	942	G0	JIS X 0212: Supplementary Kanji set

Character Set Description	Defined Term	Standard for Code Extension	ESC Sequence	ISO Registration Number	Number of Characters	Code Element	Character Set
Korean	ISO 2022 IR 149	ISO 2022	ESC 02/04 02/09 04/03	ISO-IR 149	942	G1	KS X 1001: Hangul and Hanja
Simplified Chinese	ISO 2022 IR 58	ISO 2022	ESC 02/04 02/09 04/01	ISO-IR 58	6,763	G1	GB 2312-80 China Association for Standardization

There are multi-byte character sets that prohibit the use of Code Extension Techniques. The following multi-byte character sets prohibit the use of Code Extension Techniques:

- The Unicode character set used in [ISO/IEC 10646], when encoded in UTF
- The [GB 18030] character set, when encoded per the rules of [GB 18030]
- The [GBK] character set encoded per the rules of [GBK]

These character sets may only be specified as value 1 in the Specific Character Set (0008,0005) Attribute and there shall only be one value. The minimal length UTF-8 encoding shall always be used for [ISO/IEC 10646].

Note

1. [ISO/IEC 10646] now prohibits the use of anything but the minimum length encoding for UTF-8. UTF-8 permits multiple different encodings, but when used to encode Unicode characters in accordance with ISO 10646-1 and 10646-2 (with extensions) only the minimal encodings are legal.
2. The representation for the characters in the DICOM Default Character Repertoire is the same single byte value for the Default Character Repertoire, [ISO/IEC 10646] in UTF-8, [GB 18030] and [GBK]. It is also the 7-bit US-ASCII encoding.
3. The [GBK] character set is a subset of the [GB 18030] character set, which is restricted in its one- and two-byte code points. In this subset, the [GBK] character set follows the exactly same encoding rules of [GB 18030].

Table C.12-5. Defined Terms for Multi-Byte Character Sets Without Code Extensions

Character Set Description	Defined Term
Unicode in UTF-8	ISO_IR 192
GB18030	GB18030
GBK	GBK

C.12.1.1.3 Digital Signatures Macro

This Macro allows Digital Signatures to be included in a DICOM Data Set for the purpose of insuring the integrity of the Data Set, and to authenticate the sources of the Data Set. Table C.12-6 defines the Attributes needed to embed a Digital Signature in a Data Set. This Macro may appear in individual Sequence Items as well as in the top level Data Set of the SOP Instance.

Note

1. Each Item of a Sequence of Items is a Data Set. Thus, individual Sequence Items may incorporate their own Digital Signatures in addition to any Digital Signatures added to the Data Set in which the Sequence appears.
2. The inclusion of this Macro in Sequence Items, other than as specified in this Part of the Standard, may be specified in an application-defined Standard Extended SOP Class or Private SOP Class (see PS3.2).

Table C.12-6. Digital Signatures Macro Attributes

Attribute Name	Tag	Type	Attribute Description
MAC Parameters Sequence	(4FFE,0001)	3	A Sequence of Items that describe the parameters used to calculate a MAC for use in Digital Signatures. One or more Items shall be included in this Sequence.
>MAC ID Number	(0400,0005)	1	A number, unique within this SOP Instance, used to identify this MAC Parameters Sequence (4FFE,0001) Item from an Item of the Digital Signatures Sequence (FFFA,FFFA).
>MAC Calculation Transfer Syntax UID	(0400,0010)	1	The Transfer Syntax UID used to encode the values of the Data Elements included in the MAC calculation. Only Transfer Syntaxes that explicitly include the VR and use Little Endian encoding shall be used. Note Certain Transfer Syntaxes, particularly those that are used with compressed data, allow the fragmentation of the pixel data to change. If such fragmentation changes, Digital Signatures generated with such Transfer Syntaxes could become invalid.
>MAC Algorithm	(0400,0015)	1	The algorithm used in generating the MAC to be encrypted to form the Digital Signature. Defined Terms: **RIPEMD160** **MD5** **SHA1** **SHA256** **SHA384** **SHA512** Note Digital Signature Security Profiles (see PS3.15) may require the use of a restricted subset of these terms.
>Data Elements Signed	(0400,0020)	1	A list of Data Element Tags in the order they appear in the Data Set that identify the Data Elements used in creating the MAC for the Digital Signature. See Section C.12.1.1.3.1.1.
Digital Signatures Sequence	(FFFA,FFFA)	3	Sequence holding Digital Signatures. One or more Items are permitted in this Sequence.
>MAC ID Number	(0400,0005)	1	A number used to identify which MAC Parameters Sequence Item was used in the calculation of this Digital Signature.
>Digital Signature UID	(0400,0100)	1	A UID that can be used to uniquely reference this signature.
>Digital Signature DateTime	(0400,0105)	1	The date and time the Digital Signature was created. The time shall include an offset (i.e., time zone indication) from Coordinated Universal Time. Note This is not a certified timestamp, and hence is not completely verifiable. An application can compare this date and time with those of other signatures and the validity date of the certificate to gain confidence in the veracity of this date and time.

Attribute Name	Tag	Type	Attribute Description
>Certificate Type	(0400,0110)	1	The type of certificate used in (0400,0115). Defined Terms: **X509_1993_SIG** Note Digital Signature Security Profiles (see PS3.15) may require the use of a restricted subset of these terms.
>Certificate of Signer	(0400,0115)	1	A certificate that holds the identity of the entity producing this Digital Signature, that entity's public key or key identifier, and the algorithm and associated parameters with which that public key is to be used. Algorithms allowed are specified in Digital Signature Security Profiles (see PS3.15). Note 1. As technology advances, additional encryption algorithms may be allowed in future versions. Implementations should take this possibility into account. 2. When symmetric encryption is used, the certificate merely identifies which key was used by which entity, but not the actual key itself. Some other means (e.g., a trusted third party) must be used to obtain the key.
>Signature	(0400,0120)	1	The MAC generated as described in Section C.12.1.1.3.1.1 and encrypted using the algorithm, parameters, and private key associated with the Certificate of the Signer (0400,0115). See Section C.12.1.1.3.1.2.
>Certified Timestamp Type	(0400,0305)	1C	The type of certified timestamp used in Certified Timestamp (0400,0310). Required if Certified Timestamp (0400,0310) is present. Defined Terms: **CMS_TSP** Internet X.509 Public Key Infrastructure Time Stamp Protocol Note Digital Signature Security Profiles (see PS3.15) may require the use of a restricted subset of these terms.
>Certified Timestamp	(0400,0310)	3	A certified timestamp of the Digital Signature (0400,0120) Attribute Value, which shall be obtained when the Digital Signature is created. See Section C.12.1.1.3.1.3.
>Digital Signature Purpose Code Sequence	(0400,0401)	3	The purpose of this Digital Signature. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7007 “Signature Purpose”.*

C.12.1.1.3.1 Digital Signature Attribute Descriptions

C.12.1.1.3.1.1 Data Elements Signed

The Data Elements Signed Attribute shall list the Tags of the Data Elements that are included in the MAC calculation. The Tags listed shall reference Data Elements at the same level as the Mac Parameters Sequence (4FFE,0001) Data Element in which the Data Elements Signed Attribute appears. Tags included in Data Elements Signed shall be listed in the order in which they appear within the Data Set.

The following Data Elements shall not be included either implicitly or explicitly in the list of Tags in Data Elements Signed, nor included as part of the MAC calculation:

- The Length to End (0008,0001) or any Tag with an element number of 0000 (i.e., no Data Set or group lengths may be included in MAC calculations)
- Tags with a group number less than 0008
- Tags associated with Data Elements whose VR is UN
- Tags of Data Elements whose VR is SQ, where any Data Element within that Sequence of Items has a VR of UN recursively
- Tags with a group number of FFFA (e.g., the Digital Signatures Sequence)
- MAC Parameters Sequence (4FFE,0001)
- Data Set Trailing Padding (FFFC,FFFC)
- Item Delimitation Item (FFFE,E00D)

Note

1. The Length to End and group lengths can change if non-signed Data Elements change, so it is not appropriate to include them in the MAC calculation.
2. Since the Data Element Tags that identify a Sequence and the start of each Item are included in the MAC calculation, there is no need to include the Item Delimitation Item Tags.

If any of the Data Element Tags in the list refer to a Sequence of Items, then the Tags of all Data Elements within all Items of that Sequence shall be implicitly included in the list of Data Elements Signed, except those disallowed above. This implicit list shall also include the Item Tag (FFFE,E000) Data Elements that separate the Sequence Items and the Sequence Delimitation Item (FFFE,E0DD).

Note

It is possible to sign individual Items within a Sequence by including the Digital Signatures Macro in that Sequence Item. In fact, this is a highly desirable feature, particular when used in the context of reports. The Digital Signatures Macro is applied at the Data Set level, and Sequences of Items are merely Data Sets embedded within a larger Data Set. Essentially, the Digital Signature Macro may be applied recursively.

An example of nesting Digital Signatures within Data Elements is illustrated in Figure C.12-1.

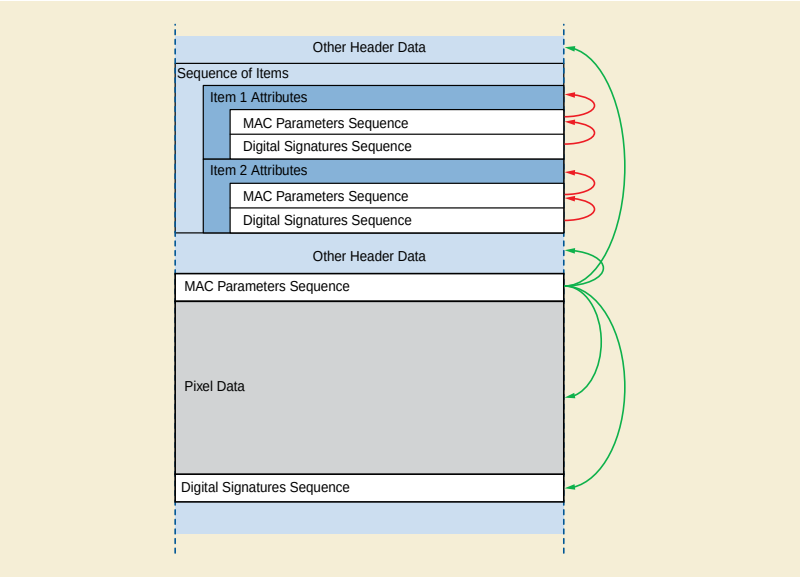


Figure C.12-1. Example of Nesting Digital Signatures (Informative)

In this example, there is main signature covering the pixel data and a few other Data Elements, plus two individually signed Items within a Sequence.

For Data Elements with a VR OB (e. g. pixel data) that have an undefined length (i.e., the data is encapsulated as described in PS3.5), the Item Data Element Tags that separate the fragments shall implicitly be included in the list of Data Elements Signed (i.e., a Data Element with a VR of OB is encoded in the same fashion as a Sequence of Items).

C.12.1.1.3.1.2 Signature

To generate the MAC, Data Elements referenced either explicitly or implicitly by the Tags in the Data Elements Signed list shall be encoded using the Transfer Syntax identified by the MAC Calculation Transfer Syntax UID (0400,0010) of the MAC Parameters Sequence Item where the Data Elements Signed Attribute appears. Data shall be formed into a byte stream and presented to the MAC Algorithm for computation of the MAC according to the following rules:

For all Data Elements except those with a VR of SQ or with a VR of OB with an undefined length, all Data Element fields, including the Tag, the VR, the reserved field (if any), the Value Length, and the Value, shall be placed into the byte stream in the order encountered.

For Data Elements with a VR of SQ or with a VR of OB with an undefined length, the Tag, the VR, and the reserved field are placed into the byte stream. The Value Length shall not be included. This is followed by each Item Tag in the order encountered, without including the Value Length, followed by the contents of the Value for that Item. In the case of an Item within a Data Element whose VR is SQ, these rules are applied recursively to all of the Data Elements within the Value of that Item. After all the Items have been incorporate into the byte stream, a Sequence Delimitation Item Tag (FFFE,E0DD) shall be added to the byte stream presented to the MAC Algorithm, regardless of whether or not it was originally present.

Note

Since the Value Length of Data Elements with a VR of SQ can be either explicit or undefined, the Value Lengths of such Data Elements are left out of the MAC calculation. Similarly, the Value Length of Data Elements with a VR of OB with an undefined length are also left out so that they are handled consistently. If such Data Elements do come with undefined lengths, including the Item Tags that separate the Items or fragments insures that Data Elements cannot be moved between Items or Fragments without compromising the Digital Signature. For those Data Elements with explicit lengths, if the length of an Item changes, the added or removed portions would also impact the MAC calculation, so it is not necessary to include explicit lengths in the MAC calculation. It is possible that including the Value Lengths could make cryptanalysis easier.

After the fields of all the Data Elements in the Data Elements Signed list have been placed into the byte stream presented to the MAC Algorithm according to the above rules, all of the Data Elements within the Digital Signatures Sequence Item except the Certificate

of Signer (0400,0115), Signature (0400,0120), Certified Timestamp Type (0400,0305), and Certified Timestamp (0400,0310) shall also be encoded according to the above rules, and presented to the MAC algorithm (i.e., the Attributes of the Digital Signature Sequence Item for this particular Digital Signature are also implicitly included in the list of Data Elements Signed, except as noted above).

The resulting MAC code after processing this byte stream by the MAC Algorithm is then encrypted as specified in the Certificate of Signer and placed in the Value of the Signature Data Element.

Note

1. The Transfer Syntax used in the MAC calculation may differ from the Transfer Syntax used to exchange the Data Set.
2. Digital Signatures require explicit VR in order to calculate the MAC. An Application Entity that receives a Data Set with an implicit VR Transfer Syntax may not be able to verify Digital Signatures that include Private Data Elements or Data Elements unknown to that Application Entity. This also true of any Data Elements whose VR is UN. Without knowledge of the Value Representation, the receiving Application Entity would be unable to perform proper byte swapping or be able to properly parse Sequences in order to generate a MAC.
3. If more than one entity signs, each Digital Signature would appear in its own Digital Signatures Sequence Item. The Digital Signatures may or may not share the same MAC Parameters Sequence Item.
4. The notion of a notary public (i.e., someone who verifies the identity of the signer) for Digital Signatures is partially filled by the authority that issued the Certificate of Signer.

C.12.1.1.3.1.3 Certified Timestamp

To generate a certified timestamp, the Value of the Signature (0400,0120) Attribute is transmitted to a third party, as specified by the protocol referred to by the Certified Timestamp Type (0400,0305) Attribute. The third party then generates and returns a certified timestamp in the form specified by that protocol. The certified timestamp returned by the third party is encoded as a stream of bytes in the Certified Timestamp Attribute.

Note

The timestamp protocol may be specified by a Profile in PS3.15.

C.12.1.1.4 Encrypted Attribute Descriptions

C.12.1.1.4.1 Encrypted Attributes Sequence

Each Item of the Encrypted Attributes Sequence (0400,0500) contains an encrypted DICOM Data Set containing a single instance of the Encrypted Attributes Data Set (Table C.12-7). It also contains encrypted content-encryption keys for one or more recipients. The encoding is based on the Enveloped-data Content Type of the Cryptographic Message Syntax defined in RFC 2630. It allows to encrypt the embedded Data Set for an arbitrary number of recipients using any of the three key management techniques supported by RFC 2630:

- Key Transport: the content-encryption key is encrypted in the recipient's public key;
- Key Agreement: the recipient's public key and the sender's private key are used to generate a pairwise symmetric key, then the content-encryption key is encrypted in the pairwise symmetric key; and
- Symmetric key-encryption Keys: the content-encryption key is encrypted in a previously distributed symmetric key-encryption key.

A recipient decodes the embedded Encrypted Attributes Data Set by decrypting one of the encrypted content-encryption keys, decrypting the encrypted Data Set with the recovered content-encryption key, and then decoding the DICOM Data Set using the Transfer Syntax specified in Encrypted Content Transfer Syntax UID (0400,0510).

Multiple Items may be present in the Encrypted Attributes Sequence. The different Items may contain Encrypted Attributes Data Sets with the same or different sets of Attributes and may contain encrypted content-encryption keys for the same or different sets of recipients. However, if the same Attribute is contained in more than one embedded Encrypted Attributes Data Set, the value of the Attribute must be identical in all embedded Encrypted Attributes Data Sets in which the Attribute is contained.

Note

If the Encrypted Attributes Sequence contains more than one Item, and a recipient holds the key for more than one of the Items, the recipient may either decode any single one or more of the embedded Data Sets at its own discretion. Since the same Attribute is required to have the same value in all embedded Encrypted Attributes Data Sets, it is safe to "overlay" multiple embedded Encrypted Attributes Data Sets in an arbitrary order upon decoding.

C.12.1.1.4.2 Encrypted Content

Encrypted Content (0400,0520) contains an Enveloped-data content type of the cryptographic message syntax defined in RFC 2630. The encrypted content of the Enveloped-data content type is an instance of the Encrypted Attributes Data Set as shown in Table C.12-7 (i.e., it is a Sequence with a single Item), encoded with the Transfer Syntax specified by the Encrypted Content Transfer Syntax UID (0400,0510) Attribute. Figure C.12-2 shows an example of how the Encrypted Content is encoded. The exact use of this Data Set is defined in the Attribute Confidentiality Profiles in PS3.15.

Since the de-identified SOP Instance is a significantly altered version of the original Data Set, it is a new SOP Instance, with a SOP Instance UID that differs from the original Data Set.

Note

1. Content encryption may require that the content (the DICOM Data Set) be padded to a multiple of some block size. This shall be performed according to the Content-encryption Process defined in RFC-2630.
2. Any Standard or Private Transfer Syntax may be specified in Encrypted Content Transfer Syntax UID (0400,0510) unless encoding is performed in accordance with an Attribute Confidentiality Profile that specifies additional restrictions. In general, an application entity decoding the Encrypted Attributes Sequence may not assume any particular Transfer Syntax or set of Transfer Syntaxes to be used with Encrypted Content Transfer Syntax UID (0400,0510).
3. For certain applications it might be necessary to "blacken" (remove) identifying information that is burned in to the image pixel data. The Encrypted Attributes Data Set does not specify a means of restoring the original image information without the complete image pixel data being encoded inside the Modified Attributes Sequence (0400,0550). If access to the original, unmodified pixel data is required and the image pixel data cannot be replicated inside the Modified Attributes Sequence (0400,0550) due to resource considerations, the SOP Instance UID may be used to locate the original SOP Instance from which the de-identified version was derived.
4. There is no guarantee that the original SOP Instance can be reconstructed from the data in Encrypted Content. If access to the original data is required, the (de-encrypted) UIDs may be used to locate the original SOP Instance from which the de-identified version was derived.

Table C.12-7. Encrypted Attributes Data Set Attributes

Attribute Name	Tag	Type	Attribute Description
Modified Attributes Sequence	(0400,0550)	1	Sequence of Items containing all Attributes that were removed or replaced by "dummy values" in the top level Data Set during de-identification of the SOP Instance. Upon reversal of the de-identification process, the Attributes are copied back into the top level Data Set, replacing any dummy values that might have been created. Only a single Item shall be included in this Sequence.
> Any Attribute from the top level Data Set that was modified or removed during the de-identification process.		3	

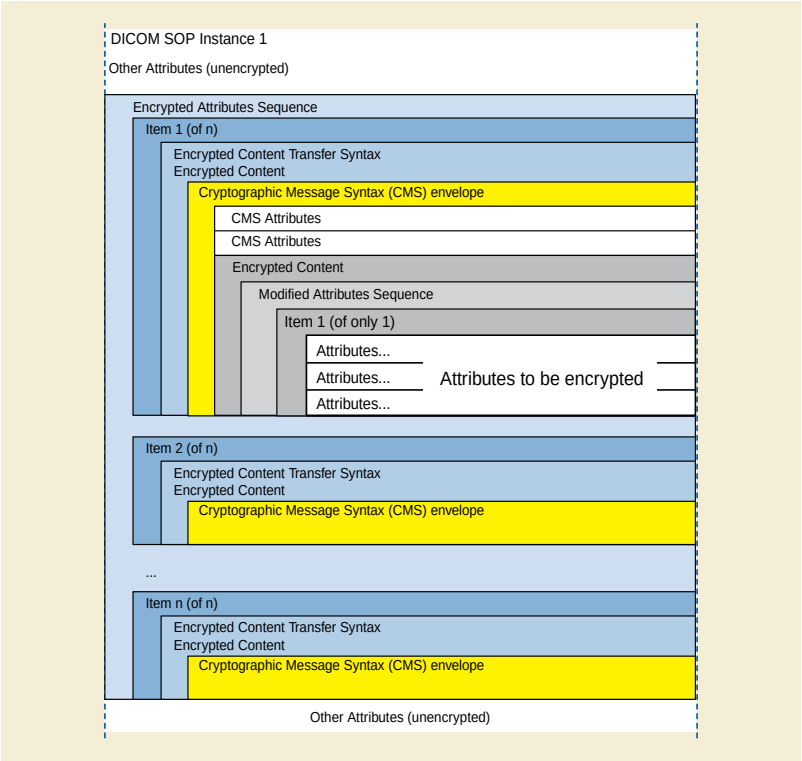


Figure C.12-2. Example of Encoding of Encrypted Attributes Data Set (Informative)

C.12.1.1.5 Contributing Equipment Sequence

Contributing Equipment Sequence (0018,A001) allows equipment that has contributed towards the creation of the Composite Instance to be described. The general class of contribution is denoted via a coded entry within the Purpose of Reference Code Sequence (0040,A170).

Note

1. For example, a post-processing application creating DERIVED images from ORIGINAL images would place its own identification within the General Equipment Module and identify the original acquisition equipment as an Item within the Contributing Equipment Sequence (0018,A001). Here, the value of Purpose of Reference Code Sequence (0040,A170) within the Item would be (109101, DCM, "Acquisition Equipment"). Image display applications wishing to annotate images with information related to the acquisition environment would prefer to extract such details from the Contributing Equipment Sequence rather than the General Equipment Module.

2. For example, an image fusion application would place its own identification within the General Equipment Module and identify each of the original acquisition equipment as separate Items within the Contributing Equipment Sequence (0018,A001). Here, the value of Purpose of Reference Code Sequence (0040,A170) within each Item would be (109101, DCM, "Acquisition Equipment").

3. For example, a post-processing application creating DERIVED images from other DERIVED images would place its own identification within the General Equipment Module and add the source equipment as an additional Item within the Contributing Equipment Sequence (0018,A001). Here, the value of Purpose of Reference Code Sequence (0040,A170) within the Item would be (109102, DCM, "Processing Equipment").

4. For example, a gateway device that coerces Attributes of existing Composite Instances (without creating new Composite Instances) would retain information about the creating equipment within the General Equipment Module and provide its own identification as an Item within the Contributing Equipment Sequence (0018,A001). Here, the value of Purpose of Reference Code Sequence (0040,A170) within the Item would be (109103, DCM, "Modifying Equipment").

5. For example, equipment that has been used for de-identifying could retain information about the creating equipment within the General Equipment Module and provide its own identification, and that of its operator, as an Item within Contributing Equipment Sequence (0018,A001). Here, the value of Purpose of Reference Code Sequence (0040,A170) within the Item would be (109104, DCM, "De-identifying Equipment").

C.12.1.1.6 HL7 Structured Document Reference Sequence

The HL7 Structured Document Reference Sequence (0040,A390) identifies instances of Structured Documents defined under an HL7 standard. The HL7 standards that define such documents include the Clinical Document Architecture (CDA) and Structured Product Labeling (SPL) standards.

References to unencapsulated HL7 Structured Documents from within DICOM SOP Instances shall be encoded with a SOP Class UID and SOP Instance UID pair. The Abstract Syntax of an HL7 Structured Document is defined by its Hierarchical Message Description; the Object Identifier of the Hierarchical Message Description shall be used as the SOP Class UID for the Structured Document reference.

Note

1. The Hierarchical Message Description Object Identifiers are specified in the HL7 OID Registry (http://hl7.org/oid). The HL7 OIDs for these types of documents are: CDA Release 1 2.16.840.1.113883.1.7.1 CDA Release 2 2.16.840.1.113883.1.7.2 SPL Release 1 2.16.840.1.113883.1.7.3

2. The Hierarchical Message Description Object Identifiers do not imply a network or media storage service, as do SOP Class UIDs. However, they do identify the Abstract Syntax, similar to SOP Class UIDs.

The HL7 Structured Document instances are natively identified by an Attribute using the Instance Identifier (II) Data Type, as defined in HL7 v3 Data Types - Abstract Specification. A UID as defined by the DICOM UI Value Representation is a valid identifier under the II Data Type; however, an II value is not always encodable as a UID. Therefore a UID shall be constructed for use within the DICOM Data Set that can be mapped to the native instance identifier encoded as an HL7 II Data Type. This mapping is performed through the combination of the local Referenced SOP Instance UID (0008,1155) and the HL7 Instance Identifier (0040,E001) Attributes in the HL7 Structured Document Reference Sequence (0040,A390).

Note

1. An HL7 II is not encodable as a UID if it exceeds 64 characters, or if it includes an extension. See HL7 v3 DT R1.

2. Even though an II may contain just a UID, applications should take care to use the II specified in HL7 Instance Identifier (0040,E001) to access the Structured Document. If the instance identifier used natively within the referenced document is encodable using the UI VR, i.e., it is an ISO 8824 OID up to 64 characters without an extension, it is recommended to be used as the Referenced SOP Instance UID within the current Instance.

3. The Referenced SOP Instance UID used to reference a particular HL7 Structured Document is not necessarily the same in all DICOM Instances. For example, two SR Documents may *internally* use different SOP Instance UIDs to reference the same HL7 Structured Document, but they will each contain a mapping to the same HL7 Instance Identifier as the *external* identifier.

4. The HL7 Instance Identifier is encoded in Attribute HL7 Instance Identifier (0040,E001) as a serialization of the UID and Extension (if any) separated by a caret character. This is the same format adopted in the IHE Cross-Enterprise Document Sharing (XDS) profile (see http://www.ihe.net/).

5. See Figure C.12-3.

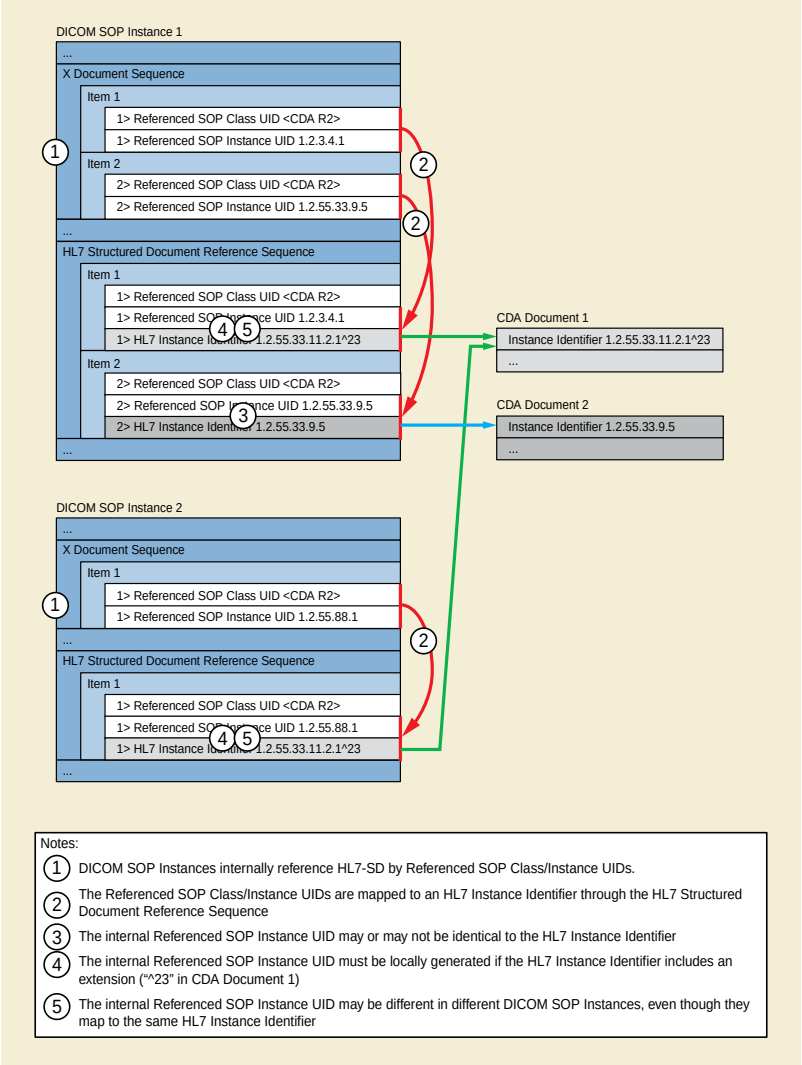


Figure C.12-3. HL7 Structured Document References

C.12.1.1.7 Private Data Element Characteristics

The creator of the Private Data Elements (identified by the value of Private Creator Reference (0008,0302)) is responsible for managing the Private Data Element Tags associated with them and ensuring that the Private Data Element (0008,0308) and the Private Data Element Keyword (0008,030D) are a unique pair, and that the other associated details in the Data Element Definition Macro are consistent.

Implementers are encouraged to describe all Private Data Elements in the Private Data Element Characteristics Sequence (0008,0300).

Note

The Private Data Element Characteristics Sequence (0008,0300) may describe Data Elements that are referenced in the current SOP Instance (for example they may be identified as a Selector Attribute), but do not exist as actual Data Elements in the current SOP Instance.

C.12.1.1.7.1 Private Data Element Value Multiplicity

For Data Elements with a fixed multiplicity, this Attribute shall contain a single integer value, e.g., 3.

For Data Elements with a variable multiplicity, this Attribute contains either two or three values. The first value is the minimum multiplicity, the second value is the maximum multiplicity. If the maximum multiplicity is open-ended, 0 is used. The third value, if present, is the "stride", i.e., the increment between valid multiplicity values. A stride is used when values are added in sets, such as an x/y/z set of coordinate values that is recorded in ~~triplets.If~~triplets. If the stride is 1, the third value may be omitted. The stride is not permitted to be 0.

Examples:

- VM of 1-3 is expressed as 1,3 or 1,3,1 meaning the multiplicity is permitted to be 1, 2 or 3
- VM of 1-n is expressed as 1,0 or 1,0,1
- VM of 0-n is expressed as 0,0 or 0,0,1
- VM of 3-3n is expressed as 3,0,3

For a Private Data Element Value Representation (0008,030A) of SQ, the multiplicity shall be 1 and the allowed number of Items in a Sequence is recorded in Private Data Element Number of Items(0008,030B).

C.12.1.1.7.2 Private Data Element Number of Items

For Sequences that permit a fixed number of Items, this Attribute shall contain a single integer value, e.g., 3.

For Sequences with a variable number of Items, this Attribute contains two values. The first value is the minimum number of Items, the second value is the maximum number of Items. If the maximum number of Items is open-ended, 0 is used.

C.12.1.1.8 Timezone Offset From UTC

Encoded as an ASCII string in the format "&ZZXX". The components of this string, from left to right, are & = "+" or "-", and ZZ = Hours and XX = Minutes of offset. Leading space characters shall not be present.

The offset for UTC shall be +0000; -0000 shall not be used.

Note

1. This encoding is the same as described in PS3.5 for the offset component of the DT Value Representation.
2. This Attribute does not apply to values with a DT Value Representation, that contains an explicitly encoded timezone offset.
3. The corrected time may cross a 24 hour boundary. For example, if Local Time = 1.00 a.m. and Offset = +0200, then UTC = 11.00 p.m. (23.00) the day before.
4. The "+" sign may not be omitted.

Time earlier than UTC is expressed as a negative offset.

Note

For example:

UTC = 5.00 a.m.

Local Time = 3.00 a.m.

Offset = -0200

C.12.1.1.9 Original Attributes Sequence

Every transfer of a SOP Instance may result in data element coercion (see Section B.4.1.3 “Coercion of Attributes” in PS3.4) by the receiving application. The receiving application may also detect and correct or remove errors in SOP Instances to bring them into conformance with the SOP Class definition without changing the SOP Instance UID or creating a derived Instance (see status Warning in Section 9.1.1.1.9 “Status” in PS3.4 and Section B.2.3 “Statuses” in PS3.4. When performing such actions, the application

may add an Item to the Original Attributes Sequence (0400,0561) describing the change and the prior values of coerced, modified, or removed Attributes. Any existing Items in the Original Attributes Sequence shall be preserved.

C.12.1.1.9.1 Modified Attributes Sequence

Attributes that were modified or removed shall be placed in the Modified Attributes Sequence (0400,0550) with their prior values. If an Attribute within a Sequence was modified or removed, the entire prior value of the Sequence shall be placed in the Modified Attributes Sequence; this applies recursively up to the enclosing Sequence Attribute in the top level Data Set.

Attributes that were empty or absent and for which values have been added may be present in the Modified Attributes Sequence with a zero length value.

If an Attribute was modified or removed because its value was nonconforming to its Value Representation or Value Multiplicity, it shall be included in the Modified Attributes Sequence with a zero length value.

Any Private Data Elements present in the Item shall be accompanied by their respective Private Data Element Creator Attribute.

C.12.1.1.9.2 Nonconforming Modified Attributes Sequence

If an Attribute was modified or removed because its value was nonconforming to its Value Representation or Value Multiplicity, the original value (which was replaced by a zero length value in the Modified Attributes Sequence) may be recorded in the Nonconforming Modified Attributes Sequence (0400,0551).

The nonconforming Attribute is identified by the attributes of the Selector Attribute Macro. Because a single Attribute is being identified, Selector Attribute (0072,0026) shall be present.

The Data Set to which the Selector Attribute Macro applies is the single Item of the Modified Attributes Sequence (0400,0550) within the same Item of the Original Attributes Sequence (0400,0561). Therefore, the Modified Attributes Sequence (0400,0550) is not identified in the Selector Sequence Pointer (0072,0052).

Note

1. This is effectively the same as a pointer to the equivalent attribute in the original top level Data Set.
2. Characters in text attributes non-conformant to the identified Specific Character Set (0008,0005) may be considered non-conformant to the VR.
3. For example, if Body Part Examined had a nonconforming value, the Modified Attributes Sequence Item would have the Attributes:

(0072,0026)	00180015	Selector Attribute
(0072,0028)	1	Selector Value Number
(0400,0552)	ABDOMEN&PELVIS	Nonconforming Data Element Value

4. The Nonconforming Data Element Value (0400,0552) has Value Representation OB, which allows an arbitrary byte string to be encoded.

C.12.2 Common Instance Reference Module

Table C.12-8 defines the Attributes that describe the hierarchical relationships of any SOP Instances referenced from other Modules within the Instance in which this Module occurs.

Table C.12-8. Common Instance Reference Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Series Sequence	(0008,1115)	1C	Sequence of Items each of which includes the Attributes of one Series. One or more Items shall be included in this Sequence. Required if this Instance references Instances in this Study.
>Series Instance UID	(0020,000E)	1	Unique identifier of the Series containing the referenced Instances.
>Referenced Instance Sequence	(0008,114A)	1	Sequence of Items each providing a reference to an Instance that is part of the Series defined by Series Instance UID (0020,000E) in the enclosing Item. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Studies Containing Other Referenced Instances Sequence	(0008,1200)	1C	Sequence of Items each identifying a Study other than the Study of which this Instance is a part, which Studies contain Instances that are referenced elsewhere in this Instance. One or more Items shall be included in this Sequence. Required if this Instance references Instances in other Studies.
>Study Instance UID	(0020,000D)	1	Unique identifier of the Study containing the referenced Instances.
>Include Table 10-4 “Series and Instance Reference Macro Attributes”			

C.12.3 Frame Extraction Module

Table C.12-9 defines the Attributes that describe the frames extracted if the SOP Instance was created in response to a Frame-Level retrieve request.

Table C.12-9. Frame Extraction Module Attributes

Attribute Name	Tag	Type	Attribute Description
Frame Extraction Sequence	(0008,1164)	1	Sequence containing details of how this SOP Instance was extracted from a source multi-frame SOP Instance. If this Instance was created from an Instance that contains a Frame Extraction Sequence, then this Sequence shall contain all of the Items from the parent's Frame Extraction Sequence and a new Item that describes this extraction. One or more Items shall be included in this Sequence.
>Multi-frame Source SOP Instance UID	(0008,1167)	1	SOP Instance from which the frames of this Instance are extracted.
>Simple Frame List	(0008,1161)	1C	A list of Frames that were extracted in the form of a simple list. Required if object extraction is based on a Frame Level Retrieve using the Simple Frame List (0008,1161) Attribute. See PS3.4 "Instance and Frame Level Retrieve SOP Classes"

Attribute Name	Tag	Type	Attribute Description
>Calculated Frame List	(0008,1162)	1C	A list of Frames that were extracted in the form of one or more triplets Required if object extraction is based on a Frame Level Retrieve using the Calculated Frame List (0008,1162) Attribute. See PS3.4 "Instance and Frame Level Retrieve SOP Classes"
>Time Range	(0008,1163)	1C	The start and end times of the frames that were extracted. Required if object extraction is based on a Frame Level Retrieve using Time Range (0008,1163). See PS3.4 "Instance and Frame Level Retrieve SOP Classes"

C.12.4 General Reference Module

Table C.12-10 specifies the Attributes that reference source and other related Instances and describe the manner of derivation.

Table C.12-10. General Reference Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Image Sequence	(0008,1140)	3	Other images significantly related to this image (e.g., post-localizer CT image or Mammographic biopsy or partial view images). One or more Items are permitted in this Sequence.
>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7201 “Referenced Image Purposes of Reference”.*
Referenced Instance Sequence	(0008,114A)	3	Non-image composite SOP Instances that are significantly related to this Image, including waveforms that may or may not be temporally synchronized with this image. One or more Items are permitted in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the Instance(s). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7004 “Waveform Purposes of Reference” for referenced waveforms.* *DCID 7022 “Radiotherapy Purposes of Reference” for referenced RT Instances.*
Derivation Description	(0008,2111)	3	A text description of how this image was derived. See Section C.12.4.1.1 for further explanation.
Derivation Code Sequence	(0008,9215)	3	A coded description of how this image was derived. See Section C.12.4.1.1 for further explanation. One or more Items are permitted in this Sequence. More than one Item indicates that successive derivation steps have been applied.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7203 “Image Derivation”.*

Attribute Name	Tag	Type	Attribute Description
Source Image Sequence	(0008,2112)	3	The set of Image SOP Class/Instance pairs of the Images that were used to derive this Image. One or more Items are permitted in this Sequence. See Section C.12.4.1.2 for further explanation.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made, that is what role the source image or frame(s) played in the derivation of this image. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7202 "Source Image Purposes of Reference".*
>Spatial Locations Preserved	(0028,135A)	3	The extent to which the spatial locations of all pixels are preserved during the processing of the source image that resulted in the current image Enumerated Values: **YES** **NO** **REORIENTED_ONLY** A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees Note 1. This applies not only to images with a known relationship to a 3D space, but also to projection images. For example, a projection radiograph such as a mammogram that is processed by a point image processing operation such as contrast enhancement, or a smoothing or edge enhancing convolution, would have a value of YES for this Attribute. A projection radiograph that had been magnified or warped geometrically would have a value of NO for this Attribute. A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees, such that transformation of pixel locations is possible by comparison of the values of Patient Orientation (0020,0020) would have a value of REORIENTED_ONLY. This Attribute is typically of importance in relating images with Presentation Intent Type (0008,0068) values of FOR PROCESSING and FOR PRESENTATION. 2. When the value of this Attribute is NO, it is not possible to locate on the current image any pixel coordinates that are referenced relative to the source image, such as for example, might be required for rendering CAD findings derived from a referenced FOR PROCESSING image on the current FOR PRESENTATION image.

Attribute Name	Tag	Type	Attribute Description
>Patient Orientation	(0020,0020)	1C	The Patient Orientation values of the source image. Required if the value of Spatial Locations Preserved (0028,135A) is REORIENTED_ONLY.
Source Instance Sequence	(0042,0013)	3	The set of non-image composite SOP Instances that were used to derive this Instance. One or more Items are permitted in this Sequence. See Section C.12.4.1.2 for further explanation.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made, that is what role the source Instance(s) played in the derivation of this Instance. Only a single Item single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7013 "Non-Image Source Instance Purposes of Reference".*

C.12.4.1 General Reference Module Attributes

C.12.4.1.1 Derivation Description

If an Image is identified to be a Derived Image (see Section C.7.6.1.1.2 "Image Type"), Derivation Description (0008,2111) and Derivation Code Sequence (0008,9215) describe the way in which the image was derived. They may be used whether or not the Source Image Sequence (0008,2112) is provided. They may also be used in cases when the Derived Image pixel data is not significantly changed from one of the source images and the SOP Instance UID of the Derived Image is the same as the one used for the source image.

Note

1. Examples of Derived Images that would normally be expected to affect professional interpretation and would thus have a new UID include:

   a. images resulting from image processing of another image (e.g., unsharp masking),

   b. a multiplanar reformatted CT image,

   c. a DSA image derived by subtracting pixel values of one image from another.

   d. an image that has been decompressed after having been compressed with a lossy compression algorithm. To ensure that the user has the necessary information about the lossy compression, the approximate compression ratio may be included in Derivation Description (0008,2111).

   An example of a Derived Image that would normally not be expected to affect professional interpretation and thus would not require a new UID is an image that has been padded with additional rows and columns for more display purposes.

2. An image may be lossy compressed, e.g., for long term archive purposes, and its SOP Instance UID changed. PS3.4 provides a mechanism by which a query for the original Image Instance may return a reference to the UID of the lossy compressed version of the image using the Alternate Representation Sequence (0008,3001). This allows an application processing a SOP Instance that references the original image UID, e.g., a Structured Report, to obtain a reference to an accessible version of the image even if the original SOP Instance is no longer available.

C.12.4.1.2 Source Image Sequence

If an Image is identified to be a Derived Image (see Section C.7.6.1.1.2 "Image Type"), Source Image Sequence (0008,2112) is an optional list of source images used to create the Derived image. Source Instance Sequence (0042,0013) is an optional list of non-image source Instances that were used to create this Instance. Source Image Sequence (0008,2112) and/or Source Instance Sequence (0042,0013) may be used whether or not there is a description of the way the Instance was derived in Derivation Description (0008,2111) or Derivation Code Sequence (0008,9215).

Images shall not be referenced by Source Instance Sequence (0042,0013).

Note

Multiple Items may be present within Source Image Sequence (0008,2112) and/or Source Instance Sequence (0042,0013), in which case either:

a. those Instance were combined to make the derived Instance (e.g., multiple source images to make an MPR or MIP), or

b. each of the Items represents a step in the successive derivation of an Instance (e.g., when an image has had successive lossy compression steps applied to it),

c. some combination of the above.

The Purpose of Reference Code Sequence (0040,A170) and the Attributes within the referenced Instances themselves may be used to determine the history of the derivation, which is not otherwise explicitly specified.

C.12.5 Timezone Module

Table C.12.5-1 defines the Attributes that are required for proper functioning and identification of the timezone within which an Instance was created.

Table C.12.5-1. Timezone Module Attributes

Attribute Name	Tag	Type	Attribute Description
Timezone Offset From UTC	(0008,0201)	1	Contains the offset from UTC to the timezone for all DA and TM Attributes present in this SOP Instance, and for all DT Attributes present in this SOP Instance that do not contain an explicitly encoded timezone offset. See Section C.12.1.1.8

C.13 Print Management Specific Modules

The following Sections specify Modules used for Print Management.

C.13.1 Basic Film Session Presentation Module

Table C.13-1. Basic Film Session Presentation Module Attributes

Attribute name	Tag	Attribute Description
Number of Copies	(2000,0010)	Number of copies to be printed for each film of the film session.
Print Priority	(2000,0020)	Specifies the priority of the print job. Enumerated Values: **HIGH** **MED** **LOW**
Medium Type	(2000,0030)	Type of medium on which the print job will be printed. Defined Terms: **PAPER** **CLEAR FILM** **BLUE FILM** **MAMMO CLEAR FILM** **MAMMO BLUE FILM**

Attribute name	Tag	Attribute Description
Film Destination	(2000,0040)	Film destination. Defined Terms: **MAGAZINE** the exposed film is stored in film magazine **PROCESSOR** the exposed film is developed in film processor **BIN_i** the exposed film is deposited in a sorter bin where "I" represents the bin number. Film sorter BINs shall be numbered sequentially starting from 1 and no maximum is placed on the number of BINs. The encoding of the BIN number shall not contain leading zeros.
Film Session Label	(2000,0050)	Human readable label that identifies the film session
Memory Allocation	(2000,0060)	Amount of memory allocated for the film session. Value is expressed in KB
Owner ID	(2100,0160)	Identification of the owner of the film session

C.13.2 Basic Film Session Relationship Module

Table C.13-2. Basic Film Session Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Referenced Film Box Sequence	(2000,0500)	A set of Film Boxes. Zero or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		

Note

Proposed Study Sequence (2130,00A0) was previously included in this Module but has been retired. See PS3.3-2004.

C.13.3 Basic Film Box Presentation Module

Table C.13-3. Basic Film Box Presentation Module Attributes

Attribute Name	Tag	Attribute Description
Image Display Format	(2010,0010)	Type of image display format. Enumerated Values: **STANDARD\C,R** film contains equal size rectangular image boxes with R rows of image boxes and C columns of image boxes; C and R are integers **ROW\R1,R2,R3, etc.** film contains rows with equal size rectangular image boxes with R1 image boxes in the first row, R2 image boxes in second row, R3 image boxes in third row, etc.; R1, R2, R3, etc. are integers **COL\C1,C2,C3, etc.** film contains columns with equal size rectangular image boxes with C1 image boxes in the first column, C2 image boxes in second column, C3 image boxes in third column, etc.; C1, C2, C3, etc. are integers **SLIDE** film contains 35mm slides; the number of slides for a particular film size is configuration dependent **SUPERSLIDE** film contains 40mm slides; the number of slides for a particular film size is configuration dependent **CUSTOM\i** film contains a customized ordering of rectangular image boxes; i identifies the image display format; the definition of the image display formats is defined in the Conformance Statement; i is an integer
Annotation Display Format ID	(2010,0030)	Identification of annotation display format. The definition of the annotation display formats and the annotation box position Sequence are defined in the Conformance Statement
Film Orientation	(2010,0040)	Film orientation. Enumerated Values: **PORTRAIT** vertical film position **LANDSCAPE** horizontal film position
Film Size ID	(2010,0050)	Film size identification. Defined Terms: **8INX10IN** **8_5INX11IN** **10INX12IN** **10INX14IN** **11INX14IN** **11INX17IN** **14INX14IN** **14INX17IN** **24CMX24CM** **24CMX30CM** **A4** **A3** Note 10INX14IN corresponds with 25.7CMX36.4CM, A4 corresponds with 210 x 297 millimeters, A3 corresponds with 297 x 420 millimeters

Attribute Name	Tag	Attribute Description
Magnification Type	(2010,0060)	Interpolation type by which the printer magnifies or decimates the image in order to fit the image in the image box on film. Defined Terms: **REPLICATE** **BILINEAR** **CUBIC** **NONE**
Smoothing Type	(2010,0080)	Further specifies the type of the interpolation function. Values are defined in Conformance Statement. Only valid for Magnification Type (2010,0060) = CUBIC
Border Density	(2010,0100)	Density of the film areas surrounding and between images on the film. Defined Terms: **BLACK** **WHITE** i where i represents the desired density in hundredths of OD (e.g., 150 corresponds with 1.5 OD)
Empty Image Density	(2010,0110)	Density of the image box area on the film that contains no image. Defined Terms: **BLACK** **WHITE** i where i represents the desired density in hundredths of OD (e.g., 150 corresponds with 1.5 OD)
Min Density	(2010,0120)	Minimum density of the images on the film, expressed in hundredths of OD. If Min Density is lower than minimum printer density than Min Density is set to minimum printer density.
Max Density	(2010,0130)	Maximum density of the images on the film, expressed in hundredths of OD. If Max Density is higher than maximum printer density than Max Density is set to maximum printer density.
Trim	(2010,0140)	Specifies whether a trim box shall be printed surrounding each image on the film. Enumerated Values: **YES** **NO**
Configuration Information	(2010,0150)	Character string that contains either the ID of the printer configuration table that contains a set of values for implementation specific print parameters (e.g., perception LUT related parameters) or one or more configuration data values, encoded as characters. If there are multiple configuration data values encoded in the string, they shall be separated by backslashes. The definition of values shall be contained in the SCP's Conformance Statement. Defined Terms: **CS000-CS999** Implementation specific curve type. Note It is recommended that for SCPs, CS000 represent the lowest contrast and CS999 the highest contrast levels available.
Illumination	(2010,015E)	Luminance of lightbox illuminating a piece of transmissive film, or for the case of reflective media, luminance obtainable from diffuse reflection of the illumination present. Expressed as L0, in candelas per square meter (cd/m^2).

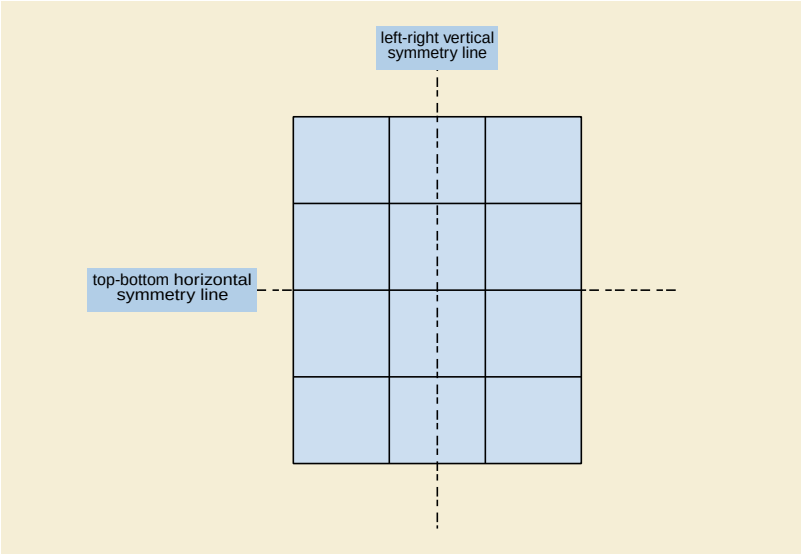
Attribute Name	Tag	Attribute Description
Reflected Ambient Light	(2010,0160)	For transmissive film, luminance contribution due to reflected ambient light. Expressed as La, in candelas per square meter (cd/m^2).
Requested Resolution ID	(2020,0050)	Specifies the resolution at which images in this Film Box are to be printed. Defined Terms: **STANDARD** Approximately 4k x 5k printable pixels on a 14 x 17 inch film **HIGH** Approximately twice the resolution of STANDARD.
ICC Profile	(0028,2000)	An ICC Profile encoding the transformation of device-dependent color stored pixel values into PCS-Values. See Section C.11.15. Note This is an Input Device Profile that describes the characteristics of the pixel data in the film box, not an Output Device Profile that might describe the characteristics of the Print SCP.

C.13.3.1 Image Display Format

C.13.3.1.1 Standard Image Display Format

The standard format subdivides a film into image boxes of equal size. Therefore, the film layout is fully symmetrical, i.e., the arrangement of image boxes on film is left-right and top-bottom symmetric.

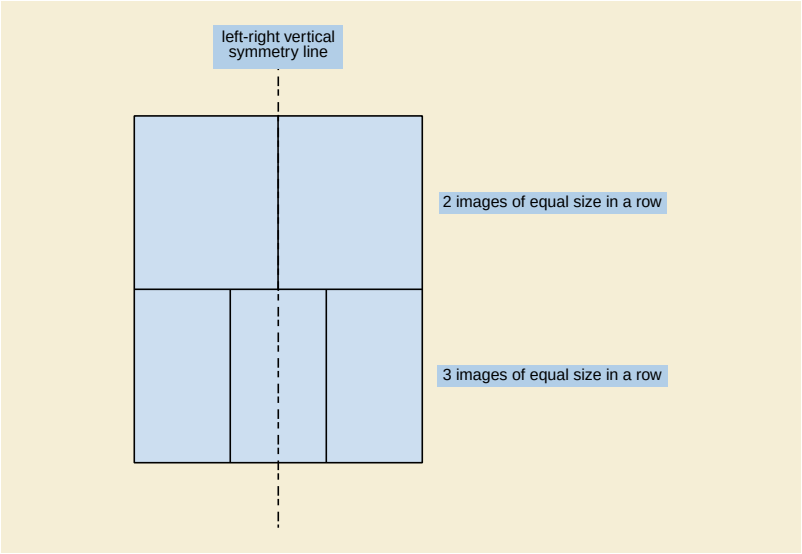
Example: STANDARD\3,4



C.13.3.1.2 Row Symmetric Image Display Format

The row symmetric image display format subdivides a film into rows of image boxes of equal size. As a result, the layout is left-right symmetric, the associated symmetry line is vertical (V). There is no top-bottom symmetry.

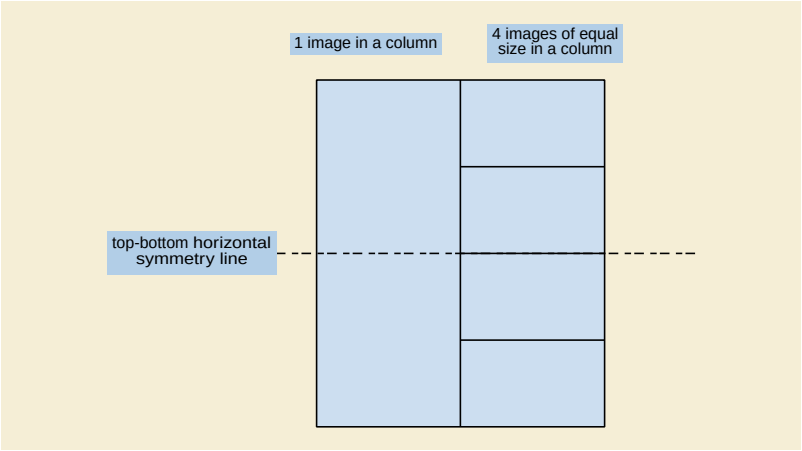
Example: ROW\2,3



C.13.3.1.3 Column Symmetric Image Display Format

The column symmetric image display format subdivides a film into columns of image boxes of equal size. As a result, the layout is top-button symmetric, the associated symmetry line is horizontal (H). There is no left-right symmetry.

Example: COL\1,4



C.13.4 Basic Film Box Relationship Module

Table C.13-4. Basic Film Box Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Referenced Film Session Sequence	(2010,0500)	A Film Session. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Image Box Sequence	(2010,0510)	A set of Image Boxes. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Basic Annotation Box Sequence	(2010,0520)	A set of Basic Annotation Boxes. Zero or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Presentation LUT Sequence	(2050,0500)	A Presentation LUT. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		

C.13.5 Image Box Pixel Presentation Module

Table C.13-5. Image Box Pixel Presentation Module Attributes

Attribute Name	Tag	Attribute Description
Image Box Position	(2020,0010)	The position of the image on the film, based on Image Display Format (2010,0010). See Section C.13.5.1 for specification.
Polarity	(2020,0020)	Specifies whether minimum pixel values (after VOI LUT transformation) are to printed black or white. Enumerated Values: **NORMAL** pixels shall be printed as specified by Photometric Interpretation (0028,0004) **REVERSE** pixels shall be printed with the opposite polarity as specified by Photometric Interpretation (0028,0004) If Polarity (2020,0020) is not specified by the SCU, the SCP shall print with NORMAL polarity.
Magnification Type	(2010,0060)	Description is the same as in Table C.13-3. Overrides the Magnification Type specified for the Film Box.
Smoothing Type	(2010,0080)	Description is the same as in Table C.13-3. Overrides the Smoothing Type specified for the Film Box.
Configuration Information	(2010,0150)	See Table C.13-3 for description of Configuration Information.
Requested Image Size	(2020,0030)	Width (x-dimension) in mm of the image to be printed. This value overrides the size that corresponds with optimal filling of the Image Box.

Attribute Name	Tag	Attribute Description
Requested Decimate/Crop Behavior	(2020,0040)	Specifies whether image pixels are to be decimated or cropped if the image rows or columns is greater than the available printable pixels in an Image Box. Decimation means that a magnification factor <1 is applied to the image. The method of decimation shall be that specified by Magnification Type (2010,0060) or the SCP default if not specified Cropping means that some image rows and/or columns are deleted before printing Enumerated Values: **DECIMATE** A magnification factor <1 to be applied to the image. **CROP** Some image rows and/or columns are to be deleted before printing. The specific algorithm for cropping shall be described in the SCP Conformance Statement. **FAIL** The SCP shall not crop or decimate
Basic Grayscale Image Sequence	(2020,0110)	A Sequence that provides the content of the grayscale image pixel data to be printed. This is a specialization of the Image Pixel Module defined in Section C.7.6.3. It is encoded as a Sequence of Attributes of the Image Pixel Module. Zero or one Item shall be included in this Sequence. See PS3.4 for further description.
>Samples Per Pixel	(0028,0002)	See Section C.7.6.3 for description. Enumerated Values: **1**
>Photometric Interpretation	(0028,0004)	See Section C.7.6.3 for description. Enumerated Values: **MONOCHROME1** **MONOCHROME2**
>Rows	(0028,0010)	See Section C.7.6.3 for description
>Columns	(0028,0011)	See Section C.7.6.3 for description
>Pixel Aspect Ratio	(0028,0034)	See Section C.7.6.3 for description
>Bits Allocated	(0028,0100)	See Section C.7.6.3 for description. Enumerated Values if Bits Stored = 8: **8** Enumerated Values if Bits Stored = 12: **16**
>Bits Stored	(0028,0101)	See Section C.7.6.3 for description. Enumerated Values: **8** **12**

Attribute Name	Tag	Attribute Description
>High Bit	(0028,0102)	See Section C.7.6.3 for description. Enumerated Values if Bits Stored = 8: **7** Enumerated Values if Bits Stored = 12: **11**
>Pixel Representation	(0028,0103)	See Section C.7.6.3 for description. Enumerated Values: **0** unsigned integer
>Pixel Data	(7FE0,0010)	See Section C.7.6.3 for description
Basic Color Image Sequence	(2020,0111)	A Sequence that provides the content of the color image pixel data to be printed. It is a specialization of the Image Pixel Module defined in Section C.7.6.3. It is encoded as a Sequence of Attributes of the Image Pixel Module. Zero or one Item shall be included in this Sequence. See PS3.4 for further description.
>Samples Per Pixel	(0028,0002)	See Section C.7.6.3 for description. Enumerated Values: **3**
>Photometric Interpretation	(0028,0004)	See Section C.7.6.3 for description. Enumerated Values: **RGB**
>Planar Configuration	(0028,0006)	See Section C.7.6.3 for description. Enumerated Values: **1** frame interleave
>Rows	(0028,0010)	See Section C.7.6.3 for description.
>Columns	(0028,0011)	See Section C.7.6.3 for description.
>Pixel Aspect Ratio	(0028,0034)	See Section C.7.6.3 for description.
>Bits Allocated	(0028,0100)	See Section C.7.6.3 for description. Enumerated Values: **8**
>Bits Stored	(0028,0101)	See Section C.7.6.3 for description. Enumerated Values: **8**
>High Bit	(0028,0102)	See Section C.7.6.3 for description. Enumerated Values: **7**

Attribute Name	Tag	Attribute Description
>Pixel Representation	(0028,0103)	See Section C.7.6.3 for description. Enumerated Values: **0000H** unsigned integer
>Pixel Data	(7FE0,0010)	See Section C.7.6.3 for description

Note

Referenced Image Overlay Box Sequence (2020,0130) and Original Image Sequence (2130,00C0) were previously included in this Module but have been retired. See PS3.3-2004.

C.13.5.1 Image Box Position

The position of the image on the film; the encoding of the image position sequence is based on the selected Image Display Format (2010,0010). The image position sequence shall be increasing order beginning with the value 1. Image Box Position (2020,0010) is defined as follows:

- STANDARD display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be equal to 1.
- ROW display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- COL display format: image box sequence shall be major column order (from top-to-bottom and from left-to-right); top left image position shall be equal to 1.
- SLIDE display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- SUPERSLIDE display format: image box sequence shall be major row order (from left-to-right and from top-to-bottom); top left image position shall be set to 1.
- CUSTOM STANDARD display format: image box sequence shall be defined in the Conformance Statement; top left image position shall be set to 1.

C.13.6 Image Box Relationship Module (Retired)

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

C.13.7 Basic Annotation Presentation Module

Table C.13-7. Basic Annotation Presentation Module Attributes

Attribute Name	Tag	Attribute Description
Annotation Position	(2030,0010)	The position of the annotation box in the parent film box. Annotation position sequence depends on the selected Annotation Display Format ID (2010,0030)
Text String	(2030,0020)	Text string

C.13.8 Print Job Module

Table C.13-8. Print Job Module Attributes

Attribute Name	Tag	Attribute Description
Execution Status	(2100,0020)	Execution status of print job. Enumerated Values: **PENDING** **PRINTING** **DONE** **FAILURE**
Execution Status Info	(2100,0030)	Additional information about Execution Status (2100,0020). Defined Terms if Execution Status (2100,0030) is DONE or PRINTING: **NORMAL** Defined Terms if Execution Status (2100,0030) is FAILURE: **INVALID PAGE DES** The specified page layout cannot be printed or other page description errors have been detected. **INSUFFIC MEMORY** There is not enough memory available to complete this job. See Section C.13.9.1 for additional Defined Terms when the Execution Status is PENDING or FAILURE.
Creation Date	(2100,0040)	Date of print job creation.
Creation Time	(2100,0050)	Time of print job creation.
Print Priority	(2000,0020)	Priority of print job (see Section C.13.1 for further explanation).
Printer Name	(2110,0030)	User defined name identifying the printer.
Originator	(2100,0070)	DICOM Application Entity Title that issued the print operation.

C.13.9 Printer Module

Table C.13-9. Printer Module Attributes

Attribute Name	Tag	Attribute Description
Printer Status	(2110,0010)	Printer device status. Enumerated Values: **NORMAL** **WARNING** **FAILURE**
Printer Status Info	(2110,0020)	Additional information about Printer Status (2110,0010). Defined Terms if Printer Status (2110,0010) is NORMAL: **NORMAL** See Section C.13.9.1 for Defined Terms when the Printer Status is equal to WARNING or FAILURE.
Printer Name	(2110,0030)	User defined name identifying the printer.
Manufacturer	(0008,0070)	Manufacturer of the printer.
Manufacturer Model Name	(0008,1090)	Manufacturer's model number of the printer.

Attribute Name	Tag	Attribute Description
Device Serial Number	(0018,1000)	Manufacturer's serial number of the printer.
Software Versions	(0018,1020)	Manufacturer's designation of software version of the printer.
Date Of Last Calibration	(0018,1200)	Date when the printer was last calibrated.
Time Of Last Calibration	(0018,1201)	Time when the printer was last calibrated.

C.13.9.1 Printer Status Info and Execution Status Info

Additional Defined Terms for Printer Status Info (2110,0020) and Execution Status Info (2100,0030) are:

Table C.13.9.1-1. Defined Terms for Printer and Execution Status Info

BAD RECEIVE MGZ	There is a problem with the film receive magazine. Films from the printer cannot be transported into the magazine.
BAD SUPPLY MGZ	There is a problem with a film supply magazine. Films from this magazine cannot be transported into the printer.
CALIBRATING	Printer is performing self calibration, it is expected to be available for normal operation shortly.
CALIBRATION ERR	An error in the printer calibration has been detected, quality of processed films may not be optimal.
CHECK CHEMISTRY	A problem with the processor chemicals has been detected, quality of processed films may not be optimal.
CHECK SORTER	There is an error in the film sorter.
CHEMICALS EMPTY	There are no processing chemicals in the processor, films will not be printed and processed until the processor is back to normal.
CHEMICALS LOW	The chemical level in the processor is low, if not corrected, it will probably shut down soon.
COVER OPEN	One or more printer or processor covers, drawers, doors are open.
ELEC CONFIG ERR	Printer configured improperly for this job.
ELEC DOWN	Printer is not operating due to some unspecified electrical hardware problem.
ELEC SW ERROR	Printer not operating for some unspecified software error.
EMPTY 8X10	The 8x10 inch film supply magazine is empty.
EMPTY 8X10 BLUE	The 8x10 inch blue film supply magazine is empty.
EMPTY 8X10 CLR	The 8x10 inch clear film supply magazine is empty.
EMPTY 8X10 PAPR	The 8x10 inch paper supply magazine is empty.
EMPTY 10X12	The 10x12 inch film supply magazine is empty.
EMPTY 10X12 BLUE	The 10x12 inch blue film supply magazine is empty.
EMPTY 10X12 CLR	The 10x12 inch clear film supply magazine is empty.
EMPTY 10X12 PAPR	The 10x12 inch paper supply magazine is empty.
EMPTY 10X14	The 10x14 inch film supply magazine is empty.
EMPTY 10X14 BLUE	The 10x14 inch blue film supply magazine is empty.
EMPTY 10X14 CLR	The 10x14 inch clear film supply magazine is empty.
EMPTY 10X14 PAPR	The 10x14 inch paper supply magazine is empty.
EMPTY 11X14	The 11x14 inch film supply magazine is empty.
EMPTY 11X14 BLUE	The 11x14 inch blue film supply magazine is empty.
EMPTY 11X14 CLR	The 11x14 inch clear film supply magazine is empty.
EMPTY 11X14 PAPR	The 11x14 inch paper supply magazine is empty.

EMPTY 14X14	The 14x14 inch film supply magazine is empty.
EMPTY 14X14 BLUE	The 14x14 inch blue film supply magazine is empty.
EMPTY 14X14 CLR	The 14x14 inch clear film supply magazine is empty.
EMPTY 14X14 PAPR	The 14x14 inch paper supply magazine is empty.
EMPTY 14X17	The 14x17 inch film supply magazine is empty.
EMPTY 14X17 BLUE	The 14x17 inch blue film supply magazine is empty.
EMPTY 14X17 CLR	The 14x17 inch clear film supply magazine is empty.
EMPTY 14X17 PAPR	The 14x17 inch paper supply magazine is empty.
EMPTY 24X24	The 24x24 cm film supply magazine is empty.
EMPTY 24X24 BLUE	The 24x24 cm blue film supply magazine is empty.
EMPTY 24X24 CLR	The 24x24 cm clear film supply magazine is empty.
EMPTY 24X24 PAPR	The 24x24 cm paper supply magazine is empty.
EMPTY 24X30	The 24x30 cm film supply magazine is empty.
EMPTY 24X30 BLUE	The 24x30 cm blue film supply magazine is empty.
EMPTY 24X30 CLR	The 24x30 cm clear film supply magazine is empty.
EMPTY 24X30 PAPR	The 24x30 cm paper supply magazine is empty.
EMPTY A4 PAPR	The A4 paper supply magazine is empty.
EMPTY A4 TRANS	The A4 transparency supply magazine is empty.
EXPOSURE FAILURE	The exposure device has failed due to some unspecified reason.
FILM JAM	A film transport error has occurred and a film is jammed in the printer or processor.
FILM TRANSP ERR	There is a malfunction with the film transport, there may or may not be a film jam.
FINISHER EMPTY	The finisher is empty.
FINISHER ERROR	The finisher is not operating due to some unspecified reason.
FINISHER LOW	The finisher is low on supplies
LOW 8X10	The 8x10 inch film supply magazine is low.
LOW 8X10 BLUE	The 8x10 inch blue film supply magazine is low.
LOW 8X10 CLR	The 8x10 inch clear film supply magazine is low.
LOW 8X10 PAPR	The 8x10 inch paper supply magazine is low.
LOW 10X12	The 10x12 inch film supply magazine is low.
LOW 10X12 BLUE	The 10x12 inch blue film supply magazine is low.
LOW 10X12 CLR	The 10x12 inch clear film supply magazine is low.
LOW 10X12 PAPR	The 10x12 inch paper supply magazine is low.
LOW 10X14	The 10x14 inch film supply magazine is low.
LOW 10X14 BLUE	The 10x14 inch blue film supply magazine is low.
LOW 10X14 CLR	The 10x14 inch clear film supply magazine is low.
LOW 10X14 PAPR	The 10x14 inch paper supply magazine is low.
LOW 11X14	The 11x14 inch film supply magazine is low.
LOW 11X14 BLUE	The 11x14 inch blue film supply magazine is low.
LOW 11X14 CLR	The 11x14 inch clear film supply magazine is low.
LOW 11X14 PAPR	The 11x14 inch paper supply magazine is low.
LOW 14X14	The 14x14 inch film supply magazine is low.
LOW 14X14 BLUE	The 14x14 inch blue film supply magazine is low.
LOW 14X14 CLR	The 14x14 inch clear film supply magazine is low.

LOW 14X14 PAPR	The 14x14 inch paper supply magazine is low.
LOW 14X17	The 14x17 inch film supply magazine is low.
LOW 14X17 BLUE	The 14x17 inch blue film supply magazine is low.
LOW 14X17 CLR	The 14x17 inch clear film supply magazine is low.
LOW 14X17 PAPR	The 14x17 inch paper supply magazine is low.
LOW 24X24	The 24x24 cm film supply magazine is low.
LOW 24X24 BLUE	The 24x24 cm blue film supply magazine is low.
LOW 24X24 CLR	The 24x24 cm clear film supply magazine is low.
LOW 24X24 PAPR	The 24x24 cm paper supply magazine is low.
LOW 24X30	The 24x30 cm film supply magazine is low.
LOW 24X30 BLUE	The 24x30 cm blue film supply magazine is low.
LOW 24X30 CLR	The 24x30 cm clear film supply magazine is low.
LOW 24X30 PAPR	The 24x30 cm paper supply magazine is low.
LOW A4 PAPR	The A4 paper supply magazine is low.
LOW A4 TRANS	The A4 transparency supply magazine is low.
NO RECEIVE MGZ	The film receive magazine not available
NO RIBBON	The ribbon cartridge needs to be replaced.
NO SUPPLY MGZ	The film supply magazine specified for this job is not available.
CHECK PRINTER	The printer is not ready at this time, operator intervention is required to make the printer available.
CHECK PROC	The processor is not ready at this time, operator intervention is required to make the printer available.
PRINTER DOWN	The printer is not operating due to some unspecified reason.
PRINTER BUSY	Printer is not available at this time, but should become ready without user intervention. This is to handle non-initialization instances.
PRINT BUFF FULL	The Printer 's buffer capacity is full. The printer is unable to accept new images in this state. The printer will correct this without user intervention. The SCU should retry later.
PRINTER INIT	The printer is not ready at this time, it is expected to become available without intervention. For example, it may be in a normal warm-up state.
PRINTER OFFLINE	The printer has been disabled by an operator or service person.
PROC DOWN	The processor is not operating due to some unspecified reason.
PROC INIT	The processor is not ready at this time, it is expected to become available without intervention. For example, it may be in a normal warm-up state.
PROC OVERFLOW FL	Processor chemicals are approaching the overflow full mark.
PROC OVERFLOW HI	Processor chemicals have reached the overflow full mark.
QUEUED	Print Job in Queue
RECEIVER FULL	The Film receive magazine is full.
REQ MED NOT INST	The requested film, paper, or other media supply magazine is installed in the printer, but may be available with operator intervention.
REQ MED NOT AVAI	The requested film, paper, or other media requested is not available on this printer.
RIBBON ERROR	There is an unspecified problem with the print ribbon.
SUPPLY EMPTY	The printer is out of film.
SUPPLY LOW	The film supply is low.
UNKNOWN	There is an unspecified problem.

C.13.10 Image Overlay Box Presentation Module (Retired)

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

C.13.11 Image Overlay Box Relationship Module (Retired)

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

C.13.12 Print Request Module

Retired. See PS3.3-2004.

C.13.13 Printer Configuration Module

This Module describes Printer Configuration Information.

Table C.13-13. Printer Configuration Module Attributes

Attribute Name	Tag	Attribute Description
Printer Configuration Sequence	(2000,001E)	Contains printer configuration information for a single Application Entity title. See Print Management Service Class Structure in PS3.4. The Sequence shall contain one Item for each physical printer/Meta SOP Class combination supported by the Application Entity title.
>SOP Classes Supported	(0008,115A)	The Meta-SOP Class and a list of optional SOP Classes supported. It shall contain one Meta SOP Class UID and 0-n optional SOP Class UIDs.
>Maximum Memory Allocation	(2000,0061)	Maximum number of kilobytes of memory that can be allocated for a Film Session. The value shall be 0 if Memory Allocation (2000,0060) is not supported.
>Memory Bit Depth	(2000,00A0)	The maximum number of bits for each pixel that can be stored in printer memory.
>Printing Bit Depth	(2000,00A1)	The number of bits used by the print engine for internal LUT calculation and printing of each pixel.
>Media Installed Sequence	(2000,00A2)	A Sequence that specifies the combinations of Medium Type and Film Size IDs available in the printer at this time and the Min and Max Densities supported by these media. The Item Number with the value of 1 is the printer default. There is no significance to other Item numbers. One Item for each Medium Type and Film Size ID installed shall be included.
>>Item Number	(0020,0019)	A number that labels this Item. Each Item in the Sequence shall have a unique number.
>>Medium Type	(2000,0030)	See Section C.13.1
>>Film Size ID	(2010,0050)	See Section C.13.3
>>Min Density	(2010,0120)	Minimum density that can be printed, expressed in hundredths of OD.
>>Max Density	(2010,0130)	Maximum density that can be printed, expressed in hundredths of OD.
>Other Media Available Sequence	(2000,00A4)	A Sequence that specifies combinations of Medium Type and Film Size ID for which the printer will accept an N-CREATE of a Film Box, but are not physically installed in the printer at this time. It also specifies the Min and Max Densities supported by these media. User intervention may be required to instal these media in the printer. One Item for each Medium Type and Film Size ID available, but not installed shall be included.

Attribute Name	Tag	Attribute Description
>>Medium Type	(2000,0030)	See Section C.13.1
>>Film Size ID	(2010,0050)	See Section C.13.3
>>Min Density	(2010,0120)	Minimum density that can be printed, expressed in hundredths of OD.
>>Max Density	(2010,0130)	Maximum density that can be printed, expressed in hundredths of OD.
>Supported Image Display Formats Sequence	(2000,00A8)	A Sequence that specifies the Image Display Formats supported, rows and columns in Image Boxes for each format, pixel spacing, and whether Requested Image Size is supported as a function of Film Orientation, Film Size ID, and Printer Resolution ID. One Item for each display format, film orientation, film size, and printer resolution combination shall be included.
>>Rows	(0028,0010)	Number of printable rows in an Image Box.
>>Columns	(0028,0011)	Number of printable columns in an Image Box
>>Image Display Format	(2010,0010)	See Section C.13.3
>>Film Orientation	(2010,0040)	See Section C.13.3
>>Film Size ID	(2010,0050)	See Section C.13.3
>>Printer Resolution ID	(2010,0052)	Printer Resolution identification. Defined Terms are the same as Requested Resolution ID (2020,0050). See Section C.13.3.
>>Printer Pixel Spacing	(2010,0376)	Physical distance on the printed film between the center of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order.
>>Requested Image Size Flag	(2020,00A0)	Indicates whether the printer supports Requested Image Size (2020,0030) for this display format and film orientation and size combination. Enumerated Values: **NO** not supported **YES** supported
>Default Printer Resolution ID	(2010,0054)	The printer's default resolution identification. Defined Terms are the same as Requested Resolution ID (2020,0050). See Section C.13.3.
>Default Magnification Type	(2010,00A6)	Printer's default magnification type. See Section C.13.3 for Defined Terms.
>Other Magnification Types Available	(2010,00A7)	Other magnification types available in the printer. See Section C.13.3 for Defined Terms.
>Default Smoothing Type	(2010,00A8)	Printer's default smoothing type. See Section C.13.3.
>Other Smoothing Types Available	(2010,00A9)	Other smoothing types available in the printer. See Section C.13.3.
>Configuration Information Description	(2010,0152)	A free form text description of Configuration Information (2010,0150) supported by the printer.
>Maximum Collated Films	(2010,0154)	The maximum number of films that can be collated for an N-ACTION of the Film Session. The value shall be 0 if N-ACTION of the Film Session is not supported.

Attribute Name	Tag	Attribute Description
>Decimate/Crop Result	(2020,00A2)	Indicates whether the printer will decimate or crop image pixels if the image rows or columns is greater than the available printable pixels in an Image Box. See Section C.13.5. Enumerated Values when the printer does not support Requested Decimate/Crop Behavior (2020,0040): **DECIMATE** image will be decimated to fit. **CROP** image will be cropped to fit. **FAIL** N-SET of the Image Box will fail. Enumerated Values when the printer supports Requested Decimate/Crop Behavior (2020,0040): **DEF DECIMATE** image will be decimated to fit. **DEF CROP** image will be cropped to fit. **DEF FAIL** N-SET of the Image Box will fail. This value indicates the printer default if the SCU does not create or set Requested Decimate/Crop Behavior for the Image Box.

C.14 Storage Commitment Module

Table C.14-1 defines the Attributes for referencing SOP Instances that are contained in a Storage Commitment Request/Response.

Table C.14-1. Storage Commitment Module Attributes

Attribute Name	Tag	Attribute Description
Transaction UID	(0008,1195)	Uniquely identifies this Storage Commitment transaction.
Retrieve AE Title	(0008,0054)	Application Entity Title where the SOP Instance(s) may be retrieved via a network based retrieve service.
Storage Media File-Set ID	(0088,0130)	User or implementation specific human readable identification of a Storage Media on which the SOP Instances reside.
Storage Media File-Set UID	(0088,0140)	Uniquely identifies a Storage Media on which the SOP Instances reside.
Referenced SOP Sequence	(0008,1199)	A Sequence of Items where each Item references a single SOP Instance for which storage commitment is requested / or has been provided.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
>Retrieve AE Title	(0008,0054)	Application Entity Title from which the SOP Instance may be retrieved via a network based retrieve service.
>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies a Storage Media on which this SOP Instance resides.
>Storage Media File-Set UID	(0088,0140)	Uniquely identifies a Storage Media on which this SOP Instance resides.
Failed SOP Sequence	(0008,1198)	A Sequence of Items where each Item references a single SOP Instance for which storage commitment could not be provided.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
>Failure Reason	(0008,1197)	The reason that storage commitment could not be provided for this SOP Instance. See Section C.14.1.1.

Note

1. Conditions under which Attributes are required (i.e., Retrieve AE Title, etc.) are defined in the Storage Commitment Service Class in PS3.4.
2. Referenced Performed Procedure Step Sequence (0008,1111) was included in this Module in earlier versions, but its use here has been retired. See PS3.4-2001, in which the Attribute was formerly known as Referenced Study Component Sequence.

C.14.1 Storage Commitment Attribute Description

C.14.1.1 Failure Reason

The following values and semantics shall be used for Failure Reason (0008,1197):

Enumerated Values:

0110H Processing failure

A general failure in processing the operation was encountered.

0112H No such object instance

One or more of the elements in the Referenced SOP Instance Sequence was not available.

0213H Resource limitation

The SCP does not currently have enough resources to store the requested SOP Instance(s).

0122H Referenced SOP Class not supported

Storage Commitment has been requested for a SOP Instance with a SOP Class that is not supported by the SCP.

0119H Class/Instance conflict

The SOP Class of an element in the Referenced SOP Instance Sequence did not correspond to the SOP class registered for this SOP Instance at the SCP.

0131H Duplicate transaction UID

The Transaction UID of the Storage Commitment Request is already in use.

C.15 Queue Management Specific Modules

Retired. See PS3.3-2004.

C.16 Stored Print Specific Modules

Retired. See PS3.3-2004.

C.17 SR Document Modules

C.17.1 SR Document Series Module

Table C.17-1 defines the Attributes of the SR Document Series. A Series of SR Documents may contain any number of SR Documents.

Note

Series of SR Documents are separate from Series of Images or other Composite SOP Instances. SR Documents do not reside in a Series of Images or other Composite SOP Instances.

Table C.17-1. SR Document Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type. Enumerated Values: **SR** SR Document
Series Instance UID	(0020,000E)	1	Unique identifier of the Series. Note No SR-specific semantics are specified.
Series Number	(0020,0011)	1	A number that identifies the Series. Note No SR-specific semantics are specified.
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Protocol Name	(0018,1030)	3	Description of the conditions under which the Series was performed. Note This may represent the type of analysis used in creation of the SR SOP Instances.
Series Description	(0008,103E)	3	Description of the Series
Series Description Code Sequence	(0008,103F)	3	A coded description of the Series. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Referenced Performed Procedure Step Sequence	(0008,1111)	2	Uniquely identifies the Performed Procedure Step SOP Instance for which the Series is created. Zero or one Item shall be included in this Sequence. Note 1. The Performed Procedure Step referred to by this Attribute is the Step during which this Document is generated. 2. If this Document is generated during the same Performed Procedure Step as the evidence in the current interpretation procedure, this Attribute may contain reference to that Performed Procedure Step. 3. This Attribute is not used to convey reference to the evidence in the current interpretation procedure. See Current Requested Procedure Evidence Sequence (0040,A375). 4. This Sequence may be zero length if the Performed Procedure Step is unknown.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.17.2 SR Document General Module

Table C.17-2 defines the general Attributes of an SR Document Instance. These Attributes identify the SR Document and provide context for the entire document.

Table C.17-2. SR Document General Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies the SR Document.
Preliminary Flag	(0040,A496)	3	Indicates whether this SR Document is intended to be regarded as a preliminary or final report. Enumerated Values: **PRELIMINARY** This report precedes the final report and may contain limited information; it may be time sensitive, and it is not expected to contain all the reportable findings. **FINAL** This report is the definitive means of communicating the results of a procedure. Note The definitions of the Enumerated Values are derived from the ACR Practice Guideline for Communication of Diagnostic Imaging Findings, Revised 2005.
Completion Flag	(0040,A491)	1	The estimated degree of completeness of this SR Document. See Section C.17.2.7. Enumerated Values: **PARTIAL** Partial content. **COMPLETE** Complete content.
Completion Flag Description	(0040,A492)	3	Explanation of the value of Completion Flag (0040,A491).
Verification Flag	(0040,A493)	1	Indicates whether this SR Document is Verified. Enumerated Values: **UNVERIFIED** Not attested to. **VERIFIED** Attested to by a Verifying Observer Name (0040,A075) who is accountable for its content. A value of "VERIFIED" shall be used only when the value of Completion Flag (0040,A491) is "COMPLETE". Note The intent of this specification is that the "prevailing final version" of an SR Document is the version having the most recent Verification DateTime (0040,A030), Verification Flag (0040,A493) of VERIFIED and Preliminary Flag (0040,A496) of FINAL.
Content Date	(0008,0023)	1	The date the document content creation started.
Content Time	(0008,0033)	1	The time the document content creation started.

Attribute Name	Tag	Type	Attribute Description
Verifying Observer Sequence	(0040,A073)	1C	The person or persons authorized to verify documents of this type and accept responsibility for the content of this document. One or more Items shall be included in this Sequence. Required if Verification Flag (0040,A493) is VERIFIED. Note In HL7 Structured Documents, the comparable attribute is the "legalAuthenticator".
>Verifying Observer Name	(0040,A075)	1	The person authorized by the Verifying Organization (0040,A027) to verify documents of this type and who accepts responsibility for the content of this document.
>Verifying Observer Identification Code Sequence	(0040,A088)	2	Coded identifier of Verifying Observer. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
>Verifying Organization	(0040,A027)	1	Organization to which the Verifying Observer Name (0040,A075) is accountable in the current interpretation procedure.
>Verification DateTime	(0040,A030)	1	Date and Time of verification by the Verifying Observer Name (0040,A075).
Author Observer Sequence	(0040,A078)	3	The person or device that created the clinical content of this document. This Attribute sets the default Observer Context for the root of the content tree. One or more Items are permitted in this Sequence.
>Include Table C.17-3b “Identified Person or Device Macro Attributes”			
Participant Sequence	(0040,A07A)	3	Persons or devices related to the clinical content of this document. One or more Items are permitted in this Sequence.
>Participation Type	(0040,A080)	1	Participant's role with respect to the clinical content of this document. See Section C.17.2.5. Defined Terms: **SOURCE** Equipment that contributed to the content **ENT** Data enterer (e.g., transcriptionist) **ATTEST** Attestor Note In HL7 Structured Documents, the participation comparable to Attestor is the "Authenticator".
>Participation DateTime	(0040,A082)	2	DateTime of participation with respect to the clinical content of this document.
>Include Table C.17-3b “Identified Person or Device Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Custodial Organization Sequence	(0040,A07C)	3	Custodial organization for this SR Document Instance. Represents the organization from which the document originates and that is in charge of maintaining the document, i.e., the steward of the original source document. Note This may or may not be identical to the Institution identified in the General Equipment Module. Only a single Item is permitted in this Sequence.
>Institution Name	(0008,0080)	2	Name of Custodial Institution or Organization.
>Institution Code Sequence	(0008,0082)	2	Coded identifier of Custodial Institution or Organization. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
>Responsible Group Code Sequence	(0008,0220)	3	The department, unit or service that is responsible for the management of this Instance. See Section C.34.2.3. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*
Predecessor Documents Sequence	(0040,A360)	1C	References to SOP Instances (e.g., prior or preliminary reports) whose content has been wholly or partially included in this document with or without modification. One or more Items shall be included in this Sequence. Required if this document includes content from other documents. Note The amendment process of an existing SR Document may be described using the Purpose of Reference Code Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			Purpose of Reference Code Sequence in the Hierarchical SOP Instance Reference Macro DCID 7009 “Purpose of Reference to Predecessor Report”.
Identical Documents Sequence	(0040,A525)	1C	Duplicates of this document, stored with different SOP Instance UIDs. One or more Items shall be included in this Sequence. Required if this document is stored with different SOP Instance UIDs in one or more other Studies. See Section C.17.2.2 for further explanation.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Referenced Request Sequence	(0040,A370)	1C	Identifies Requested Procedures that are being fulfilled (completely or partially) by creation of this Document. One or more Items shall be included in this Sequence. Required if this Document fulfills at least one Requested Procedure. May be present otherwise.
>Study Instance UID	(0020,000D)	1	Unique identifier for the Study.
>Referenced Study Sequence	(0008,1110)	2	Uniquely identifies the Study SOP Instance. Zero or one Item shall be included in this Sequence. See Section 10.6.1.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Accession Number	(0008,0050)	2	A departmental IS generated number that identifies the order for the Study.
>Issuer of Accession Number Sequence	(0008,0051)	3	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Placer Order Number/Imaging Service Request	(0040,2016)	2	The order number assigned to the Imaging Service Request by the party placing the order.
>Order Placer Identifier Sequence	(0040,0026)	3	Identifier of the Assigning Authority that issued the Placer Order Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Filler Order Number/Imaging Service Request	(0040,2017)	2	The order number assigned to the Imaging Service Request by the party filling the order.
>Order Filler Identifier Sequence	(0040,0027)	3	Identifier of the Assigning Authority that issued the Filler Order Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Requested Procedure ID	(0040,1001)	2	Identifier of the related Requested Procedure
>Requested Procedure Description	(0032,1060)	2	Institution-generated administrative description or classification of Requested Procedure.
>Requested Procedure Code Sequence	(0032,1064)	2	A Sequence that conveys the requested procedure. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>Reason for the Requested Procedure	(0040,1002)	3	Reason for requesting this procedure.
>Reason for Requested Procedure Code Sequence	(0040,100A)	3	Coded Reason for requesting this procedure. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*

Attribute Name	Tag	Type	Attribute Description
Performed Procedure Code Sequence	(0040,A372)	2	A Sequence that conveys the codes of the performed procedures pertaining to this SOP Instance. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Current Requested Procedure Evidence Sequence	(0040,A375)	1C	Full set of Composite SOP Instances, of which the creator is aware, which were created to satisfy the current Requested Procedure(s) for which this SR Document is generated or that are referenced in the content tree. One or more Items shall be included in this Sequence. Required if the creator is aware of Composite Objects acquired in order to satisfy the Requested Procedure(s) for which the SR Document is or if Instances are referenced in the content tree. May be present otherwise. See Section C.17.2.3 for further explanation.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Pertinent Other Evidence Sequence	(0040,A385)	1C	Other Composite SOP Instances that are considered to be pertinent evidence by the creator of this SR Document. This evidence must have been acquired in order to satisfy Requested Procedures other than the one(s) for which this SR Document is generated. One or more Items shall be included in this Sequence. Required if pertinent evidence from other Requested Procedures needs to be recorded. See Section C.17.2.3 for further explanation.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			
Referenced Instance Sequence	(0008,114A)	1C	Sequence specifying SOP Instances significantly related to the current SOP Instance. Such referenced Instances may include equivalent documents or renderings of this document. One or more Items shall be included in this Sequence. Required if the identity of a CDA Document equivalent to the current SOP Instance is known at the time of creation of this SOP Instance (see Section C.17.2.6). May be present otherwise.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Code describing the purpose of the reference to the Instance(s). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7006 "SR Document Purposes of Reference".*

C.17.2.1 Hierarchical SOP Instance Reference Macro

Table C.17-3 specifies the Attributes that reference a list of SOP Instances.

Table C.17-3. Hierarchical SOP Instance Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Study Instance UID	(0020,000D)	1	Unique identifier for the Study
Referenced Series Sequence	(0008,1115)	1	Sequence of Items where each Item includes the Attributes of a Series containing referenced Composite Object(s). One or more Items shall be included in this Sequence
>Include Table C.17-3a "Hierarchical Series Reference Macro Attributes"			

Table C.17-3a specifies the Attributes that reference a Series of SOP Instances.

Table C.17-3a. Hierarchical Series Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Series Instance UID	(0020,000E)	1	Unique identifier of a Series that is part of this Study and contains the referenced Composite Object(s).
Retrieve AE Title	(0008,0054)	3	Title of the DICOM Application Entity where the Composite Object(s) may be retrieved on the network.
Retrieve Location UID	(0040,E011)	3	Unique identifier of the system where the Composite Object(s) may be retrieved on the network.
Retrieve URL	(0008,1190)	3	URL specifying the location of the referenced Instance(s).
Storage Media File-Set ID	(0088,0130)	3	The user or implementation specific human readable identifier that identifies the Storage Media on which the Composite Object (s) reside.
Storage Media File-Set UID	(0088,0140)	3	Uniquely identifies the Storage Media on which the Composite Object(s) reside.
Referenced SOP Sequence	(0008,1199)	1	References to Composite Object SOP Class/SOP Instance pairs that are part of the Study defined by Study Instance UID and the Series defined by Series Instance UID (0020,000E). One or more Items shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Baseline CID may be specified in Macro invocation.*
>Referenced Digital Signature Sequence	(0400,0402)	3	Sequence of references to Digital Signatures in the referenced SOP Instance. One or more Items are permitted in this Sequence. Note The Attributes in this Sequence can be used to detect if the referenced SOP Instance has been altered.
>>Digital Signature UID	(0400,0100)	1	The Unique Identifier of a Digital Signature held in the referenced SOP Instance.
>>Signature	(0400,0120)	1	The Signature Value identified by the Digital Signature UID within the Referenced SOP Instance UID.

Attribute Name	Tag	Type	Attribute Description
>Referenced SOP Instance MAC Sequence	(0400,0403)	3	A MAC Calculation from data in the referenced SOP Instance that can be used as a data integrity check. Only a single Item is permitted in this Sequence. Note This Attribute may be used in place of Referenced Digital Signature Sequence (0400,0402), particularly if the SOP Instance does not have appropriate Digital Signatures that can be referenced.
>>MAC Calculation Transfer Syntax UID	(0400,0010)	1	The Transfer Syntax UID used to encode the values of the Data Elements included in the MAC calculation. When computing the MAC, only Transfer Syntaxes that explicitly include the VR and use Little Endian encoding shall be used. Note 1. Certain Transfer Syntaxes, particularly those that are used with compressed data, allow the fragmentation of the pixel data to change. If such fragmentation changes, Digital Signatures generated with such Transfer Syntaxes could become invalid. 2. This does not constrain the Transfer Syntax used to transmit the object.
>>MAC Algorithm	(0400,0015)	1	The algorithm used in generating the MAC. Defined Terms: **RIPEMD160** **MD5** **SHA1** **SHA256** **SHA384** **SHA512** Note Digital Signature Security Profiles (see PS3.15) may require the use of a restricted subset of these terms.
>>Data Elements Signed	(0400,0020)	1	A list of Data Element Tags in the order they appear at the top level of the referenced SOP Instance that identify the Data Elements used in creating the MAC. See Section C.12.1.1.3.1.1.
>>MAC	(0400,0404)	1	The MAC generated as described in Section C.12.1.1.3, but unencrypted and without inclusion of fields from the Digital Signatures Sequence. See Section C.12.1.1.3.1.2.

C.17.2.2 Identical Documents Sequence

If identical copies of a document are to be included in multiple Studies then the entire document shall be duplicated with appropriate changes for inclusion into the different Studies (i.e., Study Instance UID, Series Instance UID, SOP Instance UID, Identical Documents Sequence etc.). The Identical Documents Sequence Attribute in each SOP Instance shall contain references to all other duplicate SOP Instances.

Note

If a document contains an Identical Documents Sequence then it will not be further duplicated without producing a new complete set of duplicate SOP Instances with re-generated Identical Documents Sequences. This is a consequence of the rules for modification of document content in PS3.4. For example, if there are two identical reports and an application is creating a third identical report, then the first two reports must be re-generated in order that their Identical Documents Sequence will reference the new duplicate document and all other identical documents.

If a new document is created using content from a document that contains an Identical Documents Sequence and is part of the same Requested Procedure, then the new document shall only contain a new Identical Documents Sequence if the new document is duplicated. The Predecessor Documents Sequence in all the new documents shall contain references to the original document and all its duplicates as well as any other documents from which content is included.

Note

It is up to an implementation to decide whether a new document is duplicated across multiple Studies. This may require user input to make the decision.

C.17.2.3 Current Requested Procedure Evidence Sequence and Pertinent Other Evidence Sequence

The intent of the Current Requested Procedure Evidence Sequence (0040,A375) is to reference all evidence created in order to satisfy the current Requested Procedure(s) for this SR Document. This shall include, but is not limited to, all current evidence referenced in the content tree.

For a completed SR Document satisfying (i.e., being the final report for) the current Requested Procedure(s), this Sequence shall list the full set of Composite SOP Instances created for the current Requested Procedure(s). For other SOP Instances that include the SR Document General Module, this Sequence shall contain at minimum the set of Composite SOP Instances from the current Requested Procedure(s) that are referenced in the content tree.

The Pertinent Other Evidence Sequence (0040,A385) Attribute is used to reference all other evidence considered pertinent for this SR Document that is not listed in the Current Requested Procedure Evidence Sequence (0040,A375).

This requires that the same SOP Instance shall not be referenced in both of these Sequences.

For the purposes of inclusion in the Current Requested Procedure Evidence Sequence (0040,A375) and the Pertinent Other Evidence Sequence (0040,A385), the set of Composite SOP Instances is defined to include not only the images and waveforms referenced in the content tree, but also all presentation states, real world value maps and other accompanying Composite Instances that are referenced from the Content Items.

C.17.2.4 Identified Person or Device Macro

Table C.17-3b defines the Attributes that identify a person or a device. This Macro contains content equivalent to TID 1002 (see PS3.16).

Table C.17-3b. Identified Person or Device Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Observer Type	(0040,A084)	1	The type of entity being identified. Enumerated Values: **PSN** Person **DEV** Device
Person Name	(0040,A123)	1C	Name of the person observer identified. Required if Observer Type value is PSN.

Attribute Name	Tag	Type	Attribute Description
Person Identification Code Sequence	(0040,1101)	2C	Coded identifier of the person identified. Zero or one Item shall be included in this Sequence. Required if Observer Type value is PSN.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Organizational Role Code Sequence	(0044,010A)	3	The organizational capacity in which the person observer is participating.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline Context ID defined.*
Station Name	(0008,1010)	2C	Name of the identified device. Required if Observer Type value is DEV.
Device UID	(0018,1002)	1C	Unique identifier of the device identified. Required if Observer Type value is DEV.
Manufacturer	(0008,0070)	1C	Manufacturer of the device identified. Required if Observer Type value is DEV.
Manufacturer's Model Name	(0008,1090)	1C	Model Name of the device identified. Required if Observer Type value is DEV.
Station AE Title	(0008,0055)	3	Application Entity Title of the device identified.
Device Serial Number	(0018,1000)	3	Manufacturer's serial number of the identified device. Note While the serial number will be unique within the scope of the Manufacturer and Model, it might not be universally unique.
Software Versions	(0018,1020)	3	Manufacturer's designation of software version of the identified device. See Section C.7.5.1.1.3.
Institution Name	(0008,0080)	2	Institution or organization to which the identified person is responsible or accountable, or that manages the identified device.
Institution Code Sequence	(0008,0082)	2	Institution or organization to which the identified person is responsible or accountable, or that manages the identified device. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Institutional Department Name	(0008,1040)	3	Department in the institution or organization to which the identified person is responsible or accountable, or that manages the identified device.
Institutional Department Type Code Sequence	(0008,1041)	3	A coded description of the type of Department or Service within the healthcare facility. Note This might be obtained from a corresponding HL7v2 message containing PV1:10 Hospital Service. Only a single Item is permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*

C.17.2.5 Verifying Observer, Author Observer and Participant Sequences

The Verifying Observer Sequence (0040,A073), Author Observer Sequence (0040,A078), and Participant Sequence (0040,A07A) identify significant contributors to the SR document. The Author creates the clinical content of the document. The Verifying Observer verifies and accepts legal responsibility for the content. Other participants may include an Attestor, a person identified as a Participant who "signs" an SR document, but who does not have legal authority to verify the clinical content. E.g., an SR document may be authored and attested by a resident, and then verified by a staff physician; or a document may be authored by a CAD device and attested by a technologist, and then verified by a physician; or a technologist working with a measurement software package may be the author, the package is a Source participant, and the final content is verified by a physician.

An individual shall not be identified in both the Verifying Observer Sequence (as the legal authenticator) and in the Participant Sequence as an Attestor. An individual may be identified in both the Author Observer Sequence and either the Verifying Observer Sequence or the Participant Sequence.

The participation DateTime for the Verifying Observer is conveyed in Verification DateTime (0040,A030) within the Verifying Observer Sequence, for the Author Observer in Observation DateTime (0040,A032) in the top level Data Set (see Section C.17.3), and for other participants in Participation DateTime (0040,A082) within the Participant Sequence.

C.17.2.6 Equivalent CDA Document

The Referenced Instance Sequence (0008,114A) with a Purpose of Reference Code Sequence value of (121331, DCM, "Equivalent CDA Document") identifies an HL7 Clinical Document Architecture (CDA) Document that contains clinical content equivalent to this SR Document SOP Instance. This referenced CDA Document may be a source document that was transformed to create this SR Document, or it may be a transcoding of the content created simultaneously for both the SR Document and the CDA Document.

Note

1. Reference to a CDA Document created as a transcoding of the SR Document subsequent to the creation of the SR SOP Instance would not be encodable in that SOP Instance.

2. There is no requirement that the transform or transcoding between DICOM SR and HL7 CDA be reversible. In particular, some Attributes of the DICOM Patient, Study, and Series IEs have no corresponding standard encoding in the HL7 CDA Header, and vice versa. Such Attributes, if transcoded, may need to be encoded in implementation-dependent "local markup" (in HL7 CDA) or Private Data Elements (in DICOM SR) in an implementation-dependent manner; some such ~~Attributess~~Attributes may not be transcoded at all. It is a responsibility of the transforming application to ensure clinical equivalence.

3. Due to the inherent differences between DICOM SR and HL7 CDA, a transcoded document should have a different UID than the source document.

The Referenced SOP Instance UID (0008,1155) in Items of this Sequence is mapped to the native HL7 Instance Identifier through the HL7 Structured Document Reference Sequence (0040,A390) of the SOP Common Module.

C.17.2.7 Completion Flag

Completion Flag (0040,A491) describes the estimated degree of completeness of this SR Document.

Completeness of an SR Document is defined in relation to the scope of the Requested Procedure and the scope of the Root Concept Name. E.g., a Completion Flag value of "COMPLETE" may indicate that the document content includes all significant observations within the topic of the root Concept Name (as restricted by any Concept Modifiers) that are related to the Requested Procedure identified in the Referenced Request Sequence (0040,A370).

The criteria by which the Application Entity determines completeness shall be specified in the Conformance Statement.

Note

1. The concept of "completeness" is independent of the concept of preliminary or final; see the description of Preliminary Flag (0040,A496). An SR Document may be Complete, but may also be Preliminary pending a laboratory test result.

2. A Requested Procedure may have multiple Complete SR Documents on different topics. These SR Documents may use the same or different SOP Classes.

3. For example, an AE might state in its Conformance Statement that it allows an authorized user to check a box on the user interface to indicate that an SR Document is Complete. As another example, an AE might state that an SR Document created from a fully filled in user interface screen will be marked as Complete. As another example, an AE might state that only Verified SR Documents will be marked as Complete.

C.17.3 SR Document Content Module

This section specifies the Attributes contained in the SR Document Content Module. The Attributes in this Module convey the content of an SR Document.

Table C.17-4. SR Document Content Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.17-5 “Document Content Macro Attributes”			With a Value Type (0040,A040) of CONTAINER
Include Table C.17-6 “Document Relationship Macro Attributes”			

Table C.17-5. Document Content Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Value Type	(0040,A040)	1	The type of the value encoded in this Content Item. Enumerated Values: **TEXT** **NUM** **CODE** **DATE** **TIME** **DATETIME** **UIDREF** **PNAME** **COMPOSITE** **IMAGE** **WAVEFORM** **SCOORD** **SCOORD3D** **TCOORD** **CONTAINER** See Section C.17.3.2.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
Concept Name Code Sequence	(0040,A043)	1C	Code describing the concept represented by this Content Item. Also conveys the value of Document Title and section headings in documents. Only a single Item shall be included in this Sequence. Required if Value Type (0040,A040) is TEXT, NUM, CODE, DATETIME, DATE, TIME, UIDREF or PNAME. Required if Value Type (0040,A040) is CONTAINER and a heading is present, or this is the Root Content Item. Note That is, containers without headings do not require Concept Name Code Sequence Required if Value Type (0040,A040) is COMPOSITE, IMAGE, WAVEFORM, SCOORD, SCOORD3D or TCOORD, and the Purpose of Reference is conveyed in the Concept Name. See Section C.17.3.2.2 for further explanation.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Text Value	(0040,A160)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is TEXT. Text data that is unformatted and whose manner of display is implementation dependent. The text value may contain spaces, as well as multiple lines separated by CR LF, but otherwise no format control characters (such as horizontal or vertical tab and form feed) shall be present, even if permitted by the Value Representation of UT. The text shall be interpreted as specified by Specific Character Set (0008,0005) if present in the SOP Common Module. Note The text may contain single or multi-byte characters and use code extension techniques as described in PS3.5 if permitted by the values of Specific Character Set (0008,0005).
DateTime	(0040,A120)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is DATETIME.
Date	(0040,A121)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is DATE.
Time	(0040,A122)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is TIME.

Attribute Name	Tag	Type	Attribute Description
Person Name	(0040,A123)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is PNAME.
UID	(0040,A124)	1C	This is the value of the Content Item. Required if Value Type (0040,A040) is UIDREF.
Include Table C.18.1-1 "Numeric Measurement Macro Attributes" if and only if Value Type (0040,A040) is NUM.			
Include Table C.18.2-1 "Code Macro Attributes" if and only if Value Type (0040,A040) is CODE.			
Include Table C.18.3-1 "Composite Object Reference Macro Attributes" if and only if Value Type (0040,A040) is COMPOSITE.			
Include Table C.18.4-1 "Image Reference Macro Attributes" if and only if Value Type (0040,A040) is IMAGE.			
Include Table C.18.5-1 "Waveform Reference Macro Attributes" if and only if Value Type (0040,A040) is WAVEFORM.			
Include Table C.18.6-1 "Spatial Coordinates Macro Attributes" if and only if Value Type (0040,A040) is SCOORD.			
Include Table C.18.9-1 "3D Spatial Coordinates Macro Attributes" if and only if Value Type (0040,A040) is SCOORD3D.			
Include Table C.18.7-1 "Temporal Coordinates Macro Attributes" if and only if Value Type (0040,A040) is TCOORD.			
Include Table C.18.8-1 "Container Macro Attributes" if and only if Value Type (0040,A040) is CONTAINER.			

Table C.17-6. Document Relationship Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Observation DateTime	(0040,A032)	1C	The date and time on which this Content Item was completed. For the purpose of recording measurements or logging events, completion time is defined as the ending time of data acquisition of the measurement, or the ending time of occurrence of the event. Required if the date and time are different from Content Date (0008,0023) and Content Time (0008,0033) or Observation DateTime (0040,A032) defined in higher Items. May be present otherwise. Note When Content Items are copied into successor reports, Content Date (0008,0023) and Content Time (0008,0033) of the new report are likely to be different than the date and time of the original observation. Therefore this Attribute may need to be included in any copied Content Items to satisfy the condition.
Observation UID	(0040,A171)	3	Unique identifier for the observation Content Item (and its subsidiary Content Items, if any). The UID represents the semantic content of the observation; an encoding of the same observation with the same context into another representation (e.g., a CDA Entry) may use the same UID.

Attribute Name	Tag	Type	Attribute Description
Content Sequence	(0040,A730)	1C	A potentially recursively nested Sequence of Items that conveys content that is the Target of Relationships with the enclosing Source Content Item. One or more Items shall be included in this Sequence. Required if the enclosing Content Item has relationships. Note 1. If this Attribute is not present then the enclosing Item is a leaf. 2. The order of Items within this Sequence is semantically significant for presentation. See Section C.17.3.2.4 for further explanation.
>Relationship Type	(0040,A010)	1	The type of relationship between the (enclosing) Source Content Item and the Target Content Item. IODs specify additional constraints on Relationships (including lists of Enumerated Values). Enumerated Values: **CONTAINS** **HAS PROPERTIES** **HAS OBS CONTEXT** **HAS ACQ CONTEXT** **INFERRED FROM** **SELECTED FROM** **HAS CONCEPT MOD** See Section C.17.3.2.4 for further explanation.
>Include Table C.17-6 “Document Relationship Macro Attributes” if the Target Content Item is included by-value in the Source Content Item. The Macro shall not be present if the relationship is by-reference.			
>Include Table C.17-5 “Document Content Macro Attributes” if the Target Content Item is included by-value in the Source Content Item. The Macro shall not be present if the relationship is by-reference.			

Attribute Name	Tag	Type	Attribute Description
>Referenced Content Item Identifier	(0040,DB73)	1C	An ordered set of one or more integers that uniquely identifies the Target Content Item of the relationship. The root Content Item is referenced by a single value of 1. Each subsequent integer represents an ordinal position of a Content Item in the Content Sequence (0040,A730) in which it belongs. The Referenced Content Item Identifier is the set of these ordinal positions along the by-value relationship path. The number of values in this Multi-Value Attribute is exactly the number of relationships traversed in the SR content tree plus one. Note 1. See Section C.17.3.2.5. 2. Content Items are ordered in a Content Sequence starting from 1 as defined in VR of SQ (see PS3.5). Required if the Target Content Item is denoted by-reference, i.e., the Document Relationship Macro and Document Content Macro are not included.

C.17.3.1 SR Document Content Tree

The Module consists of a single root Content Item that is the root of the SR Document tree. The root Content Item is of type CONTAINER, and its Content Sequence conveys either directly or indirectly through further nested Content Sequences, all of the other Content Items in the document. This root Content Item shall have a heading in the Concept Name Code Sequence (0040,A043) that conveys the title of the SR Document, i.e., the Document Title.

Figure C.17.3-1 depicts the relationship of SR Documents to Content Items and the relationships of Content Items to other Content Items and to Observation Context.

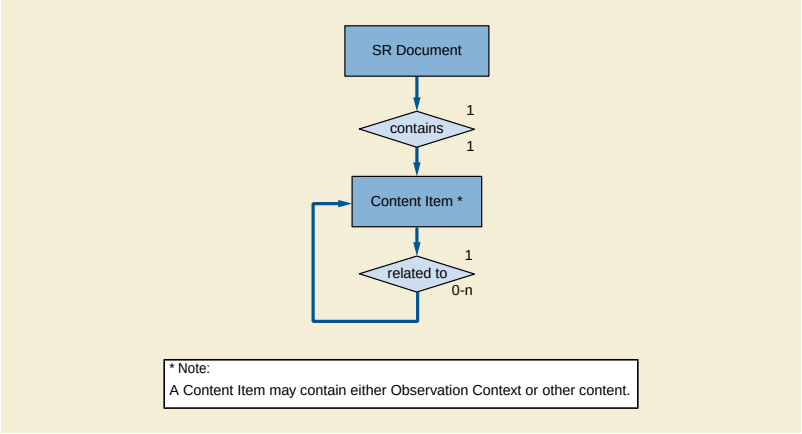


Figure C.17.3-1. SR Information Model

Note

Whether or not relationships by-reference are allowed to ancestor Content Items, is specified in the IOD.

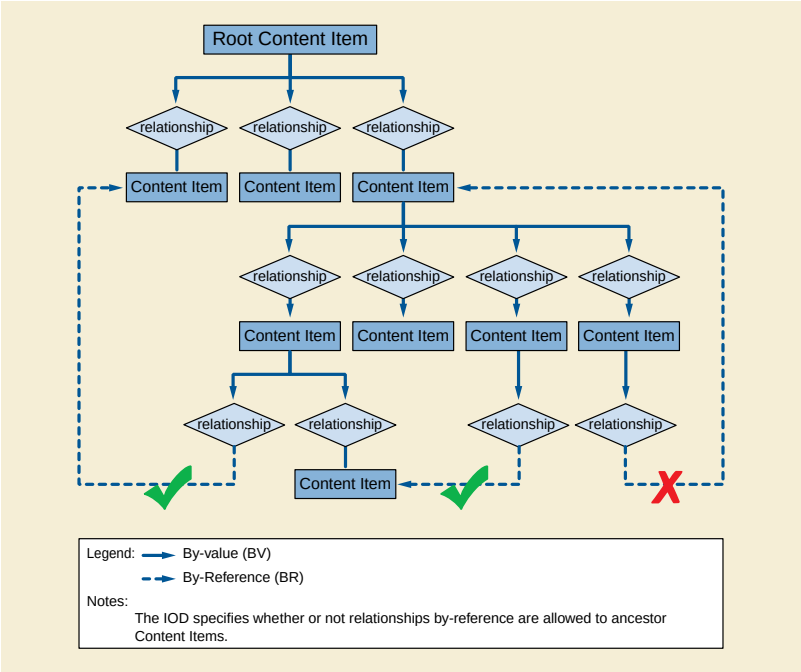


Figure C.17.3-2. Example of an SR Content Tree (Informative)

C.17.3.2 Content Item Attributes

Each Content Item contains:

- name/value pair, consisting of
- a single Concept Name Code Sequence (0040,A043) that is the name of a name/value pair or a heading,
- a value (text, codes, etc.),
- references to images, waveforms or other composite objects, with or without coordinates,
- relationships to other Items, either
- by-value through nested Content Sequences, or
- by-reference.

C.17.3.2.1 Content Item Value Type

The value of the name/value pair is encoded with one of the Value Types defined in Table C.17.3-7 (the choice of which may be constrained by the IOD in which this Module is contained). Value Type (0040,A040) explicitly conveys the type of Content Item value encoding.

Table C.17.3-7. Value Type Definitions

Value Type	Concept Name	Concept Value	Description
TEXT	Type of text, e.g., "Findings", or name of identifier, e.g., "Lesion ID"	Textual expression of the concept	Free text, narrative description of unlimited length. May also be used to provide a label or identifier value.
NUM	Type of numeric value or measurement, e.g., "BPD"	Numeric value and associated Unit of Measurement	Numeric value fully qualified by coded representation of the measurement name and unit of measurement.

Value Type	Concept Name	Concept Value	Description
CODE	Type of code, e.g., "Findings"	Coded expression of the concept	Categorical coded value. Representation of nominal or non-numeric ordinal values.
DATETIME	Type of DateTime, e.g., "Date/Time of onset"	Concatenated date and time	Date and time of occurrence of the type of event denoted by the Concept Name.
DATE	Type of Date, e.g., "Birth Date"	Calendar date	Date of occurrence of the type of event denoted by the Concept Name.
TIME	Type of Time, e.g "Start Time"	Time of day	Time of occurrence of the type of event denoted by the Concept Name.
UIDREF	Type of UID, e.g "Study Instance UID"	Unique Identifier	Unique Identifier (UID) of the entity identified by the Concept Name.
PNAME	Role of person, e.g., "Recording Observer"	Name of person	Person name of the person whose role is described by the Concept Name.
COMPOSITE	Purpose of Reference	Reference to UIDs of Composite SOP Instances	A reference to one Composite SOP Instance that is not an Image or Waveform.
IMAGE	Purpose of Reference	Reference to UIDs of Image Composite SOP Instances	A reference to one Image. IMAGE Content Item may convey a reference to a Softcopy Presentation State associated with the Image.
WAVEFORM	Purpose of Reference	Reference to UIDs of Waveform Composite SOP Instances	A reference to one Waveform.
SCOORD	Purpose of Reference	Listing of spatial coordinates	Spatial coordinates of a geometric region of interest in the DICOM image coordinate system. The IMAGE Content Item from which spatial coordinates are selected is denoted by a SELECTED FROM relationship.
SCOORD3D	Purpose of reference	Listing of spatial 3D coordinates	3D spatial coordinates (x,y,z) of a geometric region of interest in a Reference Coordinate System.
TCOORD	Purpose of Reference	Listing of temporal coordinates	Temporal Coordinates (i.e., time or event-based coordinates) of a region of interest in the DICOM waveform coordinate system. The WAVEFORM or IMAGE or SCOORD Content Item from which Temporal Coordinates are selected is denoted by a SELECTED FROM relationship.
CONTAINER	Document Title or document section heading. Concept Name conveys the Document Title (if the CONTAINER is the Document Root Content Item) or the category of observation.	The content of the CONTAINER. The value of a CONTAINER Content Item is the collection of Content Items that it contains.	CONTAINER groups Content Items and defines the heading or category of observation that applies to that content. The heading describes the content of the CONTAINER Content Item and may map to a document section heading in a printed or displayed document.

Note

It is recommended that drawings and sketches, sometimes used in reports, be represented by IMAGE Content Items that reference separate SOP Instances (e.g., 8-bit, MONOCHROME2, Secondary Capture, or Multi-frame Single Bit Secondary Capture).

C.17.3.2.2 Concept Name Code Sequence

Concept Name Code Sequence (0040,A043) conveys the name of the concept whose value is expressed by the value attribute or set of attributes. Depending on the Value Type (0040,A040), the meaning of the Concept Name Code Sequence may reflect specifics of the use of the particular data type (see Table C.17.3-7).

C.17.3.2.3 Continuity of Content

See Section C.18.8.1.1.

C.17.3.2.4 Content Sequence and Relationship Type

Content Sequence (0040,A730) provides the hierarchical structuring of the Content Tree (see Section C.17.3.1) by recursively nesting Content Items. A parent (or source) Content Item has an explicit relationship to each child (or target) Content Item, conveyed by Relationship Type (0040,A010).

Table C.17.3-8 describes the Relationship Types between Source Content Items and the Target Content Items.

Table C.17.3-8. Relationship Type Definitions

Relationship Type	Description	Definition and Example
CONTAINS	Contains	Source Item contains Target Content Item. E.g., CONTAINER "History" {CONTAINS: TEXT "mother had breast cancer", CONTAINS: IMAGE}
HAS OBS CONTEXT	Has Observation Context	Target Content Items shall convey any specialization of Observation Context needed for unambiguous documentation of the Source Content Item. E.g., CONTAINER "Report" {HAS OBS CONTEXT: PNAME "Recording Observer" = "Smith^John^^Dr^"}
HAS CONCEPT MOD	Has Concept Modifier	Used to qualify or describe the Concept Name of the Source Content Item, such as to create a post-coordinated description of a concept, or to further describe a concept. E.g., CODE "Chest X-Ray" {HAS CONCEPT MOD: CODE "View = PA and Lateral"} E.g., CODE "Breast" {HAS CONCEPT MOD: TEXT "French Translation" = "Sein"} E.g., CODE "2VCXRPALAT" {HAS CONCEPT MOD: TEXT "Further Explanation" = "Chest X-Ray, Two Views, Postero-anterior and Lateral"}
HAS PROPERTIES	Has Properties	Description of properties of the Source Content Item. E.g., CODE "Mass" {HAS PROPERTIES: CODE "anatomic location", HAS PROPERTIES: CODE "diameter", HAS PROPERTIES: CODE "margin", …}.
HAS ACQ CONTEXT	Has Acquisition Context	The Target Content Item describes the conditions present during data acquisition of the Source Content Item. E.g., IMAGE {HAS ACQ CONTEXT: CODE "contrast agent", HAS ACQ CONTEXT: CODE "position of imaging subject", …}.
INFERRED FROM	Inferred From	Source Content Item conveys a measurement or other inference made from the Target Content Items. Denotes the supporting evidence for a measurement or judgment. E.g., CODE "Malignancy" {INFERRED FROM: CODE "Mass", INFERRED FROM: CODE "Lymphadenopathy", …}. E.g., NUM: "BPD" = "5mm" {INFERRED FROM: SCOORD}.
SELECTED FROM	Selected From	Source Content Item conveys spatial or temporal coordinates selected from the Target Content Item(s). E.g., SCOORD "POLYLINE1,1 5,10 5,10 1,10 1,1" {SELECTED FROM: IMAGE}. E.g., TCOORD "SEGMENT 60-200mS" {SELECTED FROM: WAVEFORM}.

C.17.3.2.5 Referenced Content Item Identifier

Content Items are identified by their position in the Content Item tree. They have an implicit order as defined by the order of the Sequence Items. When a Content Item is the target of a by-reference relationship, its position is specified in the Referenced Content Item Identifier (0040,DB73) in a Content Sequence Item subsidiary to the source Content Item.

Note

Figure C.17.3-3 illustrates an SR content tree and identifiers associated with each Content Item:

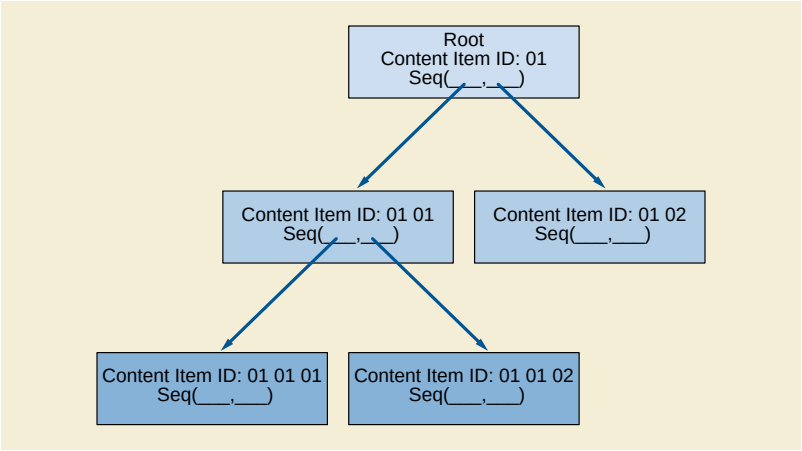


Figure C.17.3-3. Use of Position as SR Content Item Identifier (Informative)

C.17.4 SR Content Tree Example (Informative)

Figure C.17.4-1 depicts the content of an example diagnostic interpretation.

Note

1. For nodes of type CONTAINER, the contents of the Concept Name Code Sequence are shown in quotes and italicized.
2. For nodes of Value Type CODE, PNAME, NUM the contents are shown as "Concept Name Code Sequence = Value".
3. For the nodes of Value Type IMAGE and SCOORD, the contents of the Concept Name Code Sequence indicating the purpose of reference are shown in quotes and italicized.
4. The root node containing the Document Type is illustrated using a post-coordinated node of "Chest X-Ray", qualified using a HAS CONCEPT MOD relationship by a child with a CODE meaning "Views = PA and Lateral". An alternative would be to use a single pre-coordinated code in one node that applies to the entire concept of a "Two-view (PA and Lateral) Chest X-Ray". However, the use of pre-coordinated terms to describe complex concepts rapidly becomes unwieldy and difficult to search on (in the sense that more specific pre-coordinated codes do not have a visible relationship with more general codes). If it were necessary to include a longer textual description of Document Type, then this could be achieved with a HAS CONCEPT MOD relationship with one or more TEXT nodes, perhaps in different languages.
5. The Document Type is only a title, and is not being used to convey the Procedure Context, although in this example it does appear to contain a description of some aspects of Procedure Context.

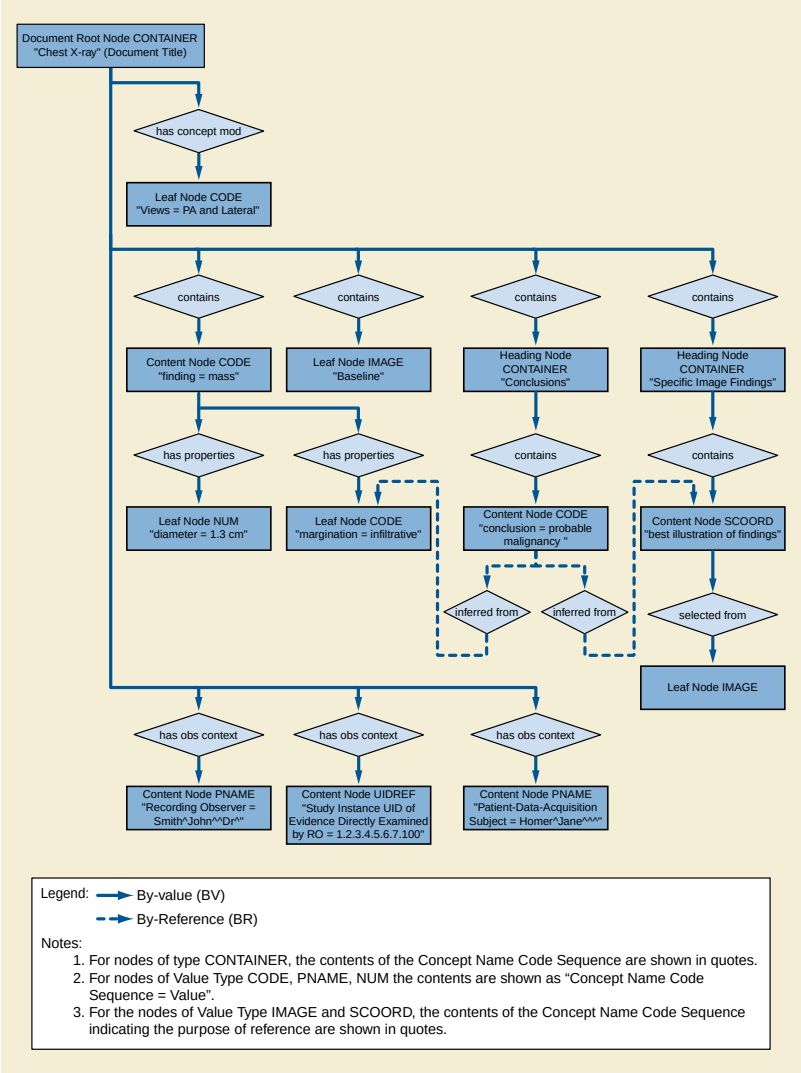


Figure C.17.4-1. SR Content Tree for an Example Diagnostic Interpretation (Informative)

C.17.5 Observation Context Encoding

Observation Context describes who or what is performing the interpretation (observer context), whether the examination of evidence is direct or quoted (quotation mode), what procedure generated the evidence that is being interpreted (procedure context), and who or what is the subject of the evidence that is being interpreted (subject context).

Initial Observation Context is defined outside the SR Document Content tree by other Modules in the SR IOD. The Patient Module specifies the default Subject Context, the General Study Module specifies the default Procedure Context, and the SR Document General Module specifies the default Observer Context. The default context has the meaning "this Structured Report was produced by the observer identified in the SR Document General Module, using direct observation, for the procedure identified in the General Study Module, and is about the patient identified in the Patient Module." Observation Context defined by Attributes in these Modules applies to all Content Items in the SR Document Content tree and need not be explicitly coded in the tree. The initial Observation Context from outside the tree can be explicitly replaced for the entire tree, or for any sub-tree.

Observer Context is set from the Author Observer Sequence (0040,A078), if present, or secondarily from the Verifying Observer Sequence (0040,A073). If neither is present, the Observer Context is undefined.

Note

In the absence of Observer Context, it may be presumed that the observations were generated by or with the equipment identified in the General Equipment Module.

The Procedure Context is set from the Study Instance UID (0020,000D), Study ID (0020,0010), Accession Number (0008,0050), and Procedure Code Sequence (0008,1032) of the General Study Module. The Referenced Request Sequence (0040,A370) might include an Item with the same Study Instance UID that further elaborates the Procedure Context, e.g., providing Placer Order Number (0040,2016) and/or Filler Order Number (0040,2017). If the Referenced Request Sequence includes Items with different Study Instance UIDs, those shall be treated as Procedure Context only if explicitly encoded in the Content Tree.

Medical or clinical characteristics of the patient specified in the Patient Study Module, such as in Attributes Patient's Size (0010,1020) and Patient's Weight (0010,1030), shall not be inherited by the Content Tree as part of the default Patient Context. Such characteristics must be specifically encoded in the Content Tree to be part of the Structured Report.

Note

The Patient Study Module may be included in SR SOP Instances. As part of the Study IE shared by all SOP Instances within a Study, such inclusion should be consistent across all Instances. However, its purpose is to provide a minimum set of clinical context for the (initial) interpretation of the images or waveforms of the Study. An SR SOP Instance that documents the interpretation must explicitly describe the relevant clinical context in the SR Content Tree.

If a Content Item in the SR Document Content tree has Observation Context different from the initial context already encoded elsewhere in the IOD, the context information applying to that Content Item shall be encoded as child nodes of the Content Item in the tree using the HAS OBS CONTEXT relationship. That is, Observation Context is a property of its parent Content Item.

The context information specified in the Observation Context child nodes (i.e., target of the HAS OBS CONTEXT relationship) sets the Observation Context of their parent node Content Item. Observation Context is encoded in the same manner as any other Content Item.

The Observation Context applies to all the by-value descendant nodes of that parent node regardless of the relationship type between the parent and the descendant nodes, until and unless the context of a descendant node is reset by other Observation Context Content Items. Observation Context shall not be inherited across by-reference relationships. The four dimensions of Observation Context (observer context, quotation mode, procedure context, and subject context) may be reset independently; e.g., resetting the subject context does not reset the observer or procedure context, or the quotation mode. See the example in Figure C.17.5-1.

Note

For example, the "subject context" may be defined by attaching an appropriate Content Item to the root node with a HAS OBS CONTEXT relationship. This "subject context" then applies not only to the root node, but to all its descendants, until such time as a Content Item explicitly replaces the "subject context" attribute, the new value of which is then inherited by all of that nodes descendants.

Observation DateTime is not included as part of the HAS OBS CONTEXT relationship, and therefore is not inherited along with other Observation Context. The Observation DateTime Attribute is included in each Content Item, which allows different observation dates and times to be attached to different Content Items.

The IOD may specify restrictions on Content Items and Relationship Types that also constrain the flexibility with which Observation Context may be described.

The IOD may specify Templates that offer or restrict patterns and content in Observation Context.

Note

1. Node 2 inherits any Observation Context of Node 1, which is then extended or replaced by the additional Observation Context defined in Nodes C1 and C2 (that is C1 and C2 are properties of 2).

2. Node 3 and its descendents inherit the Observation Context of Node 2, which includes C1 and C2.

3. Node 4 inherits the Observation Context of Node 2, which includes C1 and C2.

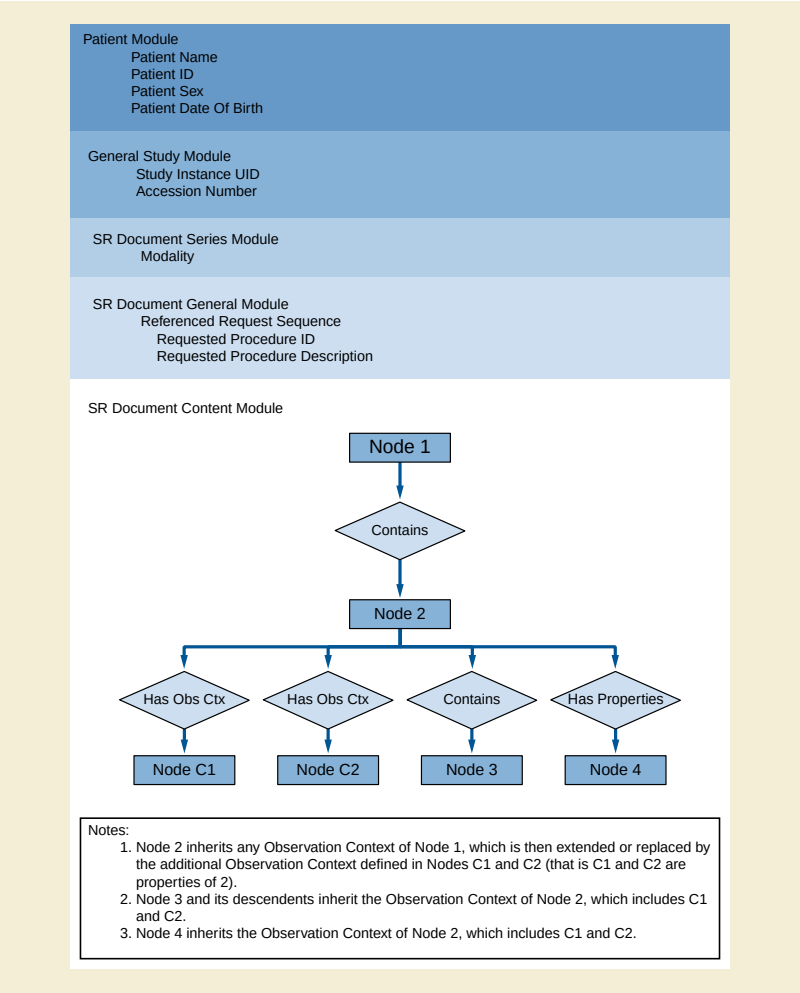


Figure C.17.5-1. Definition and Inheritance of Observation Context (Informative)

C.17.6 Key Object Selection Modules

C.17.6.1 Key Object Document Series Module

Table C.17.6-1 defines the Attributes of the Key Object Document Series.

Note

Series of Key Object Selection Documents are separate from Series of Images or other Composite SOP Instances. Key Object Documents do not reside in a Series of Images or other Composite SOP Instances.

Table C.17.6-1. Key Object Document Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type. Enumerated Values: **KO** Key Object Selection

Attribute Name	Tag	Type	Attribute Description
Series Instance UID	(0020,000E)	1	Unique identifier of the Series. Note No specific semantics are specified.
Series Number	(0020,0011)	1	A number that identifies the Series. Note No specific semantics are specified.
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Protocol Name	(0018,1030)	3	Description of the conditions under which the Series was performed. Note This may represent the type of analysis used in creation of the KO SOP Instances.
Series Description	(0008,103E)	3	Description of the Series
Series Description Code Sequence	(0008,103F)	3	A coded description of the Series. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Referenced Performed Procedure Step Sequence	(0008,1111)	2	Uniquely identifies the Performed Procedure Step SOP Instance for which the Series is created. Zero or one Item shall be included in this Sequence. Note See notes on this Attribute in Section C.17.1
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.17.6.2 Key Object Document Module

Table C.17.6-2 defines the general Attributes of a Key Object Selection Document. These Attributes identify and provide context for the Key Object Selection Document.

Table C.17.6-2. Key Object Document Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies the Document.
Content Date	(0008,0023)	1	The date the document content creation started.
Content Time	(0008,0033)	1	The time the document content creation started.
Referenced Request Sequence	(0040,A370)	1C	Identifies Requested Procedures to which this Document pertains. One or more Items shall be included in this Sequence. Required if this Document pertains to at least one Requested Procedure.
>Study Instance UID	(0020,000D)	1	Unique identifier for the Study.

Attribute Name	Tag	Type	Attribute Description
>Referenced Study Sequence	(0008,1110)	2	Uniquely identifies the Study SOP Instance. Zero or one Item shall be included in this Sequence. See Section 10.6.1.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Accession Number	(0008,0050)	2	A departmental IS generated number that identifies the order for the Study.
>Issuer of Accession Number Sequence	(0008,0051)	3	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Placer Order Number/Imaging Service Request	(0040,2016)	2	The order number assigned to the Imaging Service Request by the party placing the order.
>Order Placer Identifier Sequence	(0040,0026)	3	Identifier of the Assigning Authority that issued the Placer Order Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Filler Order Number/Imaging Service Request	(0040,2017)	2	The order number assigned to the Imaging Service Request by the party filling the order.
>Order Filler Identifier Sequence	(0040,0027)	3	Identifier of the Assigning Authority that issued the Filler Order Number. Only a single Item is permitted in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"			
>Requested Procedure ID	(0040,1001)	2	Identifier of the related Requested Procedure
>Requested Procedure Description	(0032,1060)	2	Institution-generated administrative description or classification of Requested Procedure.
>Requested Procedure Code Sequence	(0032,1064)	2	A Sequence that conveys the requested procedure. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Current Requested Procedure Evidence Sequence	(0040,A375)	1	List of all Composite SOP Instances referenced in Content Sequence (0040,A730), including all presentation states, real world value maps and other accompanying Composite Instances that are referenced from the Content Items. One or more Items shall be included in this Sequence. Note In the context of the Key Object Selection, the current evidence is considered to be only the set of Instances referenced within the Key Object Selection.
>Include Table C.17-3 "Hierarchical SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
Identical Documents Sequence	(0040,A525)	1C	Duplicates of this document, stored with different SOP Instance UIDs. One or more Items shall be included in this Sequence. Required if this Key Object Selection document references Instances in more than one Study. See Section C.17.2.2 and Section C.17.6.2.1 for further explanation and conditions.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			

C.17.6.2.1 Identical Documents

If the Current Requested Procedure Evidence Sequence (0040,A375) references SOP Instances both in the current Study and in one or more other Studies, this document shall be duplicated into each of those other Studies, and the duplicates shall be referenced in the Identical Documents Sequence (0040,A525).

Note

Thus a Key Object Selection Document that references images in the current Study as well as in a prior or comparison Study, would be duplicated into the other Study. This allows an application displaying that other Study to easily access notes relevant to that Study's SOP Instances.

C.18 Content Macros

C.18.1 Numeric Measurement Macro

Table C.18.1-1 specifies the Attributes that convey a NUM (numeric measurement) value.

Note

The Measured Value Sequence (0040,A300) may be empty to convey the concept of a measurement whose value is unknown or missing, or a measurement or calculation failure.

Table C.18.1-1. Numeric Measurement Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Measured Value Sequence	(0040,A300)	2	This is the value of the Content Item. Shall consist of a Sequence of Items conveying the measured value(s), which represent integers or real numbers and units of measurement. Zero or one Item shall be included in this Sequence.
>Numeric Value	(0040,A30A)	1	Numeric measurement value. Only a single value shall be present.
>Floating Point Value	(0040,A161)	1C	The floating point representation of Numeric Value (0040,A30A). Only a single value shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent the value as a string. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Rational Numerator Value	(0040,A162)	1C	The integer numerator of a rational representation of Numeric Value (0040,A30A). Encoded as a signed integer value. Only a single value shall be present. Required if Numeric Value (0040,A30A) has insufficient precision to represent a rational value as a string. May be present otherwise.
>Rational Denominator Value	(0040,A163)	1C	The integer denominator of a rational representation of Numeric Value (0040,A30A). Encoded as a non-zero unsigned integer value. Only a single value shall be present. Required if Rational Numerator Value (0040,A162) is present.
>Measurement Units Code Sequence	(0040,08EA)	1	Units of measurement. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 82 "Units of Measurement".*
Numeric Value Qualifier Code Sequence	(0040,A301)	3	Qualification of Numeric Value (0040,A30A) in Measured Value Sequence (0040,A300), or reason for absence of Measured Value Sequence (0040,A300) Item. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 42 "Numeric Value Qualifier".*

C.18.2 Code Macro

Table C.18.2-1 specifies the Attributes that convey a CODE value.

Table C.18.2-1. Code Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Concept Code Sequence	(0040,A168)	1	This is the value of the Content Item. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*

C.18.3 Composite Object Reference Macro

Table C.18.3-1 specifies the Attributes that convey a reference to a DICOM Composite Object that is not a DICOM Image or Waveform (such as an SR Document), or to an HL7 Structured Document.

Note

1. If a Softcopy Presentation State is to be applied to an Image, it should be referenced by an Image Reference Macro.
2. Other SR Documents may be referenced by this Macro, but there is no facility to reference individual Content Items within those reports.
3. HL7 Structured Documents include, in particular, those conforming to the Clinical Document Architecture (CDA). See Section C.12.1.1.6 for further details about this type of referenced object.

Table C.18.3-1. Composite Object Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced SOP Sequence	(0008,1199)	1	References to Composite Object SOP Class/SOP Instance pairs. Only a single Item shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.18.4 Image Reference Macro

Table C.18.4-1 specifies the Attributes that convey a reference to a DICOM image.

Table C.18.4-1. Image Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.18.3-1 "Composite Object Reference Macro Attributes"			
>Referenced Frame Number	(0008,1160)	1C	Identifies the frame numbers within the Referenced SOP Instance to which the reference applies. The first frame shall be denoted as frame number 1. Note This Attribute may be multi-valued. Required if the Referenced SOP Instance is a multi-frame image and the reference does not apply to all frames, and Referenced Segment Number (0062,000B) is not present.
>Referenced Segment Number	(0062,000B)	1C	Identifies the segments to which the reference applies identified by Segment Number (0062,0004). Required if the Referenced SOP Instance is a Segmentation and the reference does not apply to all segments and Referenced Frame Number (0008,1160) is not present.
>Referenced SOP Sequence	(0008,1199)	3	Reference to a Softcopy Presentation State SOP Class/SOP Instance pair. Only a single Item is permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Real World Value Mapping Instance Sequence	(0008,114B)	3	Reference to a Real World Value Mapping SOP Class/SOP Instance pair. Only a single Item is permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Image. Only a single Item is permitted in this Sequence. The Icon Image shall be no greater than 128 rows by 128 columns.
>>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6*

C.18.5 Waveform Reference Macro

Table C.18.5-1 specifies the Attributes that convey a reference to a DICOM waveform.

Table C.18.5-1. Waveform Reference Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.18.3-1 "Composite Object Reference Macro Attributes"			
>Referenced Waveform Channels	(0040,A0B0)	1C	List of channels in Waveform to which the reference applies. See Section C.18.5.1.1 Required if the Referenced SOP Instance is a Waveform that contains multiple Channels and not all Channels in the Waveform are referenced.

C.18.5.1 Waveform Reference Macro Attribute Descriptions

C.18.5.1.1 Referenced Waveform Channels

Referenced Waveform Channels (0040,A0B0) is a multi-value Attribute that lists the channels referenced. Each channel is specified as a pair of values (M,C), where the first value is the Item number of Waveform Sequence (5400,0100) in the referenced object (i.e., the Multiplex Group Number), and the second value is the Item number of Channel Definition Sequence (003A,0200) (i.e., the Channel Number) within the multiplex group.

If the specified channel number is 0, the annotation applies to all channels in the multiplex group.

Note

As an example, an annotation that applies to the entire first multiplex group and channels 2 and 3 of the third multiplex group would have Referenced Waveform Channels (0040,A0B0) value 0001 0000 0003 0002 0003 0003.

C.18.6 Spatial Coordinates Macro

Table C.18.6-1 specifies the Attributes that convey Spatial Coordinates in an SCOORD Content Item. An SCOORD Content Item shall always be the Source Content Item of one or more SELECTED FROM Relationships with IMAGE Target Content Items. Each IMAGE Target Content Item shall contain a reference to one single-frame or multi-frame Image.

Note

The same set of spatial coordinates may be selected from more than one single-frame image, or more than one frame of a multi-frame image when the purpose of reference is applicable to multiple images. For example, the spatial coordinates may specify the outline of a sampling region at the same spatial location on multiple images acquired over time.

Table C.18.6-1. Spatial Coordinates Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Graphic Data	(0070,0022)	1	An ordered set of (column,row) pairs that denote positions in an image specified with sub-pixel resolution such that the origin at the TLHC of the TLHC pixel is 0.0\0.0, the BRHC of the TLHC pixel is 1.0\1.0, and the BRHC of the BRHC pixel is Columns\Rows. The values must be within the range 0\0 to Columns\Rows. The maximum values are those contained in the referenced image in Attributes Columns (0028,0011) and Rows (0028,0010), or in the case of spatial coordinates with Pixel Origin Interpretation (0048,0301) value VOLUME, in Attributes Total Pixel Matrix Columns (0048,0006) and Total Pixel Matrix Rows (0048,0007). See Section C.18.6.1.1 for further explanation.
Graphic Type	(0070,0023)	1	See Section C.18.6.1.2 for Enumerated Values.

Attribute Name	Tag	Type	Attribute Description
Pixel Origin Interpretation	(0048,0301)	1C	For a referenced multi-frame image, specifies whether the Graphic Data (0070,0022) values are to be interpreted relative to the individual frame pixel origins, or relative to the Total Pixel Matrix origin (see Section C.8.12.4.1.4). Required if the value of Referenced SOP Class UID (0008,1150) of the referenced image is 1.2.840.10008.5.1.4.1.1.77.1.6 (VL Whole Slide Microscopy Image). May be present otherwise. Enumerated Values: **FRAME** relative to individual frame **VOLUME** relative to Total Image Matrix If not present, Graphic Data values are defined relative to the frame pixel origin.
Fiducial UID	(0070,031A)	3	The globally unique identifier for this fiducial Item. Note The fiducial UID can be used to associate this set of graphics with other Content Items.

C.18.6.1 Spatial Coordinates Macro Attribute Descriptions

C.18.6.1.1 Graphic Data

Graphic Data may be used to associate an anatomic or spatial Concept with a defined subset of one or more images. Graphic Data may be explicitly defined as a single point (i.e., to denote the epicenter of an anatomic site or lesion) or more than one point (i.e., representing a set of points or an open or closed polygon).

Note

Spatial coordinates may be used to associate observational data with a set of Image features. Spatial coordinates also may be used to convey coordinates that are input data for a measurement.

C.18.6.1.2 Graphic Type

When annotation applies to an image, this Attribute defines the type of geometry of the annotated region of interest.

Enumerated Values:

POINT a single pixel denoted by a single (column,row) pair
MULTIPOINT multiple pixels each denoted by an (column,row) pair
POLYLINE a series of connected line segments with ordered vertices denoted by (column,row) pairs; if the first and last vertices are the same it is a closed polygon
CIRCLE a circle defined by two (column,row) pairs. The first point is the central pixel. The second point is a pixel on the perimeter of the circle.
ELLIPSE an ellipse defined by four pixel (column,row) pairs, the first two points specifying the endpoints of the major axis and the second two points specifying the endpoints of the minor axis of an ellipse

Note

1. The order of encoding of successive points for any particular Graphic Type is significant, but its meaning is not specified. The meaning of the order may be defined by a particular Template that uses them. For example, a closed POLYLINE may be encoded with a clockwise (right) or counter-clockwise (left) winding order (when viewed from a specified direction). A two-point POLYLINE used to encode a vector with a direction might be expected to originate at the first encoded point and be directed towards the second encoded point, but that is not specified.

2. A Polygon encoded as a POLYLINE is not restricted to being a simple polygon, unless so specified by the Template that uses it.

C.18.7 Temporal Coordinates Macro

Table C.18.7-1 specifies the Attributes that convey TCOORD Content Items. A TCOORD Content Item shall be the Source Content Item of one or more SELECTED FROM relationships with one or more SCOORD Content Items, one or more IMAGE Content Items, or one or more WAVEFORM Content Items.

Note

1. The same set of temporal coordinates may be selected from more than one single-frame image, or more than one frame of a multi-frame image, or from images and waveforms when the purpose of reference is applicable to multiple objects. For example, the definition of a sampling period at different spatial locations on multiple images and a synchronously acquired waveform.

2. Temporal coordinates may refer to spatial coordinates, which in turn refer to one or more frames or images, for example to indicate a region localized in both time and space.

Table C.18.7-1. Temporal Coordinates Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Temporal Range Type	(0040,A130)	1	See Section C.18.7.1.1 for Enumerated Values.
Referenced Sample Positions	(0040,A132)	1C	List of samples within a multiplex group specifying temporal points of the referenced data. Position of first sample is 1. Required if the Referenced SOP Instance is a Waveform and Referenced Time Offsets (0040,A138) and Referenced DateTime (0040,A13A) are not present. ~~May~~Shall only be used ~~only if~~when Referenced Channels (0040,A0B0) refers to channels within a single multiplex group.
Referenced Time Offsets	(0040,A138)	1C	Specifies temporal points for reference by number of seconds after start of data. Required if Referenced Sample Positions (0040,A132) and Referenced DateTime (0040,A13A) are not present.
Referenced DateTime	(0040,A13A)	1C	Specifies temporal points for reference by absolute time. Required if Referenced Sample Positions (0040,A132) and Referenced Time Offsets (0040,A138) are not present.

C.18.7.1 Temporal Coordinates Macro Attribute Descriptions

C.18.7.1.1 Temporal Range Type

This Attribute defines the type of temporal extent of the region of interest. A temporal point (or instant of time) may be defined by a waveform sample offset (for a single waveform multiplex group only), time offset, or absolute time.

Enumerated Values:

POINT a single temporal point
MULTIPOINT multiple temporal points
SEGMENT a range between two temporal points
MULTISEGMENT multiple segments, each denoted by two temporal points
BEGIN a range beginning at one temporal point, and extending beyond the end of the acquired data
END a range beginning before the start of the acquired data, and extending to (and including) the identified temporal point

C.18.8 Container Macro

Table C.18.8-1 specifies the Attributes that convey a CONTAINER Content Item.

Table C.18.8-1. Container Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Continuity of Content	(0040,A050)	1	This flag specifies for a CONTAINER whether or not its contained Content Items are logically linked in a continuous textual flow, or are separate Items. Enumerated Values: **SEPARATE** **CONTINUOUS** See Section C.18.8.1.1 for further explanation.
Content Template Sequence	(0040,A504)	1C	Template that describes the content of this Content Item and its subsidiary Content Items. Only a single Item shall be included in this Sequence. Required if a template defined and known to the implementation at the time of encoding was used to define the content of this Item, and the template consists of a single CONTAINER with nested content, and it is the outermost invocation of a set of nested templates that start with the same CONTAINER (see Section C.18.8.1.2).
>Mapping Resource	(0008,0105)	1	Mapping Resource that defines the template. See Section 8.4. Defined Terms: **DCMR** DICOM Content Mapping Resource
>Mapping Resource UID	(0008,0118)	3	Uniquely identifies the Mapping Resource that defines the template. Note The unique identifier for the DICOM Content Mapping Resource "DCMR" is defined in PS3.6.
>Template Identifier	(0040,DB00)	1	Template identifier.

C.18.8.1 Container Macro Attribute Descriptions

C.18.8.1.1 Continuity of Content

Continuity of Content (0040,A050) specifies whether or not all the Content Items contained in a CONTAINER are logically linked in a continuous textual flow, or are separate entities. It only applies to the children contained in the container, and not their children (which if containers themselves, will have the Attribute specified explicitly).

Note

1. This allows the interspersing of measurements, codes, and image references, amongst text. For example, the following: "A mass of diameter = 3 cm was detected." can be represented by the following Content Items in a CONTAINER with a Continuity of Content (0040,A050) of CONTINUOUS:

   TEXT "A mass of"

   NUM "Diameter" 3 "cm"

   TEXT "was detected."

2. The Continuity of Content applies only to subsidiary Content Items with Relationship Type CONTAINS. Other subsidiary Content Items, e.g., with Relationship Type HAS CONCEPT MOD or HAS OBS CONTEXT, are not part of the Continuity of Content, but apply to the Container as a whole.

C.18.8.1.2 Content Template Sequence

A Template for SR Documents defines a set of constraints on the relationships and content (Value Types, Codes, etc.) of Content Items. Specific Templates for SR Documents are defined either by the DICOM Standard (see PS3.16) or by users of the Standard for particular purposes. Usage of Templates for SR Documents may improve comparability of essential data, facilitate data-entry and revisions, enable automatic processing and simplify presentation of information to the user.

Note

New subordinate templates may be factored out of existing Templates during revisions to the Standard or revisions to private Template definitions. It is permissible for Instances created by implementations made prior to such refactoring to omit identification of a Template of which they had no future knowledge. Receivers should be wary of depending on the presence of identification information for subordinate templates.

An SR Document consists of a Root CONTAINER Content Item with nested content, and as such may be defined by a Template specifying a single CONTAINER with nested content. Sub-trees of an SR Document may similarly be defined by a Template specifying a single CONTAINER with nested content. If created using such a Template, the Root and/or sub-tree shall identify the Template in the CONTAINER Content Item. When a Template invokes (includes) another Template, the outermost invoking Template is the one identified as the defining Template for the CONTAINER in the Content Template Sequence (0040,A504).

The Content Template Sequence (0040,A504) identifies the Template that was used in the creation of the associated Content Item and its subsidiary Content Items. A Template is identified by a Mapping Resource (0008,0105) (the entity that manages or registers the Template), and an identifier of the Template. DICOM Standard Templates are identified in Template Identifier (0040,DB00) using the CS value representation.

The DICOM Template Identifier (0040,DB00) is a string of digits, without leading zeroes, and does not include the string "TID".

C.18.9 3D Spatial Coordinates Macro

Table C.18.9-1 specifies the Attributes that convey 3D Spatial Coordinates in an SCOORD3D Content Item.

Table C.18.9-1. 3D Spatial Coordinates Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Frame of Reference UID	(3006,0024)	1	Uniquely identifies the Frame of Reference within which the coordinates are defined. Note 1. There is no requirement that the Frame of Reference be the same for all SCOORD3D Content Items in the same SR SOP Instance, nor is there any requirement that the Frame of Reference Module be present. 2. The Frame of Reference may be any type of DICOM Reference Coordinate System, whether it be patient-relative (Patient Based Coordinate System), volume-relative (including acquired and presentation state volumes), or whole slide relative (Slide Coordinate System).
Graphic Data	(0070,0022)	1	An ordered set of (x,y,z) triplets (in mm and may be negative) that define a region of interest in the patient-relative Reference Coordinate System defined by Referenced Frame of Reference UID (3006,0024). See Reference Coordinate System (RCS). See Section C.18.9.1.1 for further explanation.
Graphic Type	(0070,0023)	1	See Section C.18.9.1.2 for Enumerated Values.

Attribute Name	Tag	Type	Attribute Description
Fiducial UID	(0070,031A)	3	The globally unique identifier for this fiducial Item. Note The fiducial UID can be used to associate this set of graphics with other Content Items.

C.18.9.1 3D Spatial Coordinates Macro Attribute Descriptions

C.18.9.1.1 Graphic Data

Graphic Data may be used to associate an anatomic or spatial Concept with a defined set of patient relative 3D locations in a defined Frame of Reference, independent of any image. Graphic Data may be defined explicitly as a single point (i.e., to denote the epicenter of an anatomic site or lesion) or more than one point (i.e., representing a set of points or an open or closed polygon).

C.18.9.1.2 Graphic Type

This Attribute defines the type of geometry of the region of interest.

Enumerated Values:

POINT a single location denoted by a single (x,y,z) triplet

MULTIPOINT multiple locations each denoted by an (x,y,z) triplet; the points need not be coplanar

POLYLINE a series of connected line segments with ordered vertices denoted by (x,y,z) triplets; the points need not be coplanar

POLYGON a series of connected line segments with ordered vertices denoted by (x,y,z) triplets, where the first and last vertices shall be the same forming a polygon; the points shall be coplanar

ELLIPSE an ellipse defined by four (x,y,z) triplets, the first two triplets specifying the endpoints of the major axis and the second two triplets specifying the endpoints of the minor axis

ELLIPSOID a three-dimensional geometric surface whose plane sections are either ellipses or circles and contains three intersecting orthogonal axes, "a", "b", and "c"; the ellipsoid is defined by six (x,y,z) triplets, the first and second triplets specifying the endpoints of axis "a", the third and fourth triplets specifying the endpoints of axis "b", and the fifth and sixth triplets specifying the endpoints of axis "c"

Note

1. A circle is a special case of ELLIPSE where the major and minor axis points are equidistant from the center.
2. Coplanar is in the mathematical sense and is not necessarily related to a specific Image Instance.
3. The order of encoding of successive points for any particular Graphic Type is significant, but its meaning is not specified. The meaning of the order may be defined by a particular Template that uses them. For example, a closed POLYGON may be encoded with a clockwise (right) or counter-clockwise (left) winding order (when viewed from a specified direction). A two-point POLYLINE used to encode a vector with a direction might be expected to originate at the first encoded point and be directed towards the second encoded point, but that is not specified.
4. A POLYGON is not restricted to being a simple polygon, unless so specified by the Template that uses it.

C.19 Raw Data Specific Modules

The following Modules are used by the Raw Data IOD.

C.19.1 Raw Data Module

Table C.19-1 specifies the Attributes that describe a raw data stream.

Table C.19-1. Raw Data Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	2	A number that identifies this raw data. The value shall be unique within a Series.
Content Date	(0008,0023)	1	The date the raw data creation was started.
Content Time	(0008,0033)	1	The time the raw data creation was started.
Acquisition DateTime	(0008,002A)	3	The date and time that the acquisition of data started. Note The synchronization of this time with an external clock is specified in the synchronization Module in Acquisition Time synchronized (0018,1800).
Content Label	(0070,0080)	3	A label that is used to identify this SOP Instance.
Content Description	(0070,0081)	3	A description of the content of the SOP Instance.
Concept Name Code Sequence	(0040,A043)	3	A coded description of the content of the SOP Instance. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Image Laterality	(0020,0062)	3	Laterality of (possibly paired) body part examined. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right
Creator-Version UID	(0008,9123)	1	Unique identification of the equipment and version of the software that has created the Raw Data information. The UID allows one to avoid attempting to interpret raw data with an unknown format.
Referenced Instance Sequence	(0008,114A)	3	Other Instances significantly related to this Instance. One or more Items are permitted in this Sequence.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	1	Describes the purpose for which the reference is made. Only a single Item shall be included in this Sequence. See Section C.7.6.16.2.5.1.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Include any Private Attributes that contain Raw Data information. See Section C.19.1.1 for further explanation.			

C.19.1.1 Raw Data

The Raw Data stored with the Raw Data Module consists of one or more Private Attributes that are vendor specific. No rules are specified about the content and format of the raw data.

C.20 Spatial Registration

C.20.1 Spatial Registration Series Module

Table C.20.1-1 defines the general Attributes of the Spatial Registration Series Module.

Table C.20.1-1. Spatial Registration Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type. Enumerated Values: **REG**

C.20.2 Spatial Registration Module

Table C.20.2-1 defines the general Attributes of the Spatial Registration Module.

Table C.20.2-1. Spatial Registration Module Attributes

Attribute Name	Tag	Type	Attribute Description
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Registration Sequence	(0070,0308)	1	A Sequence of registration Items. Each Item defines a spatial registration of the images referenced in that Item to the Registered RCS established by this SOP Instance. All referenced images are in the same spatial Frame of Reference or atlas. One or more Items shall be included in this Sequence.
>Frame of Reference UID	(0020,0052)	1C	Identifies the Frame of Reference of the referenced data, that may or may not be an image set (e.g., atlas or physical space). See Section C.7.4.1.1.1 for further explanation. Required if Referenced Image Sequence (0008,1140) is absent. May be present otherwise.
>Referenced Image Sequence	(0008,1140)	1C	Identifies the set of images of the referenced data, registered in this Item. One or more Items shall be included in this Sequence. Required if Frame of Reference UID (0020,0052) is absent. May be present otherwise.
>>Include Table 10-3 “Image SOP Instance Reference Macro Attributes”			
>Matrix Registration Sequence	(0070,0309)	1	A Sequence that specifies one spatial registration. Only a single Item shall be included in this Sequence.
>>Frame of Reference Transformation Comment	(3006,00C8)	3	User description or comments about the registration.
>>Registration Type Code Sequence	(0070,030D)	2	Describes the information input into the registration process. Zero or one Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7100 “RCS Registration Method Type”.*

Attribute Name	Tag	Type	Attribute Description
>>Matrix Sequence	(0070,030A)	1	Specifies one transformation, that registers the Source RCS/images to the Registered RCS. It is expressible as multiple matrices, each in a separate Item of the Sequence. One or more Items shall be included in this Sequence. The Item order is significant and corresponds to matrix multiplication order. See Section C.20.2.1.1.
>>>Frame of Reference Transformation Matrix	(3006,00C6)	1	A 4x4 affine transformation matrix that registers a homogeneous coordinate system A to B. Matrix elements shall be listed in row-major order. See Section C.20.2.1.1.
>>>Frame of Reference Transformation Matrix Type	(0070,030C)	1	Type of Frame of Reference Transformation Matrix (3006,00C6). Enumerated Values: **RIGID** **RIGID_SCALE** **AFFINE** See Section C.20.2.1.2
>Used Fiducials Sequence	(0070,0314)	3	The fiducials used to determine the Frame of Reference Transformation Matrix. One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			Reference to the Spatial Fiducial SOP Instance identifying the Used Fiducial(s)
>>Fiducial UID	(0070,031A)	1	The UID that identifies the fiducial used as registration input.
>Used Segments Sequence	(0062,0012)	3	The segments used to determine the Frame of Reference Transformation Matrix. One or more Items are permitted in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			Reference to the Segmentation or Surface Segmentation SOP Instance identifying the Used Segments.
>>Referenced Segment Number	(0062,000B)	1	Uniquely identifies the segment described in Segment Sequence (0062,0002) by reference to Segment Number (0062,0004). Referenced Segment Number (0062,000B) shall not be multi-valued.

C.20.2.1 Registration Module Attribute Descriptions

C.20.2.1.1 Frame of Reference Transformation Matrix

The Frame of Reference Transformation Matrix (3006,00C6) ${}^{A}M_{B}$ describes how to transform a point (${}^{B}x$,${}^{B}y$,${}^{B}z$) with respect to RCS_B into (${}^{A}x$,${}^{A}y$,${}^{A}z$) with respect to RCS_A according to Equation C.20.2-1.

$$\begin{bmatrix} A_x \\ A_y \\ A_z \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & T_x \\ M_{21} & M_{22} & M_{23} & T_y \\ M_{31} & M_{32} & M_{33} & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} B_x \\ B_y \\ B_z \\ 1 \end{bmatrix} \quad \text{(C.20.2-1)}$$

The Matrix Registration is expressible as multiple matrices, each in a separate Item of Matrix Sequence (0070,030A). Equation C.20.2-2 specifies the order of the matrix multiplication where $\mathbf{M_1}$, $\mathbf{M_2}$ and $\mathbf{M_3}$ are the first, second and third Items in the Sequence.

$$[x' \;\; y' \;\; z' \;\; 1]^T = M_3\left(M_2\left(M_1[x \;\; y \;\; z \;\; 1]^T\right)\right) \quad \text{(C.20.2-2)}$$

where

$$[x \;\; y \;\; z \;\; 1]^T = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Registration often involves two or more RCS, each with a corresponding Frame of Reference Transformation Matrix. For example, another Frame of Reference Transformation Matrix ${}^{A}M_{C}$ can describe how to transform a point (${}^{C}x, {}^{C}y, {}^{C}z$) with respect to RCS $_{C}$ into (${}^{A}x, {}^{A}y, {}^{A}z$) with respect to RCS_{A}. It is straightforward to find the Frame of Reference Transformation Matrix ${}^{B}M_{C}$ that describes how to transform the point (${}^{C}x, {}^{C}y, {}^{C}z$) with respect to RCS_{C} into the point (${}^{B}x, {}^{B}y, {}^{B}z$) with respect to RCS_{B}. The solution is to invert ${}^{A}M_{B}$ and multiply by ${}^{A}M_{C}$, as shown in Equation C.20.2-3.

$$\begin{bmatrix} B_x \\ B_y \\ B_z \\ 1 \end{bmatrix} = \left({}^{A}M_{B}\right)^{-1} * {}^{A}M_{C} \begin{bmatrix} C_x \\ C_y \\ C_z \\ 1 \end{bmatrix} \qquad \text{(C.20.2-3)}$$

If two or more transformation matrices describe the relation between Patient coordinates and a device-centric Well-known Frame of Reference, any calculations assuming transitivity via the Well-known Frame of Reference must be performed with great care to assure that both registrations reflect the same positioning of the patient with respect to the common Well-known Frame of Reference.

C.20.2.1.2 Frame of Reference Transformation Matrix Type

There are three types of Registration Matrices:

RIGID: This is a registration involving only translations and rotations. Mathematically, the matrix is constrained to be orthonormal and describes six degrees of freedom: three translations, and three rotations.

RIGID_SCALE: This is a registration involving only translations, rotations and scaling. Mathematically, the matrix is constrained to be orthogonal and describes nine degrees of freedom: three translations, three rotations and three scales. This type of transformation is sometimes used in atlas mapping.

AFFINE: This is a registration involving translations, rotations, scaling and shearing. Mathematically, there are no constraints on the elements of the Frame of Reference Transformation Matrix other than that the last row shall be (0,0,0,1) to preserve the homogeneous coordinates, so it conveys twelve degrees of freedom. This type of transformation is sometimes used in atlas mapping.

See Annex P “Transforms and Mappings (Informative)” in PS3.17 for more detail.

C.20.3 Deformable Spatial Registration Module

Table C.20.3-1 defines the general Attributes of the Deformable Spatial Registration Module.

Table C.20.3-1. Deformable Spatial Registration Module Attributes

Attribute Name	Tag	Type	Attribute Description
Content Date	(0008,0023)	1	The date the vector grid data creation started.
Content Time	(0008,0033)	1	The time the vector grid data creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Deformable Registration Sequence	(0064,0002)	1	A Sequence of registration Items. Each Item defines a spatial registration to the referenced images in that Item. At least one Item shall have a Deformable Registration Grid Sequence (0064,0005) with one Item. See Section C.20.3.1.1. One or more Items shall be included in this Sequence.
>Source Frame of Reference UID	(0064,0003)	1	Identifies the Frame of Reference of a Source RCS. The Source RCS may or may not include an image set (e.g., atlas). See Section C.7.4.1.1.1 for further explanation.

Attribute Name	Tag	Type	Attribute Description
>Referenced Image Sequence	(0008,1140)	1C	Identifies the set of images registered in this Item. One or more Items shall be included in this Sequence. Required if the registration applies to a subset of images within the specified Source Frame of Reference UID (0064,0003). All referenced images shall be in the same spatial Frame of Reference.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Frame of Reference Transformation Comment	(3006,00C8)	3	User description or comments about the registration.
>Registration Type Code Sequence	(0070,030D)	2	Describes the method used for the registration process. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7100 "RCS Registration Method Type".*
>Pre Deformation Matrix Registration Sequence	(0064,000F)	1C	A Sequence that specifies one spatial registration to be applied prior to the deformation. Only a single Item shall be included in this Sequence. Required if a matrix transformation is to be applied prior to deformation.
>>Frame of Reference Transformation Matrix	(3006,00C6)	1	A 4x4 homogeneous transformation ~~matrix.Matrix~~matrix. Matrix elements shall be listed in row-major order. See Section C.20.2.1.1.
>>Frame of Reference Transformation Matrix Type	(0070,030C)	1	Type of Frame of Reference Transformation Matrix (3006,00C6). Enumerated Values: **RIGID** **RIGID_SCALE** **AFFINE** See Section C.20.2.1.2
>Post Deformation Matrix Registration Sequence	(0064,0010)	1C	A Sequence that specifies one spatial registration to be applied after the application of the deformation. Only a single Item shall be included in this Sequence. Required if matrix transformation is to be performed after application of the deformation.
>>Frame of Reference Transformation Matrix	(3006,00C6)	1	A 4x4 homogeneous transformation matrix. Matrix elements shall be listed in row-major order. See Section C.20.2.1.1.
>>Frame of Reference Transformation Matrix Type	(0070,030C)	1	Type of Frame of Reference Transformation Matrix (3006,00C6). Defined Terms: **RIGID** **RIGID_SCALE** **AFFINE** See Section C.20.2.1.2

Attribute Name	Tag	Type	Attribute Description
>Deformable Registration Grid Sequence	(0064,0005)	1C	Describes the deformation grid used to sample into the Source RCS. Only a single Item shall be included in this Sequence. Required if deformation is performed. See Section C.20.3.1.2.
>>Image Orientation (Patient)	(0020,0037)	1	The direction of cosines of the first row and first column of the Vector Grid Data (0064,0009) with respect to the patient. See Section C.7.6.2.1.1 for further explanation.
>>Image Position (Patient)	(0020,0032)	1	The x, y, and z coordinates of the upper left hand voxel (center of the first voxel transmitted) of the grid, in mm in the Registered Frame of Reference. See Section C.7.6.2.1.1 for further explanation.
>>Grid Dimensions	(0064,0007)	1	The dimensions of the grid, in voxels. A triple representing the number of voxels along the X, Y, and Z axes.
>>Grid Resolution	(0064,0008)	1	The resolution of the grid voxels. A triple representing the size of a deformation voxel in along the X, Y, and Z dimension, in mm.
>>Vector Grid Data	(0064,0009)	1	A data stream of vectors. See Section C.20.3.1.3 for further explanation.
>Used Fiducials Sequence	(0070,0314)	3	The fiducials used to determine the registration. One or more Items are permitted in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			Reference to the Spatial Fiducial SOP Instance identifying the Used Fiducial(s)
>>Fiducial UID	(0070,031A)	1	The UID that identifies the fiducial used as registration input.

C.20.3.1 Deformable Spatial Registration Module Attribute Descriptions

C.20.3.1.1 Deformable Registration Sequence Application

The registrations in this Module are applied to the Registered RCS coordinates in the following order. First, transform the coordinates using the matrix described in the Pre Deformation Matrix Registration Sequence (0064,000F). Next apply the deformation offsets to the resulting coordinates. Finally, transform those coordinates using the matrix described in the Post Deformation Matrix Registration Sequence (0064,0010). The resulting coordinate addresses the sample point within the Source RCS.

Thus a source coordinate may be calculated using Equation C.20.3-1 (this assumes that the center position of each deformation voxel will be transformed).

$$\begin{bmatrix} X_{Source} \\ Y_{Source} \\ Z_{Source} \\ 1 \end{bmatrix} = M_{Post}\left(M_{Pre} \begin{bmatrix} X_{Row}X_R & X_{Column}Y_R & X_{Depth}Z_R & X_{Start} \\ Y_{Row}X_R & Y_{Column}Y_R & Y_{Depth}Z_R & Y_{Start} \\ Z_{Row}X_R & Z_{Column}Y_R & Z_{Depth}Z_R & Z_{Start} \end{bmatrix} \begin{bmatrix} i \\ j \\ k \\ 1 \end{bmatrix} + \begin{bmatrix} \Delta X_{ijk} \\ \Delta Y_{ijk} \\ \Delta Z_{ijk} \\ 0 \end{bmatrix} \right) \quad \text{(C.20.3-1)}$$

Where:

$[X\ \ Y\ \ Z]_{Source}$ The spatial coordinate in the Source RCS.

$[X\ \ Y\ \ Z]_{Start}$ The start coordinate, in the Registered RCS, of the deformation grid as specified in Image Position (Patient) (0020,0032).

$[X\ \ Y\ \ Z]_{Row}$ The values from the row (X) direction cosine of Image Orientation (Patient) (0020,0037).

$[X\ \ Y\ \ Z]_{Column}$	The values from the column (Y) direction cosine of Image Orientation (Patient) (0020,0037).
$[X\ \ Y\ \ Z]_{Depth}$	The cross product between the row (X) direction cosine and the column (Y) direction cosine of Image Orientation (Patient) (0020,0037).
$[X\ \ Y\ \ Z]_{Depth} = [X\ \ Y\ \ Z]_{Row}\ \ [X\ \ Y\ \ Z]_{Column}$	
$[i\ \ j\ \ k]$	The index into the deformation grid in the X, Y, and Z dimension.
$[X\ \ Y\ \ Z]_{R}$	The resolution of the deformation grid in the X, Y, and Z dimension as specified in Grid Resolution (0064,0008).
$[\Delta X_{ijk}\ \ \Delta Y_{ijk}\ \ \Delta Z_{ijk}]$	The deformation specified at index (i,j,k) in the deformation grid. If the Deformation Registration Grid Sequence (0064,0005) has no Items, the D values are zero.
M_{Pre}	The transformation matrix specified in the Pre Deformation Matrix Registration Sequence (0064,000F).
M_{Post}	The transformation matrix specified in the Post Deformation Matrix Registration Sequence (0064,0010).

C.20.3.1.2 Deformable Registration Grid Sequence

The vector represents the deformation at the center of the voxel. Deformations between voxel centers shall be determined through interpolation of the surrounding vectors in an implementation dependent manner.

C.20.3.1.3 Vector Grid Data

Vector Grid Data (0064,0009) contains the vector data. Each voxel in Vector Grid Data (0064,0009) is represented by an

$$[\Delta X_{ijk}\ \ \Delta Y_{ijk}\ \ \Delta Z_{ijk}]$$

vector. The vector describes the direction and magnitude of the deformation at the center of the deformation voxel.

The order of vectors encoded for each vector plane shall be left to right, top to bottom, i.e., the upper left vector (labeled 1,1) is encoded first followed by the remainder of row 1, followed by the first vector of row 2 (labeled 2,1) then the remainder of row 2 and so on.

A vector triple with values of (NaN,NaN,NaN) shall indicate that the transformation at that point of the deformation grid is undefined.

The size of this Attribute value is determined by the dimensions specified in Grid Dimensions (0064,0007). For dimensions of X_D\$Y_D$\$Z_D$, the size of the Attribute value can be calculated with Equation C.20.3-2.

$$\text{Number of Bytes} = X_D * Y_D * Z_D * 3 * 4 \qquad \text{(C.20.3-2)}$$

C.21 Spatial Fiducials

C.21.1 Spatial Fiducials Series Module

Table C.21.1-1 defines the general Attributes of the Spatial Fiducials Series Module.

Table C.21.1-1. Spatial Fiducials Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type. Enumerated Values: **FID**

C.21.2 Spatial Fiducials Module

Table C.21.2-1 defines the general Attributes of the Registration.

Table C.21.2-1. Spatial Fiducials Module Attributes

Attribute Name	Tag	Type	Attribute Description
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 "Content Identification Macro Attributes"			
Fiducial Set Sequence	(0070,031C)	1	A Sequence of Items, each of which is a fiducial set. One or more Items shall be included in this Sequence.
>Frame of Reference UID	(0020,0052)	1C	Identifies a Frame of Reference that may or may not be an image set (e.g., an atlas or physical space). See Section C.7.4.1.1.1 for further explanation. Required if Referenced Image Sequence (0008,1140) is absent. May be present otherwise.
>Referenced Image Sequence	(0008,1140)	1C	Identifies the set of images in which the fiducials are located. One or more Items shall be included in this Sequence. Required if Frame of Reference UID (0020,0052) is absent. May be present otherwise. All referenced images shall have the same Frame of Reference UID if present in the images.
>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Fiducial Sequence	(0070,031E)	1	A Sequence that specifies fiducials, one Item per fiducial. One or more Items shall be included in this Sequence.
>>Fiducial Identifier	(0070,0310)	1	A fiducial assignment identifier that is unique within this Fiducial Sequence (0070,031E) Item but may match the fiducial identifier of an equivalent feature in another Item.
>>Fiducials Property Category Code Sequence	(0070,031F)	3	Sequence defining the general category of the property the fiducial represents. Only a single Item is permitted in this Sequence
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7110 "Fiducials Categories".*
>>Fiducial Identifier Code Sequence	(0070,0311)	1C	A Code Sequence for a term that identifies a well-known fiducial type (potentially including methodology, anatomy, tools, etc.). Only a single Item shall be included in this Sequence. Required if Identifier (0070,0310) is absent. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7111 "Fiducials".*
>>Fiducial UID	(0070,031A)	3	Globally unique identifier for the fiducial instance of this fiducial assignment.
>>Fiducial Description	(0070,030F)	3	User description or comments about the fiducial.
>>Shape Type	(0070,0306)	1	See Section C.21.2.1.1 for Defined Terms.
>>Number of Contour Points	(3006,0046)	1C	Number of points (triplets) in Contour Data (3006,0050). Required if Contour Data is present.
>>Contour Data	(3006,0050)	1C	Specifies the coordinates of this Item's fiducial. One triplet (x,y,z) shall be present for each point in the fiducial. See Section C.21.2.1.2 for further explanation. Required if Frame of Reference UID (0020,0052) is present in this Item of the Fiducial Set Sequence (0070,031C). Shall not be present otherwise. Note Contour Data may not be properly encoded if Explicit VR Transfer Syntax is used and the VL of this Attribute exceeds 65534 bytes.
>>Contour Uncertainty Radius	(0070,0312)	3	The estimated uncertainty radius for the Contour Data in mm. See Section C.21.2.1.3
>>Graphic Coordinates Data Sequence	(0070,0318)	1C	The image pixel locations of the fiducial's points. One or more Items shall be included in this Sequence. More than one Item shall be present only if a fiducial spans more than one image. Required if Contour Data is not present. May be present otherwise.
>>>Graphic Data	(0070,0022)	1	Graphic point coordinates of the fiducial points in the image of the Referenced Image Sequence. If Fiducial's Contour Data (3006,0050) is present, these points correlate to the points in the Contour Data, one row-column pair for each point and in the same order. See Section C.10.5.1.2 for further explanation.
>>>Referenced Image Sequence	(0008,1140)	1	A Sequence that specifies the image containing the fiducial's graphic coordinates. Only a single Item shall be included in this Sequence. Shall be an image within the set of the images in the Referenced Image Sequence (0008,1140) of the encapsulating Fiducial Set Sequence (0070,031C) Item.
>>>>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>>Definition Source Sequence	(0008,1156)	3	Instances containing the source of the ROI Contour information. Only a single Item is permitted in this Sequence.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes".			

Attribute Name	Tag	Type	Attribute Description
>>>Referenced ROI Number	(3006,0084)	1C	The value of ROI Number (3006,0022) in the referenced SOP Instance that identifies the ROI that is the origin of the Spatial Fiducial information. Required if Referenced SOP Class UID (0008,1150) is RT Structure Set Storage ("1.2.840.10008.5.1.4.1.1.481.3").

C.21.2.1 Spatial Fiducials Module Attribute Descriptions

C.21.2.1.1 Shape Type

For convenient registration, correlated Fiducials exist in each image set of the Registration Sequence. Correlated Fiducials are identified with either Fiducial Identifier (0070,0310) or Fiducial Identifier Code Sequence (0070,0311).

Shape Type (0070,0306) defines the geometric interpretation of Contour Data (3006,0050) and Graphic Data (0070,0022). A point is defined as a triplet (x,y,z) in the case of spatial data or a pair (x,y) in the case of graphic data.

Defined Terms:

POINT a single point designating a single fiducial point.

Note

A point may be the epicenter of a more complex shape such as sphere.

LINE two points that specify a line or axis such as the inter-orbital line. The point locations have no significance other than identifying the line, i.e., they are not line segment end points.

PLANE three points that identify a plane such as the laterality plane

SURFACE three or more points (usually many) that reside on, or near, a region of a curved surface. The surface may be flat or curved, closed or open. The point order has no significance.

RULER two or more evenly spaced collinear points ordered sequentially along the line, such as a physical ruler placed in the imaging field.

L_SHAPE three points of two perpendicular line segments, AB and BC, having a common end point B. The order of the points is: ABC. May represent an L-shaped marker placed in the imaging field.

T_SHAPE three points of two perpendicular line segments AB and CD, such that C bisects AB. The order is ABD.

SHAPE two or more points that specify the shape of a well-known fiducial type. The term in the Fiducial Identifier Code Sequence (0070,0311) defines the shape and the order of the points that represent it. A shape is closed if the first and last point are the same, but not otherwise. Two different points are a line segment.

C.21.2.1.2 Contour Data

Contour Data (3006,0050) is an ordered set of triplets that defines a shape. The triplets (x,y,z) denote points in the Reference Coordinate System of the Registration Instance.

Note

Contours may associate observational data with a set of Image features or specify coordinates that are input data for a measurement.

C.21.2.1.3 Contour Uncertainty Radius

The uncertainty is an estimate of the standard deviation of the fiducial location process.

C.22 Media Creation Management Specific Modules

The following Sections specify Modules used for Media Creation Management.

C.22.1 Media Creation Management Module

Table C.22.1-1. Media Creation Management Module Attributes

Attribute name	Tag	Attribute Description
Storage Media File-Set ID	(0088,0130)	User or implementation specific human readable identification of the Storage Media to be created.
Storage Media File-Set UID	(0088,0140)	Uniquely identifies a Storage Media to be created.
Number of Copies	(2000,0010)	Number of copies of set of media to be created for storing this file-set. Note If the entire request fits on a single piece of media per copy, then this value corresponds to the actual number of pieces of media to be created.
Request Priority	(2200,0020)	Specifies the priority of the request. Enumerated Values: **HIGH** **MED** **LOW**
Label Using Information Extracted From Instances	(2200,0001)	Specifies whether or not to extract label information from the Instances. Enumerated Values: **YES** **NO**
Label Text	(2200,0002)	Unformatted free text to include in the label instead of or in addition to information extracted from the Instances.
Label Style Selection	(2200,0003)	An implementation-dependent code string that may be used as a hint to select a particular layout or format of label.
Media Disposition	(2200,0004)	Unstructured text that describes where and to whom the media is to be transmitted.
Barcode Value	(2200,0005)	String that describes the bar code value to be printed on the media label. Note It is SCU responsibility to convey a value for this Attribute coherent in length and content with the requested Barcode Symbology (2200,0006).
Barcode Symbology	(2200,0006)	Code string that describes the bar code symbology that shall be used for printing Barcode Value (2200,0005). See Section C.22.1.1 for Defined Terms.

Attribute name	Tag	Attribute Description
Allow Media Splitting	(2200,0007)	A flag indicating if the SCP is allowed to split this request over more than one piece of media. Enumerated Values: **YES** **NO** Note 1. The SCP is not required to support the split of a media creation request across more than one piece of media. 2. If the size of the set of SOP Instances is greater than the media storage capacity, and this flag has been set to NO, the SCP shall refuse to process the request.
Allow Lossy Compression	(2200,000F)	A flag indicating if the SCP is allowed to perform lossy compression. Enumerated Values: **YES** **NO**
Include Non-DICOM Objects	(2200,0008)	A flag indicating if the SCP should include in the media additional Non-DICOM information/objects Defined Terms: **NO** **FOR_PHYSICIAN** **FOR_PATIENT** **FOR_TEACHING** **FOR_RESEARCH**
Include Display Application	(2200,0009)	A flag indicating if the SCP should include on the media a DICOM Instance Display Application. Enumerated Values: **YES** **NO**
Preserve Composite Instances After Media Creation	(2200,000A)	A flag to indicate whether or not the SCU intends to issue a subsequent media creation request referencing some or all of the Instances contained in Referenced SOP Sequence (0008,1199). Enumerated Values: **YES** **NO**
Referenced SOP Sequence	(0008,1199)	A Sequence of Items where each Item references a single SOP Instance, the Media Application Profile to be used, and, where applicable, the icon representing the referenced image
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
>Requested Media Application Profile	(2200,000C)	The Media Application Profile to be used for this SOP Instance. Note This is the label of the profile as defined in PS3.11, e.g., "STD-XABC-CD".

Attribute name	Tag	Attribute Description
>Icon Image Sequence	(0088,0200)	This Icon Image is representative of the Image. Only a single Item is permitted in this Sequence.
>>Include Table C.7-11b "Image Pixel Macro Attributes"		*See Section C.7.6.1.1.6 for further explanation.*
Execution Status	(2100,0020)	Execution status of a request. See Section C.22.1.2 for Enumerated Values
Execution Status Info	(2100,0030)	Additional information about Execution Status (2100,0020). Defined Terms if Execution Status (2100,0020) is DONE, CREATING or IDLE: **NORMAL** See Section C.22.1.3 for Defined Terms when the Execution Status is PENDING or FAILURE.
Total Number of Pieces of Media Created	(2200,000B)	Number of pieces of media that have been successfully created, in order to store all copies of the requested file-set. Note If the entire request fits on a single piece of media per copy, then this value corresponds to the number of copies of media created.
Failed SOP Sequence	(0008,1198)	A Sequence of Items describing SOP Instances for which media creation failed.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"		
>Requested Media Application Profile	(2200,000C)	The Media Application Profile used for this SOP Instance. Note This is the label of the profile as defined in PS3.11, e.g., "STD-XABC-CD".
>Failure Reason	(0008,1197)	The reason that media creation failed for this SOP Instance. See Section C.22.1.4.
>Failure Attributes	(2200,000E)	Attributes associated with Failure Reason (0008,1197). See Section C.22.1.4.
Referenced Storage Media Sequence	(2200,000D)	A Sequence describing the identifiers of all pieces of media created to satisfy the request. One or more Items are allowed. Note If the SCP splits a media creation request across more than one piece of media (e.g., if it doesn't fit on one), then all the created pieces of media will be included in this Sequence.
> Storage Media File-Set ID	(0088,0130)	User or implementation specific human readable identification of the Storage Media that has been created.
> Storage Media File-Set UID	(0088,0140)	Uniquely identifies the Storage Media that has been created.

C.22.1.1 Barcode Symbology

Defined Terms:

CODE128 ISO/IEC 15417:2000 Information technology - Automatic identification and data capture techniques - Bar code symbology specification - Code128

CODE39 ISO/IEC 16388:1999 Information technology - Automatic identification and data capture techniques - Bar code symbology specifications - Code 39
INTER_2_5 ISO/IEC 16390:1999 Information technology - Automatic identification and data capture techniques - Bar code symbology specifications - Interleaved 2 of 5 (also known as USS ITF 2/5, I-2/5, ITF 2of5)
HIBC ANSI/HIBC 1-1996 Health Industry Bar Code (HIBC) Provider Applications Standard

Note

This doesn't list all the bar code symbologies in use (there are currently more than 400). Implementations supporting other symbologies can extend this list. Implementation specific code values shall be defined in the Conformance Statement.

C.22.1.2 Execution Status

Enumerated Values:

IDLE The SCP has created the media creation management Instance, but it has not been yet scheduled.
PENDING This media creation management Instance is still scheduled for processing
CREATING This media creation management Instance is being processed
DONE This media creation management Instance has been successfully processed
FAILURE This media creation management Instance failed to be processed

Note

IDLE describes the status of a new media creation management Instance (N-CREATE operation performed) for which the N-ACTION action has not been yet issued.

C.22.1.3 Execution Status Info

Defined Terms:

CHECK_MCD_OP The media creation request could not be accomplished since the device is not ready at this time and needs to be checked by an operator (e.g., covers/doors opened or device jammed)
CHECK_MCD_SRV The media creation request could not be accomplished since the device is not ready at this time and needs to be checked by a vendor service engineer (e.g., internal component failure)
DIR_PROC_ERR The DICOMDIR building process failed for some unspecified reason (e.g., mandatory Attributes or values missing)
DUPL_REF_INST Duplicated Instances in the Referenced SOP Sequence (0008,1199)
INST_AP_CONFLICT One or more of the elements in the Referenced SOP Sequence (0008,1199) are in conflict (e.g., the SOP Class specified is not consistent with the requested Application Profile)
INST_OVERSIZED A single Instance size exceeds the actual media capacity
INSUFFIC_MEMORY There is not enough memory available to complete this request
MCD_BUSY Media creation device is not available at this time, but should become ready without user intervention (e.g the media creation device's buffer capacity is full); the SCU should retry later
MCD_FAILURE Media creation device fails to operate; this may depend on permanent or transient hardware failures (e.g robot arm broken, DVD writer failed) or because it has been disabled by an operator
NO_INSTANCE One or more of the SOP Instances in the Referenced SOP Sequence (0008,1199) are not available
NOT_SUPPORTED One or more of the Application Profiles, and/or SOP Classes, referenced in the Referenced SOP Sequence (0008,1199) are not supported by the SCP
OUT_OF_SUPPLIES No more supplies (e.g., blank media, labeling ink) are available for the media creation device; operator intervention is required to replenish the supply
PROC_FAILURE A general processing failure was encountered
QUEUED This Media Creation Management Instance is still in queue
SET_OVERSIZED The file-set size exceeds the actual media capacity, and the device is not capable of splitting across multiple pieces of media
UNKNOWN There is an unspecified problem

Note

1. With respect to INST_OVERSIZED, DICOM media does not support spanning of Instances across volumes.

2. With respect to OUT_OF_SUPPLIES, This service is not supposed to provide detailed device status information, however sophisticated media creating devices can extend this table to return more information about the supply to be replenished. Implementation specific code values shall be defined in the Conformance Statement.

3. For most of the above statuses, the SCU can obtain more details about the processing errors (e.g., what are the SOP Instances not available) by using Failure Reason (0008,1197) within the Failed SOP Sequence (0008,1198).

C.22.1.4 Failure Reason

Defined Terms:

0110H Processing failure; a general failure in processing the operation was encountered
0112H No such object Instance; one or more of the Instances listed in the Referenced SOP Sequence (0008,1199) was not available
0122H Referenced SOP Class not supported; a media creation has been requested for a SOP Instance with a SOP Class that is not supported by the SCP
0119H Class/Instance conflict; the SOP Class of an Instance in the Referenced SOP Instance Sequence did not correspond to the SOP class of the SOP Instance stored at the SCP
0201H Media Application Profiles conflict; one or more of the Media Application Profiles referenced in the Reference SOP Sequence (0008,1199) are in conflict (e.g., for the same request a STD-GEN-CD and a STD-GEN-DVD is referenced)
0202H Media Application Profile/Instance conflict; the SOP Class of an Instance in the Referenced SOP Sequence (0008,1199) did not correspond to a SOP class permitted for the requested or supported Media Application Profiles
0203H Media Application Profile/Compression conflict; the profile for an Instance in the Referenced SOP Sequence (0008,1199) specified lossy compression but Allow Lossy Compression (2200,000F) has a value of NO
0204H Media Application Profile not supported; media creation has been requested for an Application Profile that is not supported by the SCP
0205H Instance size exceeded; a single Instance size exceeds the actual media capacity
0120H Missing Attribute; a required Attribute (e.g., Patient ID) was not supplied; the missing Attribute(s) shall be listed in Failure Attributes (2200,000E)
0121H ~~issing~~Missing Attribute value; a required Attribute Value (e.g., the Content Date for a Structured Report) was not supplied; the Attribute(s) with missing values shall be listed in Failure Attributes (2200,000E)

Note

With respect to 0205H Instance size exceeded, DICOM media does not support spanning of Instances across volumes.

C.23 Hanging Protocol Specific Modules

The following Sections specify Modules used for Hanging Protocols.

C.23.1 Hanging Protocol Definition Module

Table C.23.1-1 specifies the Attributes that describe and identify the high level definition of a Hanging Protocol, including its overall purpose, and the types of image sets to which it applies. See Annex V “Hanging Protocols (Informative)” in PS3.17 for further explanation.

Table C.23.1-1. Hanging Protocol Definition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Hanging Protocol Name	(0072,0002)	1	Short descriptor that identifies the Hanging Protocol.
Hanging Protocol Description	(0072,0004)	1	Explanation of the objective or intent of the Hanging Protocol.
Hanging Protocol Level	(0072,0006)	1	Identifies the level at which this Hanging Protocol is defined, and the intended use. Enumerated Values: **MANUFACTURER** **SITE** **USER_GROUP** **SINGLE_USER**

Attribute Name	Tag	Type	Attribute Description
Hanging Protocol Creator	(0072,0008)	1	Identifies the creator of the Hanging Protocol.
Hanging Protocol Creation DateTime	(0072,000A)	1	Date and time on which the Hanging Protocol was created.
Hanging Protocol Definition Sequence	(0072,000C)	1	Sequence that defines the type of imaging Studies to which this Hanging Protocol applies. One or more Items shall be included in this Sequence. See Section C.23.1.1.1.
>Modality	(0008,0060)	1C	Type of equipment that originally acquired the data used to create images or related objects to which this Hanging Protocol applies. See Section C.7.3.1.1.1 for Defined Terms. Required if Anatomic Region Sequence (0008,2218) is not present. May be present otherwise.
>Anatomic Region Sequence	(0008,2218)	1C	Sequence that identifies the anatomic region of interest to which this Hanging Protocol applies. One or more Items shall be included in this Sequence. Required if Modality (0008,0060) is not present. May be present otherwise.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 4 “Anatomic Region”.*
>Laterality	(0020,0060)	2C	Laterality of the body part to which this Hanging Protocol applies. Enumerated Values: **R** Right **L** Left **B** Both **U** Unpaired Zero length means not applicable. Required if Anatomic Region Sequence (0008,2218) is present.
>Procedure Code Sequence	(0008,1032)	2	Sequence that identifies a procedure to which this Hanging Protocol applies. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
>Reason for Requested Procedure Code Sequence	(0040,100A)	2	Sequence that identifies a reason for procedure to which this Hanging Protocol applies. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Number of Priors Referenced	(0072,0014)	1	Identifies the number of prior image sets used in this Hanging Protocol.
Image Sets Sequence	(0072,0020)	1	Sequence describing one or more types of Image Sets to which the Hanging Protocol applies. One or more Items shall be included in this Sequence. See Section C.23.1.1.2.

Attribute Name	Tag	Type	Attribute Description
>Image Set Selector Sequence	(0072,0022)	1	Sequence containing Image Set selection Attributes and values that are used to identify one type of image or object set for the Hanging Protocol. One or more Items shall be included in this Sequence. See Section C.23.1.1.3.
>>Image Set Selector Usage Flag	(0072,0024)	1	Indicates the behavior of matching against an image object when Selector Attribute (0072,0026) is not available in the image object. Enumerated Values: **MATCH** If the Attribute is not in the image object, consider the image to be a match anyway. **NO_MATCH** If the Attribute is not in the image object, then do not consider the image to be a match.
>>Selector Attribute	(0072,0026)	1	Data Element Tag of an Attribute from an Image or other IOD to use for Image Set selection.
>>Selector Attribute VR	(0072,0050)	1	The Value Representation of Selector Attribute (0072,0026). See PS3.5 for Enumerated Values of Value Representation.
>>Include Table C.23.4-1 “Hanging Protocol Selector Attribute Context Macro Attributes”			
>>Include Table C.23.4-2 “Hanging Protocol Selector Attribute Value Macro Attributes”			
>>Selector Value Number	(0072,0028)	1	Positive integer identifying which value of a multi-valued Attribute identified by Selector Attribute (0072,0026) is to be used for Image Set selection. The value 1 identifies the first value. The value zero identifies any value.
>Time Based Image Sets Sequence	(0072,0030)	1	Sequence containing time based Image Set selection categories and values that are used to identify one type of image set for the Hanging Protocol per Sequence Item. One or more Items shall be included in this Sequence. The Image Set Selector Sequence (0072,0022) shall be applied to each Sequence Item to define an image set. See Section C.23.1.1.2.
>>Image Set Number	(0072,0032)	1	A monotonically increasing integer, starting from 1, incrementing by 1, unique within the Hanging Protocol Instance. Note Each Item of the Display Sets Sequence (0072,0200) references one Image Set Number (0072,0032).
>>Image Set Selector Category	(0072,0034)	1	Category of the Time Based Image Set selector. Enumerated Values: **RELATIVE_TIME** **ABSTRACT_PRIOR**

Attribute Name	Tag	Type	Attribute Description
>>Relative Time	(0072,0038)	1C	Exactly two numeric values, indicating the start and end values of a prior range of Instance acquisition times relative to the date and time of a current image set. The units shall be specified in Relative Time Units (0072,003A). The value pair 0\0 shall indicate a current image set. The value pair n\n shall indicate "prior from the Instance acquisition time of a current image set by n units". Required if the value of Image Set Selector Category (0072,0034) is RELATIVE_TIME. Note 1. A value pair "1\7" with Relative Time Units (0072,003A) of DAYS would indicate the range "prior by 1 to 7 days before a current image set". 2. The VR of this Attribute is unsigned, hence future time cannot be represented.
>>Relative Time Units	(0072,003A)	1C	Units of time for Relative Time (0072,0038). Enumerated Values: **SECONDS** **MINUTES** **HOURS** **DAYS** **WEEKS** **MONTHS** **YEARS** Required if Relative Time (0072,0038) is present.
>>Abstract Prior Value	(0072,003C)	1C	Identifies a prior image set in abstract terms. Exactly two integer values, indicating the range of prior Studies to include. Each value shall be greater than zero, where 1 indicates the most recent prior and higher values indicate successively older priors. The special value -1 shall indicate the oldest prior. Note 1. The value pair n\n indicates the nth prior. 2. The value pair -1\-1 indicates the oldest prior. 3. The value pair m\n indicates the mth through nth priors, where m is the more recent prior. 4. The value pair 1\-1 indicates all priors. 5. The value pair m\-1 indicates the mth prior and all priors older than m. Required if Image Set Selector Category (0072,0034) is ABSTRACT_PRIOR and Abstract Prior Code Sequence (0072,003E) is not present.

Attribute Name	Tag	Type	Attribute Description
>>Abstract Prior Code Sequence	(0072,003E)	1C	Identifies a prior image set using coded terminology. Only a single Item shall be included in this Sequence. Required if Image Set Selector Category (0072,0034) is ABSTRACT_PRIOR and Abstract Prior Value (0072,003C) is not present.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 31 "Abstract Priors".*
>>Image Set Label	(0072,0040)	3	Description of the objective of the image set defined by this Sequence Item.
Hanging Protocol User Identification Code Sequence	(0072,000E)	2	Sequence that provides a coded identifier for the person, group, or site for which this Hanging Protocol was defined. Zero or one Item shall be included in this Sequence. Note If a standardized naming schema becomes available, it should be used. Meanwhile, local coding schemes such as employee numbers and department numbers are likely to be used.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Hanging Protocol User Group Name	(0072,0010)	3	Group or site for which this Hanging Protocol was defined.
Source Hanging Protocol Sequence	(0072,0012)	3	Sequence that identifies the Hanging Protocol from which this Hanging Protocol was derived, or on which it is based. Only a single Item is permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.23.1.1 Attribute Descriptions

C.23.1.1.1 Hanging Protocol Definition Sequence Attributes

The Hanging Protocol Definition Sequence (0072,000C) provides a collection of one or more Items that defines the intent for the Hanging Protocol with respect to modality, anatomy, laterality, procedure and/or reason.

This allows for some degree of flexibility in defining the intent for the Hanging Protocol, while providing a precise structure for query matching using the existing rules for Sequence Matching, as defined in PS3.4.

Note

1. The Hanging Protocol Definition Sequence (0072,000C) does not imply anything about the related image sets. These are defined in the Image Sets Sequence (0072,0020).

2. When creating a Hanging Protocol Instance, the values that are used for Procedure Code Sequence (0008,1032) or Reason for Requested Procedure Code Sequence (0040,100A) may come from a variety of sources, but are expected to be consistent throughout the domain in which a Hanging Protocol Instance will be exchanged. The following are recommended as potential sources of values.

   Procedure Code Sequence (0008,1032):

   - SNOMED codes
   - ICD-10-PCS Procedure Codes

- Local Codes

Reason for Requested Procedure Code Sequence (0040,100A):

- SNOMED codes
- ICD-9-CM
- ICD-10-CM
- Local Codes

C.23.1.1.2 Image Sets Sequence

The Image Sets Sequence (0072,0020) within a Hanging Protocol Instance serves to identify the type of image or other object sets to which the Hanging Protocol is intended to apply. Multiple types of image sets may be identified for a Hanging Protocol, to combine, for example, multiple imaging Studies for a specific anatomy, or multiple imaging Studies performed over a period of time, to monitor the progress of a condition. All image sets shall be for the same patient.

The images to be included in an Image Set may be specified directly by matching Attribute values within the images, or indirectly through Key Object Selection Documents or Presentation States by matching their Attribute values.

Key Object Selection Documents shall be matched by their SOP Class UID. The available Key Object Selection Documents may be further matched on the values of their other Attributes (e.g., Concept Name Code Sequence, Coding Scheme Designator = "DCM" and Code Value = "113003", which has a code meaning of "For Surgery"). When the Hanging Protocol Instance is applied, the image object Instances referenced by the matching Key Object Selection Document Instances comprise the image set.

Presentation States shall be matched by their SOP Class UID. The available Presentation States may be further matched on the values of their other Attributes (e.g., Content Label). When the Hanging Protocol Instance is applied, the image object Instances referenced by the matching Presentation State Instances comprise the image set.

Note

Image Sets Sequence (0072,0020) allows other objects such as waveforms and SR documents to be identified. However, Hanging Protocol Display Module operations such as filtering, reformatting, and sorting are defined only for image objects. The only expectation for non-image objects is to associate the objects with a position on a screen.

Each Item in the Image Sets Sequence (0072,0020) shall follow these rules:

- Each Item in the Time Based Image Sets Sequence (0072,0030) shall identify one image set, based on time criteria.
- The Items of the Image Set Selector Sequence (0072,0022) shall collectively identify one type of image set.
- One instance of time based criteria combined with the Items of the Image Set Selector Sequence (0072,0022) shall identify one image set.
- The number of image sets identified by an Item of the Image Sets Sequence (0072,0020) shall equal the number of Items in the Time Based Image Sets Sequence (0072,0030).
- The value of Image Set Number (0072,0032) in each Time Based Image Sets Sequence (0072,0030) Item shall be unique across all Items of the Image Sets Sequence (0072,0020).

Note

1. The identification of a current image set is established by the application prior to selection of a Hanging Protocol Instance. The current image set is not necessarily from a single Study.
2. In mammography screening, for example, the Hanging Protocol defines the current image set plus the screening image set for the patient from the year prior. There would be one Item in the Image Sets Sequence (0072,0020). Within this Item, the Items of the Image Set Selector Sequence (0072,0022) would identify a mammography screening image set type. The Time Based Image Sets Sequence (0072,0030) would have two Items, one to identify the current, and one to identify the prior.

C.23.1.1.3 Image Set Selector Sequence Attributes

The Image Set Selector Sequence (0072,0022) contains Items that specify the DICOM Attribute Data Element Tags and values that shall be used to identify the image or other object set.

The Image Set Selector Usage Flag (0072,0024) indicates whether the Attribute identified by Selector Attribute (0072,0026) causes matching to succeed or fail if the Attribute is not available in an image object.

Within an Item, Selector Attribute (0072,0026) identifies a DICOM Attribute Data Element Tag that is likely to be present in image or other object Instances that are desired for the Image Set. If it is a multi-valued Attribute, the Selector Value Number (0072,0028) indicates which value is intended to be used for matching. The Selector Attribute VR (0072,0050) identifies the Value Representation of Selector Attribute (0072,0026). The value of Selector Attribute VR (0072,0050) determines which Attribute of the Hanging Protocol Selector Attribute Value Macro is required to specify one or more desired values for the DICOM Attribute. If more than one value is specified for the Attribute, or more than one Item is specified in the Selector Code Sequence Value (0072,0080), then image object Instances with a corresponding Attribute that matches any one of the values shall be included in the Image Set.

Note

The values used for Selector Attribute (0072,0026) are intended to identify a type of image set via the general categories of modality, anatomy, procedure intent and/or reason. Therefore the values of the Attributes represented by Selector Attribute (0072,0026) are likely to be coded terms, Enumerated Values, Defined Terms or free text. The use of free text Attributes is less desirable, because their values are less predictable for matching.

In an image object, some Attributes occur at the top level, or nested within a Sequence or Functional Group Sequence, or both. In addition, a Private Attribute may be identified as a Selector Attribute (0072,0026). The Attributes of the Hanging Protocol Selector Attribute Context Macro identify a Sequence, Functional Group Sequence, or Private Group context for Selector Attribute (0072,0026).

The creator of a Hanging Protocol Instance uses this collection of Attributes to identify one type of image set to which the Hanging Protocol is intended to apply. The user of a Hanging Protocol Instance (e.g., softcopy review workstation or pre-fetching application) uses this collection of Attributes to match a specific image set to a Hanging Protocol, and/or to determine which image sets need to be retrieved in order to use a Hanging Protocol Instance. The Key Attributes to match against to obtain image sets are specified in Selector Attribute (0072,0026) and its context in each Sequence Item.

If the value of the Attribute represented by Selector Attribute (0072,0026) contains a free text description (i.e., Selector Attribute VR = LO, SH, ST, LT, UT), whether exact or partial matching is used to identify a specific Image Instance when applying a Hanging Protocol Instance is implementation dependent.

C.23.2 Hanging Protocol Environment Module

Table C.23.2-1 specifies the Attributes that describe and identify the best suited display environment for a Hanging Protocol.

Different viewing styles and interactions may be defined depending on a workstation's capabilities. For example, the hanging preferences for viewing a screening mammogram Study on a 1Kx1K screen with a 10 second repaint time versus a 2Kx2.5K screen may differ.

Note

1. The term Screen is intended to include all types of display devices (e.g., CRT, LCD, etc.).
2. This information may be used by an application to select a subset of the available screens on which to apply a Hanging Protocol.

Table C.23.2-1. Hanging Protocol Environment Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Screens	(0072,0100)	2	Positive integer indicating the number of screens for which this Hanging Protocol is intended.
Nominal Screen Definition Sequence	(0072,0102)	2	Sequence that describes the set of screens for which this Hanging Protocol is intended. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table C.23.2-2 “Screen Specifications Macro Attributes”			

Table C.23.2-2. Screen Specifications Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Vertical Pixels	(0072,0104)	1	Positive integer indicating the intended number of rows of the addressable area of the screen in pixels. Note The goal is not absolute size matching.
Number of Horizontal Pixels	(0072,0106)	1	Positive integer indicating the intended number of columns of the addressable area of the screen in pixels. Note The goal is not absolute size matching.
Display Environment Spatial Position	(0072,0108)	1	Exactly four dimensionless floating point values indicating the rectangular coordinate position of the screen within the overall bounding box that encompasses all the screens. See Section C.23.2.1.1.
Screen Minimum Grayscale Bit Depth	(0072,010A)	1C	Positive integer indicating the desired minimum number of grayscale bits per pixel of the screen. Required if Screen Minimum Color Bit Depth (0072,010C) is not present.
Screen Minimum Color Bit Depth	(0072,010C)	1C	Positive integer indicating the desired minimum total number of bits per color channel used to present a pixel. Required if Screen Minimum Grayscale Bit Depth (0072,010A) is not present. Note A 24-bit color system with 8 bits per color channel (red, green, blue) would have a value of 8.
Application Maximum Repaint Time	(0072,010E)	3	Positive integer indicating the desired maximum time in milliseconds required by the application to repaint the full screen once (i.e., recalculate all pixels and paint them to the screen). Note This is not the screen refresh time.

C.23.2.1 Hanging Protocol Environment Attribute Descriptions

C.23.2.1.1 Display Environment Spatial Position

For the Display Environment Spatial Position (0072,0108) Attribute, the lower left corner of the overall bounding box has Cartesian coordinates of (0.0,0.0). The upper right corner has coordinates of (1.0,1.0). The scale of the box is based on the Number of Vertical Pixels (0072,0104) and Number of Horizontal Pixels (0072,0106), not the physical size of the screens that are part of the workstation. The coordinates of each individual screen's box are defined in absolute coordinates relative to the (0,0) and (1,1) range of the overall box. Position of a box is given by a (x1,y1), (x2,y2) pair that identifies the upper left corner and lower right corner if the box is rectangular.

Note

The goal is not absolute position matching of the image boxes rendered on the screens using Hanging Protocol layout information, but that the relative positioning of the image boxes should be consistent between different workstations.

Figure C.23.2-1 depicts a 1K x 1K screen positioned to the left of a 2K x 2.5K screen. The Display Environment Spatial Position (0072,0108) of the 1K x 1K screen is (0.0,0.4) (0.33,0.0), and the Display Environment Spatial Position (0072,0108) of the 2K x 2.5K screen is (0.33,1.0) (1.0,0.0).

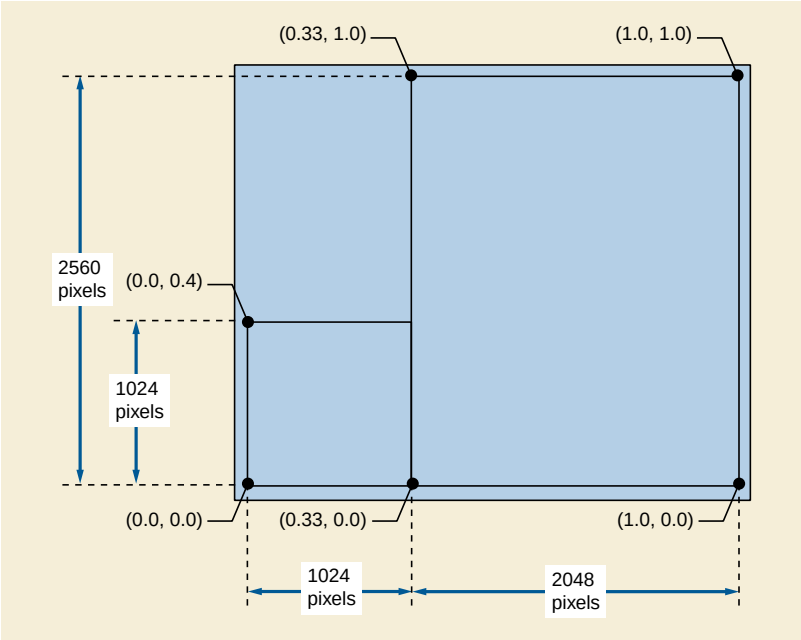


Figure C.23.2-1. Example Hanging Protocol Screen Environment

C.23.3 Hanging Protocol Display Module

Table C.23.3-1 specifies the Attributes that describe operations (filter, reformat, sort, presentation intent), layout and interactions for a Hanging Protocol. See Annex V “Hanging Protocols (Informative)” in PS3.17 for further explanation.

Table C.23.3-1. Hanging Protocol Display Module Attributes

Attribute Name	Tag	Type	Attribute Description
Display Sets Sequence	(0072,0200)	1	Sequence that describes one or more display sets used to present the Image Sets defined in the Image Sets Sequence (0072,0020). One or more Items shall be included in this Sequence. See Section C.23.3.1.
>Display Set Number	(0072,0202)	1	A monotonically increasing integer, starting from 1, incrementing by 1, unique within the Hanging Protocol Instance. It shall be used to identify linked display sets in the Display Set Scrolling Group (0072,0212).
>Display Set Label	(0072,0203)	3	Description of the objective of the display set defined by this Sequence Item.
>Display Set Presentation Group	(0072,0204)	1	Positive integer value that designates this Display Set as part of a specific presentation group. All Display Sets with the same Display Set Presentation Group (0072,0204) value shall be displayed at the same time. The value 1 shall indicate that this Display Set is part of the initial presentation group. Subsequent values incrementing by 1 shall imply successive temporal ordering of display.

Attribute Name	Tag	Type	Attribute Description
>Image Set Number	(0072,0032)	1	Image Set Number (0072,0032) value from a Time Based Image Sets Sequence (0072,0030) Item within the Image Sets Sequence (0072,0020) Item that is selected for display by this Display Set. Note Multiple Image Boxes Sequence (0072,0300) Items within a Display Sets Sequence (0072,0200) Item may be used to spread one image set over multiple image boxes with the same Display Set characteristics.
>Image Boxes Sequence	(0072,0300)	1	Sequence that defines the image boxes for this Display Set. Only a single Item shall be included in this Sequence unless Image Box Layout Type (0072,0304) is TILED, in which case one or more Items shall be included in this Sequence.
>>Image Box Number	(0072,0302)	1	A monotonically increasing integer that identifies the order of image boxes for scrolling, starting from 1, incrementing by 1, unique within a Display Sets Sequence (0072,0200) Item.
>>Display Environment Spatial Position	(0072,0108)	1	Exactly four unitless floating point values indicating the rectangular coordinate position of the image box within the overall bounding box that encompasses all the display space (across all screens). See Section C.23.2.1.1.
>>Image Box Layout Type	(0072,0304)	1	Type of layout of the image box. All types except for TILED are single rectangles containing a single frame of image pixel data. The types are primarily distinguished by their interaction technique. Defined Terms: **TILED** a scrollable array of rectangles, each containing a single frame of image pixel data. **STACK** a single rectangle containing a steppable single frame, intended for user-controlled stepping through the image set, usually via continuous device interaction (e.g., mouse scrolling) or by single stepping (mouse or button click). **CINE** a single rectangle, intended for video type play back where the user controls are play sequence, rate of play, and direction. **PROCESSED** intended for interactive 3D visualizations that have custom interfaces. **SINGLE** a single rectangle, intended for images and objects with no defined methods of interaction. Note This value may also be used for non-image objects, such as waveforms and SR documents.
>>Image Box Tile Horizontal Dimension	(0072,0306)	1C	Positive integer defining the horizontal Image Box tile dimension; the number of columns. Required if the value of Image Box Layout Type (0072,0304) is TILED.
>>Image Box Tile Vertical Dimension	(0072,0308)	1C	Positive integer defining the vertical Image Box tile dimension; the number of rows. Required if the value of Image Box Layout Type (0072,0304) is TILED.

Attribute Name	Tag	Type	Attribute Description
>>Image Box Scroll Direction	(0072,0310)	1C	Enumerated Values: **VERTICAL** scroll images by row **HORIZONTAL** scroll images by column Required if the value of Image Box Layout Type (0072,0304) is TILED, and the value of Image Box Tile Horizontal Dimension (0072,0306) or Image Box Tile Vertical Dimension (0072,0308) is greater than 1.
>>Image Box Small Scroll Type	(0072,0312)	2C	Defines the type of small increment scrolling to be applied to this Image Box. Required if the value of Image Box Layout Type (0072,0304) is TILED, and the value of Image Box Tile Horizontal Dimension (0072,0306) or Image Box Tile Vertical Dimension (0072,0308) is greater than 1. Scrolling is not specified if zero length. Enumerated Values: **PAGE** In a TILED image box, replace all image slots with the next N x M images in the set. **ROW_COLUMN** In a TILED image box, move each row or column of images to the next row or column, depending on Image Box Scroll Direction (0072,0310). **IMAGE** In a TILED image box, move each image to the next slot, either horizontally or vertically, depending on Image Box Scroll Direction (0072,0310). Note If there are multiple image boxes of different Tile Dimensions in a Display Set, then only IMAGE scrolling applies, and the value of this Attribute is ignored.
>>Image Box Small Scroll Amount	(0072,0314)	1C	Defines the positive integer number of pages, rows, columns, or images per small increment scroll, based on the values of Image Box Small Scroll Type (0072,0312) and Image Box Scroll Direction (0072,0310). The value applies to both forward and backward scrolling. Required if Image Box Small Scroll Type (0072,0312) is present with a value.
>>Image Box Large Scroll Type	(0072,0316)	2C	Defines the type of large increment scrolling to be applied to this Image Box. Required if the value of Image Box Layout Type (0072,0304) is TILED, and the value of Image Box Tile Horizontal Dimension (0072,0306) or Image Box Tile Vertical Dimension (0072,0308) is greater than 1. Enumerated Values: **PAGE** In a TILED image box, replace all image slots with the next N x M images in the set. **ROW_COLUMN** In a TILED image box, move each row or column of images to the next row or column, depending on Image Box Scroll Direction (0072,0310). **IMAGE** In a TILED image box, move each image to the next slot, either horizontally or vertically, depending on Image Box Scroll Direction (0072,0310). Note If there are multiple image boxes of different Tile Dimensions in a Display Set, then only IMAGE scrolling applies, and the value of the Attribute is ignored.

Attribute Name	Tag	Type	Attribute Description
>>Image Box Large Scroll Amount	(0072,0318)	1C	Defines the positive integer number of pages, rows, columns, or images per large increment scroll, based on the values of Image Box Large Scroll Type (0072,0316) and Image Box Scroll Direction (0072,0310). The value applies to both forward and backward scrolling. Required if Image Box Large Scroll Type (0072,0316) is present with a value.
>>Image Box Overlap Priority	(0072,0320)	3	If this Image Box overlaps in spatial position with others, this Attribute indicates the layer of this Image Box in relation to the others. The value shall be a positive integer in the range 1 to 100, where 1 = top and 100 = bottom. If this Attribute is not present, then the expected behavior is not defined.
>>Preferred Playback Sequencing	(0018,1244)	1C	Describes the preferred playback sequencing for the Image Box. Overrides any Preferred Playback Sequencing (0018,1244) value in the image objects being displayed. Required if the value of Image Box Layout Type (0072,0304) is CINE. Enumerated Values: **0** Looping (1,2…n,1,2,…n,1,2,….n,…) **1** Sweeping (1,2,…n,n-1,…2,1,2,…n,…) **2** Stop (1,2…n)
>>Recommended Display Frame Rate	(0008,2144)	1C	Recommended rate at which the frames of a multi-frame image shall be displayed, in frames/second. Shall have a value greater than zero. Overrides any Recommended Display Frame Rate (0008,2144) value in the image objects being displayed. Required if the value of Image Box Layout Type (0072,0304) is CINE and if Cine Relative to Real-Time (0072,0330) is not present.
>>Cine Relative to Real-Time	(0072,0330)	1C	A positive unitless floating point numeric factor equal to playback rate divided by acquisition rate. Required if the value of Image Box Layout Type (0072,0304) is CINE and if Recommended Display Frame Rate (0008,2144) is not present. Note The capture rate may change within the image object, as specified in Frame Time (0018,1063) or Frame Time Vector (0018,1065).
>Filter Operations Sequence	(0072,0400)	2	Sequence that defines filter criteria to be applied to the image set identified by Image Set Number (0072,0032). Zero or more Items shall be included in this Sequence. See Section C.23.3.1.1.
>>Filter-by Category	(0072,0402)	1C	Category of the filter operation. See Section C.23.3.1.1. Defined Terms: **IMAGE_PLANE** Required if Selector Attribute (0072,0026) is not present.

Attribute Name	Tag	Type	Attribute Description
>>Filter-by Attribute Presence	(0072,0404)	1C	Operation to be applied based on the presence or absence of the Attribute represented by Selector Attribute (0072,0026) in each image of the Image Set. Required if Selector Attribute (0072,0026) is present and Filter-by Operator (0072,0406) is not present. Enumerated Values: **PRESENT** Include the image if the Attribute is present. **NOT_PRESENT** Include the image if the Attribute is not present.
>>Selector Attribute	(0072,0026)	1C	Data Element Tag of an Attribute from an Image IOD to use as a filter. See Section C.23.3.1.1 for potential Attributes. Required if Filter-by Category (0072,0402) is not present.
>>Selector Attribute VR	(0072,0050)	1C	The Value Representation of Selector Attribute (0072,0026). Required if Selector Attribute (0072,0026) or Filter-by Category (0072,0402), and Filter-by Operator (0072,0406) are present.
>>Include Table C.23.4-1 "Hanging Protocol Selector Attribute Context Macro Attributes"			
>>Include Table C.23.4-2 "Hanging Protocol Selector Attribute Value Macro Attributes"			
>>Selector Value Number	(0072,0028)	1C	Positive integer identifying which value of the Attribute identified by Selector Attribute (0072,0026) is to be used for filtering. The value 1 identifies the first value. The value zero identifies any value. Required if Selector Attribute (0072,0026) and Filter-by Operator (0072,0406) are present.

Attribute Name	Tag	Type	Attribute Description
>>Filter-by Operator	(0072,0406)	1C	Operation to be applied between the value(s) in the Hanging Protocol Selector Attribute Value Macro ("selector"), and the value(s) of the Attribute identified by Selector Attribute (0072,0026) (or the value implied by the Filter-by Category (0072,0402)) in each image of the Image Set. See Section C.23.3.1.1. Required if Filter-by Category (0072,0402) is present, or if Selector Attribute (0072,0026) is present and Filter-by Attribute Presence (0072,0404) is not present. Enumerated Values: **RANGE_INCL** all values lie within the specified range, or are equal to the endpoints; applies only to numeric Selector Attribute (0072,0026) values; two values shall be present in the selector, the first of which is less than or equal to the second **RANGE_EXCL** all values lie outside the specified range, and are not equal to the endpoints; applies only to numeric Selector Attribute (0072,0026) values; two values shall be present in the selector, the first of which is less than or equal to the second **GREATER_OR_EQUAL** all values are greater than or equal to the value of the selector; applies only to numeric Selector Attribute (0072,0026) **LESS_OR_EQUAL** all values are less than or equal to the value of the selector; applies only to numeric Selector Attribute (0072,0026) **GREATER_THAN** all values are greater than the value of the selector; applies only to numeric Selector Attribute (0072,0026) **LESS_THAN** all values are less than the value of the selector; applies only to numeric Selector Attribute (0072,0026) **MEMBER_OF** one of the values in the image is present in the values of the selector; if one value is present in each, this is an "equal to" operator **NOT_MEMBER_OF** none of the values in the image is present in the values of the selector; if one value is present in each, this is a "not equal to" operator
>>Image Set Selector Usage Flag	(0072,0024)	3	Specifies the behavior of the Filter-by Operator (0072,0406) when Selector Attribute (0072,0026) is not available in the image or does not contain a value specified by Selector Value Number (0072,0028). If this Attribute is not present in this Sequence Item, MATCH shall be assumed. Shall be ignored if Filter-by Operator (0072,0406) is not present. Enumerated Values: **MATCH** include the image in the filter output. **NO_MATCH** do not include the image in the filter output.
>Sorting Operations Sequence	(0072,0600)	2	Sequence that defines sorting criteria to be applied to the result of filter and reformat operations, to define the order in which to present the images in the Image Boxes. Zero or more Items shall be included in this Sequence. See Section C.23.3.1.2.

Attribute Name	Tag	Type	Attribute Description
>>Selector Attribute	(0072,0026)	1C	Data Element Tag of an Attribute from an Image IOD to be used for sorting. See Section C.23.3.1.2 for potential Attributes. Required if Sort-by Category (0072,0602) is not present.
>>Include Table C.23.4-1 "Hanging Protocol Selector Attribute Context Macro Attributes"			
>>Selector Value Number	(0072,0028)	1C	Positive integer identifying which value of the Attribute identified by Selector Attribute (0072,0026) is to be used for sorting. The value of 1 identifies the first value. Shall not be zero. Required if Selector Attribute (0072,0026) is present.
>>Sort-by Category	(0072,0602)	1C	Category of the sorting operation. See Section C.23.3.1.2. Defined Terms: **ALONG_AXIS** for CT, MR, other cross-sectional image sets **BY_ACQ_TIME** Required if Selector Attribute (0072,0026) is not present.
>>Sorting Direction	(0072,0604)	1	Sorting direction to be applied to the value(s) in the image set of the Attribute identified by Selector Attribute (0072,0026) or Sort-by Category (0072,0602). Enumerated Values: **INCREASING** **DECREASING**
>Blending Operation Type	(0072,0500)	3	Type of blending of superimposed and underlying images from the image set, performed before reformatting. See Section C.23.3.1.3. Defined Terms: **COLOR** apply a pseudo-color to the superimposed image while blending
>Reformatting Operation Type	(0072,0510)	3	Reformatting operation to be applied to the Image Set. Defined Terms: **MPR** **3D_RENDERING** **SLAB**
>Reformatting Thickness	(0072,0512)	1C	The desired thickness of the reformatted images in millimeters. Required if value of Reformatting Operation Type (0072,0510) is SLAB or MPR. May be present otherwise.
>Reformatting Interval	(0072,0514)	1C	The desired spacing of the reformatted images in millimeters. The spacing is measured from the center-to-center of each reconstructed image. Required if value of Reformatting Operation Type (0072,0510) is SLAB or MPR. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Reformatting Operation Initial View Direction	(0072,0516)	1C	Initial view of the reformatted images. Required if the value of Reformatting Operation Type (0072,0510) is MPR or 3D_RENDERING. May be present otherwise. Defined Terms: **SAGITTAL** **TRANSVERSE** **CORONAL** **OBLIQUE**
>3D Rendering Type	(0072,0520)	1C	Describes the intended 3D rendering type. One or more values shall be present. The first value shall not be zero length. Required if the value of Reformatting Operation Type (0072,0510) is 3D_RENDERING: Defined Terms for Value 1: **MIP** **SURFACE** **VOLUME** Additional values may be used to identify implementation specific sub-types.
>Display Set Patient Orientation	(0072,0700)	3	Patient direction of the rows and columns of the images, as intended for display. See Section C.23.3.1.4.
>Display Set Horizontal Justification	(0072,0717)	3	Indicates direction in which to horizontally justify the image within a viewport that is not the same shape (aspect ratio) as the image. Enumerated Values: **LEFT** **CENTER** **RIGHT** Note Typically used in mammography display applications in which images from the patient's left and right are displayed "back to back", rather than centered.
>Display Set Vertical Justification	(0072,0718)	3	Indicates direction in which to vertically justify the image within a viewport that is not the same shape (aspect ratio) as the image. Enumerated Values: **TOP** **CENTER** **BOTTOM**
>VOI Type	(0072,0702)	3	Expected value of interest transformation for display (e.g., Window Center and Window Width or VOI LUT). Defined Terms: **LUNG** **MEDIASTINUM** **ABDO_PELVIS** **LIVER** **SOFT_TISSUE** **BONE** **BRAIN** **POST_FOSSA**

Attribute Name	Tag	Type	Attribute Description
>Pseudo-Color Type	(0072,0704)	3	A category of pseudo-color palette choice to be applied after application of the VOI LUT. If this Attribute is not present, a pseudo-color palette shall not be applied. Defined Terms are the values of Content Label (0070,0080) in the list of standard color palettes defined in PS3.6 Well-Known Color Palettes.
>Pseudo-Color Palette Instance Reference Sequence	(0072,0705)	1C	Reference to a Color Palette Storage Instance to be applied after application of the VOI LUT. Only a single Item shall be included in this Sequence. The Referenced SOP Class UID (0008,1150) shall be "1.2.840.10008.5.1.4.39.1". If the value of Pseudo-Color Type (0072,0704) is a reference to the Content Label (0070,0080) of a standard palette, the Referenced SOP Instance UID (0008,1155) shall be the corresponding Well-known SOP Instance UID defined in PS3.6. Required if Pseudo-Color Type (0072,0704) is a reference to a standard palette. May be present otherwise if Pseudo-Color Type (0072,0704) is present.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Show Grayscale Inverted	(0072,0706)	3	Whether or not to invert the rendered luminance of the displayed values. See Section C.23.3.1.4. Enumerated Values: **YES** The maximum output value after the display pipeline has been applied shall be displayed with the minimum available luminance. **NO** The maximum output value after the display pipeline has been applied shall be displayed with the maximum available luminance. Note 1. The YES and NO values of this Attribute correspond to the Presentation LUT Shape (2050,0020) values of INVERSE and IDENTITY, as described in Section C.11.6.1.2. 2. Only applicable to display of grayscale images.
>Show Image True Size Flag	(0072,0710)	3	Indicates whether or not to display images with the physical size of the rendered image pixel the same on the screen as specified in the image Attributes, unless overridden by a Presentation State Instance. Enumerated Values: **YES** Display images at True Size. **NO** The rendered size is not specified.
>Show Graphic Annotation Flag	(0072,0712)	3	Indicates whether or not to display Items from the Graphic Annotation Sequence (0070,0001) in an applied Presentation State, and the Attributes of the Overlay Plane Module in the image objects or applied Presentation State. Enumerated Values: **YES** **NO**

Attribute Name	Tag	Type	Attribute Description
>Show Patient Demographics Flag	(0072,0714)	3	Indicates whether or not to display patient and Study identification information. Enumerated Values: **YES** **NO**
>Show Acquisition Techniques Flag	(0072,0716)	3	Indicates whether or not to display image acquisition technique information. Enumerated Values: **YES** **NO**
>Display Set Presentation Group Description	(0072,0206)	3	Description of the intent of the Display Set Presentation Group (0072,0204). If present, shall have the same value in all Sequence Items assigned the same value for Display Set Presentation Group (0072,0204).
Partial Data Display Handling	(0072,0208)	2	If one or more Image Sets identified by Image Set Number (0072,0032) in the Display Sets Sequence (0072,0200) Items is not available, indicate whether or not to maintain the expected layout in the absence of complete Image Sets. Enumerated Values: **MAINTAIN_LAYOUT** If one or more Image Sets is not available, maintain the layout with empty Image Boxes. **ADAPT_LAYOUT** If one or more Image Sets is not available, rearrange the layout at the discretion of the application. If this Attribute is zero length, then the expected behavior is not defined.
Synchronized Scrolling Sequence	(0072,0210)	3	Each Item of this Attribute identifies a group of Display Sets to which synchronized scrolling is to be applied. One or more Items are permitted in this Sequence. The dimensions along which the synchronization occurs shall be those specified in the Sorting Operations Sequence (0072,0600).
>Display Set Scrolling Group	(0072,0212)	1	Multi-valued list of two or more Display Set Number (0072,0202) values. Indicates that the images within the specified Display Sets are scrolled in parallel, to maintain the established synchronization.
Navigation Indicator Sequence	(0072,0214)	3	Describes a geometric relationship between Display Sets for the purpose of static or interactive localization or navigation. One or more Items are permitted in this Sequence.
>Navigation Display Set	(0072,0216)	1C	Display Set Number (0072,0202) of the Display Set where the geometric relationship to the Reference Display Sets (0072,0218) is graphically depicted. Required if there is a one-way interaction such that the location of the Reference Display Sets is indicated on or controlled by the Navigation Display Set. Note For example, the graphical representation may indicate either the number of slices displayed or contained in the Reference Display Set(s).

Attribute Name	Tag	Type	Attribute Description
>Reference Display Sets	(0072,0218)	1	One or more Display Set Number (0072,0202) values. If Navigation Display Set is present, shall list those Display Sets that are controlled by or indicated on the Navigation Display Set. If Navigation Display Set is absent, shall indicate that all of the Reference Display Sets cross-reference each other.

C.23.3.1 Attribute Descriptions

The Attributes of a Display Sets Sequence (0072,0200) Item shall be applied to the image set represented by the value of Image Set Number (0072,0032) in the following order:

- Filter Operations Sequence
- Reformatting
- Sorting Operations Sequence
- Presentation Intent

C.23.3.1.1 Filter Operations Sequence

The Items in the Filter Operations Sequence (0072,0400) determine which subset of the images in the identified Image Set are to be displayed in the associated Display Set image boxes. If there are multiple Items in the Filter Operations Sequence (0072,0400), the filter operations shall be applied in Item order, and the output of the preceding filter shall serve as the input to the succeeding filter (i.e., an AND operation). See Section C.23.4.2.1.1 and Section C.23.4.2.1.2 for additional details on matching strings and coded values.

When Filter-by Category (0072,0402) has a value of IMAGE_PLANE, Selector Attribute VR (0072,0050) shall have a value of "CS", and abstract Enumerated Values shall be used for the value of the associated Selector CS Value (0072,0062) Attribute, which may be computed from the values of Image Orientation (Patient) (0020,0037) or Patient Orientation (0020,0020).

Enumerated Values:

TRANSVERSE
CORONAL
SAGITTAL
OBLIQUE

The MEMBER_OF and NOT_MEMBER_OF values of Filter-by Operator (0072,0406) are then applicable.

Note

Cross-sectional images do not normally contain a categorical description of the image plane, but rather only a patient-relative row and column direction cosines that are unit vectors. The category of image plane can be determined first by categorizing the row and column major directions (or detecting if the orientation is oblique according to a pre-specified threshold), and then using those categories to select a plan category.

The following pseudo-code can be used to determine the major axis (R or L, A or P, H or F) from a single direction cosine that is an (x,y,z) tuple (as defined in Section C.7.6.2.1.1):

- if (abs(x) > threshold)

  axis = "RL"

- else if (abs(y) > threshold)

  axis = "AP"

- else if (abs(z) > threshold)

axis = "HF"

- else

  is OBLIQUE

Having determined the major axis of the row and column, the category of plane can be obtained from a table lookup:

Column	**Row**		
	RL	AP	HF
RL		TRANSVERSE	CORONAL
AP	TRANSVERSE		SAGITTAL
HF	CORONAL	SAGITTAL	

Alternatively, one can obtain a single vector that is the normal to the orientation (cross product of the row and column unit vectors), then find which of the x, y and z components has the maximum absolute value that is above threshold; if x then SAGITTAL, if y then CORONAL, if z then TRANSVERSE; if all of the components are below threshold then the orientation is OBLIQUE.

Since it is also necessary to determine whether or not to flip or rotate the image into the preferred orientation (as specified by Display Set Patient orientation (0072,0700)) for the category of plane (e.g., sagittals are normally viewed with row direction posteriorly and column direction towards the feet), the categorical row and column direction to use can be obtained as above, additional accounting for the sign of the direction cosine, e.g.:

```
if x < 0 then orientationX = "R" else orientationX = "L"

if y < 0 then orientationY = "A" else orientationY = "P"

if z < 0 then orientationZ = "F" else orientationZ = "H"

if (abs(x) > threshold)

   orientation = orientationX

…
```

An application that is applying a Hanging Protocol Instance shall support any value for Selector Attribute (0072,0026). The Image Set Selector Usage Flag (0072,0024) specifies whether or not the image is included in the filter output when the Attribute or value identified by Selector Attribute (0072,0026) is not available in an image. The Attributes of the Hanging Protocol Selector Attribute Context Macro specify whether Selector Attribute (0072,0026) is contained in a Sequence, Functional Group Sequence, or Private Group.

Note

1. The following Attributes from image IODs are examples of some possible values for Selector Attribute (0072,0026) of Filter Operations Sequence (0072,0400). This is not a complete list:
   - Value 3 of Image Type (0008,0008) or Frame Type (0008,9007)
   - Anatomic Region Sequence (0008,2218)
   - Pixel Presentation (0008,9205)
   - Volume Based Calculation Technique (0008,9207)
   - Acquisition Contrast (0008,9209)
   - Contrast/Bolus Agent (0018,0010)
   - Body Part Examined (0018,0015)
   - Scanning Sequence (0018,0020)

- Intervention Drug Start Time (0018,0035)
- Echo Time (0018,0081)
- Echo Number(s) (0018,0086)
- Protocol Name (0018,1030)
- Contrast/Bolus Start Time (0018,1042)
- Contrast/Bolus Stop Time (0018,1043)
- Trigger Time (0018,1060)
- Image Trigger Delay (0018,1067)
- Radiopharmaceutical Start Time (0018,1072)
- Radiopharmaceutical Stop Time (0018,1073)
- Trigger Window (0018,1094)
- View Position (0018,5101)
- Echo Pulse Sequence (0018,9008)
- Phase Contrast (0018,9014)
- Effective Echo Time (0018,9082)
- Laterality (0020,0060)
- Image Laterality (0020,0062)
- Slice Location (0020,1041)
- View Code Sequence (0054,0220)

2. For a multi-frame image set, it is the responsibility of the application to apply the filter operations to individual frames within a multi-frame Image Instance in the image set, versus multiple single-frame Image Instances in the image set that represent individual frames.

C.23.3.1.2 Sorting Operations Sequence

The Items in the Sorting Operations Sequence (0072,0600) define the order in which the images resulting from the filter and reformat operations on the Image Set are to be displayed in the associated Image Boxes of the Display Set. The sorting criteria may include the value of a numeric, date, or time Attribute that is expected to be present in each of the image objects in the filtered Image Set, and/or an abstract sorting category. A sorting direction shall be associated with each sorting criterion. If a textual Attribute is used for sorting, then the INCREASING sorting direction indicates alphabetical order, and DECREASING indicates reverse alphabetical order.

If a Code Sequence Attribute is used for sorting, then Code Meaning (0008,0104) shall be sorted alphabetically. If a string numeric Attribute is used for sorting (VR of IS or DS), then sorting shall be on the numeric value, and padding shall be ignored. When sorting by date or time Attribute, then sorting shall be on the temporal value, not the alphabetic string.

If there are multiple Items in the Sorting Operations Sequence (0072,0600), then the sorting operations shall be applied in Item order. The least rapidly varying Attribute for the sorting operation shall be the first Item in the Sequence.

Note

For example, a Sorting Operations Sequence (0072,0600) with two Items:

Item #1: (0018,5101) View Position, INCREASING

Item #2: (0008,0020) Study Date, INCREASING

results in the following order, based on these Attribute values in the image objects:

View Position (0018,5101)	Study Date (0008,0020)
AP	20030201
AP	20030501
LL	20020705
LL	20030102
RL	20030101
RL	20030201

When the Sort-by Category (0072,0602) is used with a value of ALONG_AXIS, such as for CT, MR or other cross-sectional image sets, the sorting operation is computed from the values Image Position (Patient) (0020,0032) and Image Orientation (Patient) (0020,0037) in the image objects.

For the image set to be displayed, a "dominant axis" of the set shall be determined. The dominant axis is the normal to Image Orientation (Patient) (0020,0037) (assuming all selected images are parallel), computed as the dot product in a right-handed coordinate system (see Section C.7.6.2.1.1). The INCREASING direction for ALONG_AXIS of the image set shall be in the positive direction along the dominant axis. The DECREASING direction shall be in the negative direction along that axis.

When the Sort-by Category (0072,0602) is used with a value of BY_ACQ_TIME, the sorting operation is computed from appropriate values in the image objects (e.g., Frame Acquisition DateTime, Acquisition Time, Content Time, Acquisition DateTime), since the specific Attribute used may vary from one Image Instance or SOP Class to another, yet the Hanging Protocol Instance may be generally applicable.

An application that is applying a Hanging Protocol Instance shall support any value for Selector Attribute (0072,0026), provided that it is present in the referenced Image Set. The Attributes of the Hanging Protocol Selector Attribute Context Macro specify whether Selector Attribute (0072,0026) is contained in a Sequence, Functional Group Sequence or Private Group.

Note

1. The following Attributes from image IODs are examples of some possible values for Selector Attribute (0072,0026) of Sorting Operations Sequence (0072,0600). This is not a complete list:
   - Acquisition DateTime (0008,002A)
   - Acquisition Time (0008,0032)
   - Echo Time (0018,0081)
   - Echo Number(s) (0018,0086)
   - Trigger Time (0018,1060)
   - View Position (0018,5101)
   - Effective Echo Time (0018,9082)
   - Acquisition Number (0020,0012)
   - Instance Number (0020,0013)
   - Slice Location (0020,1041), although Sort-by Category (0072,0602) with value ALONG_AXIS may be more reliable
   - Trigger Delay Time (0020,9153)
   - Stage Number (0008,2122)
   - View Number (0008,2128)

2. For a multi-frame image set, it is the responsibility of the application to apply the sorting operations to individual frames within a multi-frame Image Instance in the image set, versus multiple single-frame Image Instances in the image set that represent individual frames.

C.23.3.1.3 Blending Operation Type

A Blending Operation Type (0072,0500) of COLOR implies that the filtered selected image set contains two sets of images appropriate for blending, such as CT and PET images defined in the same Frame of Reference or associated by a spatial registration object. The decision as to which subset are the underlying images and which subset are the superimposed images is left to the discretion of the display application. There is no mechanism to explicitly specify the two subsets.

The relative opacity and color-related aspects of blending are not specified by the Hanging Protocol, and are left to the discretion of the application.

C.23.3.1.4 Presentation Intent Attributes

The Attributes that indicate the presentation intent for each Display Set of a Hanging Protocol Instance are: Display Set Patient Orientation (0072,0700), VOI Type (0072,0702), Pseudo-color Type (0072,0704), Show Grayscale Inverted (0072,0706), Show Image True Size Flag (0072,0710), Show Graphic Annotation Flag (0072,0712), Show Patient Demographics Flag (0072,0714), and Show Acquisition Techniques Flag (0072,0716).

- If one Presentation State Instance is defined for the images that are to be displayed, then it shall be applied.
- If more than one Presentation State Instance is defined for the images that are to be displayed, then the presentation intent Attributes, if present, shall be used to select the closest matching Presentation State Instance to apply (for example, matching VOI Type (0072,0702) in the Hanging Protocol Instance with Window Center & Width Explanation in the Presentation State Instance). Otherwise, the application shall determine which Presentation State Instance to apply.
- If no Presentation State Instance is defined for the images that are to be displayed, then the presentation intent Attributes, if present, shall be applied (for example, matching VOI Type (0072,0702) in the Hanging Protocol Instance with Window Center & Width Explanation in the Image). Otherwise, the display related information in the Image Instances shall be applied.

The intent of VOI Type (0072,0702) is to support generic intensity window settings for the Display Sets in a Hanging Protocol, such as lung, soft tissue, or bone for chest CT. It is expected for most other modalities that the window/center or VOI LUT values, if not provided in a Presentation State Instance, would be provided in the Image Instance rather than by intent in a Hanging Protocol Instance.

The value of Show Grayscale Inverted (0072,0706) shall override any such intent expressed in the images or associated Presentation States to which the Hanging Protocol is applied.

Note

1. For example, an image may have a MONOCHROME2 Photometric Interpretation (0028,0004) and no Presentation LUT Shape (2050,0020), which implies that maximum values are displayed with maximum available luminance, but the presence of a Show Grayscale Inverted (0072,0706) value of YES in the Hanging Protocol requires maximum values to be displayed with minimum available luminance.
2. For example, an image may have an applicable Presentation State with a Presentation LUT Shape (2050,0020) of IDENTITY, which implies that maximum values are displayed with maximum available luminance, but the presence of a Show Grayscale Inverted (0072,0706) value of YES in the Hanging Protocol requires maximum values to be displayed with minimum available luminance.
3. For example, an image may have an applicable Presentation State with a Presentation LUT, in which case the minimum possible LUT output value (i.e., 0) will be interpreted as maximum available luminance if the value of Show Grayscale Inverted (0072,0706) is YES.

The intent of Display Set Patient Orientation (0072,0700) is to describe the preferred image rotation and/or flip for presentation within an image box. Each of the two values shall be an anatomic direction designated by the capital letters: A (anterior), P (posterior), R (right), L (left), H (head), F (foot), or X (unspecified). Each value of the orientation Attribute shall contain at least one of these characters. If refinements in the orientation descriptions are to be specified, then they shall be designated by one or two additional letters in each value. Within each value, the letters shall be ordered with the principal orientation designated in the first character. If the value "X" is used for one of the values, the patient direction for that value is not defined.

The first value is the patient direction to be oriented at the right side of the image box for each image. The second value is the patient direction to be positioned at the bottom of the image box for each image. The application shall use the patient orientation information of each image (if available) to compute the best rotate and/or flip operation to be applied within the display set. If the patient orientation of an image is not defined, then this Attribute shall be ignored.

C.23.4 Hanging Protocol Selector Attribute Macros

C.23.4.1 Hanging Protocol Selector Attribute Context Macro

Table C.23.4-1 specifies the Attributes that identify the context for a Data Element Tag that is used as a Selector Attribute (0072,0026) in Image Set Selector Sequence (0072,0022), Filter Operations Sequence (0072,0400), or Sorting Operations Sequence (0072,0600). The Attribute may be an Attribute nested within a Sequence or Functional Group Sequence, and/or a Private Attribute.

Table C.23.4-1. Hanging Protocol Selector Attribute Context Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Selector Sequence Pointer	(0072,0052)	1C	Contains the Data Element Tag of the Sequence that contains the Attribute that is identified by Selector Attribute (0072,0026). Required if Selector Attribute (0072,0026) is nested in a Sequence. Shall not be used to identify Code Sequence Attributes. See Selector Code Sequence Value (0072,0080).
Functional Group Pointer	(0020,9167)	1C	Contains the Data Element Tag of the Functional Group Sequence that contains the Attribute that is identified by Selector Attribute (0072,0026). Required if the value of Selector Attribute (0072,0026) is the Data Element Tag of an Attribute that is contained within a Functional Group Sequence.
Selector Sequence Pointer Private Creator	(0072,0054)	1C	Identification of the creator of a group of Private Data Elements. Required if the Selector Sequence Pointer (0072,0052) value is the Data Element Tag of a Private Attribute.
Functional Group Private Creator	(0020,9238)	1C	Identification of the creator of a group of Private Data Elements. Required if the Functional Group Pointer (0020,9167) value is the Data Element Tag of a Private Attribute.
Selector Attribute Private Creator	(0072,0056)	1C	Identification of the creator of a group of Private Data Elements. Required if the Selector Attribute (0072,0026) value is the Data Element Tag of a Private Attribute.

C.23.4.1.1 Hanging Protocol Selector Attribute Context Macro Attribute Descriptions

C.23.4.1.1.1 Selector Sequence Pointer

The Sequence Attribute in the referenced Image identified by the value of Selector Sequence Pointer (0072,0052) may have more than one Item, in which case the filter or image set selector is applied to the values of the Attribute identified by Selector Attribute (0072,0026) in all Items of the Sequence. The Selector shall match the specified value(s) of the specified Attribute in any Item of the Sequence Attribute in the referenced Image.

If the Functional Group Pointer (0020,9167) Attribute is not present, then the Sequence Attribute identified by Selector Sequence Pointer (0072,0052) resides in the top level Data Set of the referenced Image.

C.23.4.1.1.2 Functional Group Pointer

The Functional Group Sequence is a Sequence Attribute contained within a Shared Functional Groups Sequence (5200,9229) Item or a Per-frame Functional Groups Sequence (5200,9230) Item. See Section C.7.6.16.

The Selector Sequence Pointer (0072,0052) may be used to further nest the reference to a Sequence Attribute within a Functional Group Sequence identified by Functional Group Pointer (0020,9167).

C.23.4.1.1.3 Private Attribute References

The Functional Group Private Creator (0020,9238), Selector Sequence Pointer Private Creator (0072,0054), and the Selector Attribute Private Creator (0072,0056) each has a value that corresponds to the Private Creator Data Element numbers (gggg,00pp), where gggg is odd and pp ranges from 10 to FF. These identify a block of Private Data Elements within the block (gggg,ppxx). When Selector Attribute (0072,0026), Selector Sequence Pointer (0072,0052) or Functional Group Sequence Pointer (0020,9167) points to a Private Data Element, (gggg,ppxx), it shall have the value (gggg,00xx).

C.23.4.2 Hanging Protocol Selector Attribute Value Macro

Table C.23.4-2 specifies the Attributes that identify the value(s) for a Data Element Tag that is used as a Selector Attribute (0072,0026) in the Image Set Selector Sequence (0072,0022) or Filter Operations Sequence (0072,0400).

Table C.23.4-2. Hanging Protocol Selector Attribute Value Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Selector AT Value	(0072,0060)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is AT.
Selector CS Value	(0072,0062)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is CS.
Selector IS Value	(0072,0064)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is IS. Some leniency in precision and format (including padding with spaces and leading zeros, e.g., "001" = " 1 " = "1") will be required.
Selector LO Value	(0072,0066)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is LO.
Selector LT Value	(0072,0068)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is LT.
Selector PN Value	(0072,006A)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is PN.
Selector SH Value	(0072,006C)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SH.
Selector ST Value	(0072,006E)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is ST.
Selector UT Value	(0072,0070)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UT.

Attribute Name	Tag	Type	Attribute Description
Selector DS Value	(0072,0072)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is DS. Some leniency in precision and format (including padding and scientific notation) will be required.
Selector FD Value	(0072,0074)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is FD.
Selector FL Value	(0072,0076)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is FL.
Selector UL Value	(0072,0078)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UL.
Selector US Value	(0072,007A)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is US.
Selector SL Value	(0072,007C)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SL.
Selector SS Value	(0072,007E)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is SS.
Selector Code Sequence Value	(0072,0080)	1C	The value(s) of the Attribute identified by Selector Attribute (0072,0026). One or more Items shall be included in this Sequence. See Section C.23.4.2.1.2. Required if Selector Attribute VR (0072,0050) is present and the value is SQ, and Selector Attribute (0072,0026) is a Code Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Selector UI Value	(0072,007F)	1C	The value of the Attribute identified by Selector Attribute (0072,0026). Required if Selector Attribute VR (0072,0050) is present and the value is UI.

C.23.4.2.1 Hanging Protocol Selector Attribute Value Macro Attribute Descriptions

C.23.4.2.1.1 Selector Attribute Value Matching

The value of Specific Character Set (0008,0005) in the Image and the Hanging Protocol Instance may differ and shall be taken into account for matching.

The value of Specific Character Set (0008,0005) may influence how matching of text Attributes is performed, in an implementation dependent manner. No requirements are specified for case sensitive or accent sensitive matching, or for ignoring padding.

C.23.4.2.1.2 Selector Code Sequence Value

The matching shall be performed on Coding Scheme Designator (0008,0102) and Code Value (0008,0100) (or Long Code Value (0008,0119) or URN Code Value (0008,0120), if present). Code Meaning (0008,0104) is required to be present, but shall be ignored for matching purposes. The matching is case sensitive, and leading and trailing spaces are not significant. The Coding Scheme Version

(0008,0103) shall be ignored unless Coding Scheme Designator (0008,0102) is not sufficient to identify Code Value (0008,0100) unambiguously.

C.24 Encapsulated Document Modules

C.24.1 Encapsulated Document Series Module

Table C.24-1 defines the Encapsulated Document Series Attributes.

Table C.24-1. Encapsulated Document Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	The modality appropriate for the encapsulated document. This Type definition shall override the definition in the SC Equipment Module. See Section C.7.3.1.1.1 for Defined Terms. Note SR may be an appropriate value for an Encapsulated CDA document with a structured XML Body.
Series Instance UID	(0020,000E)	1	Unique identifier of the Series.
Series Number	(0020,0011)	1	A number that identifies the Series.
Series Date	(0008,0021)	3	Date the Series started.
Series Time	(0008,0031)	3	Time the Series started.
Referenced Performed Procedure Step Sequence	(0008,1111)	3	Uniquely identifies the Performed Procedure Step SOP Instance for which the Series is created. Only a single Item is permitted in this Sequence. Note The Performed Procedure Step referred to by this Attribute is the Step during which this Document is generated.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Protocol Name	(0018,1030)	3	Description of the conditions under which the Series was performed.
Series Description	(0008,103E)	3	Description of the Series
Series Description Code Sequence	(0008,103F)	3	A coded description of the Series. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Request Attributes Sequence	(0040,0275)	3	Sequence that contains Attributes from the Imaging Service Request. One or more Items are permitted in this Sequence.
>Include Table 10-9 “Request Attributes Macro Attributes”			*No Baseline CID is defined.*
Include Table 10-16 “Performed Procedure Step Summary Macro Attributes”			*No Baseline CID is defined.*

C.24.2 Encapsulated Document Module

Table C.24-2 defines the Encapsulated Document Attributes.

Table C.24-2. Encapsulated Document Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Number	(0020,0013)	1	A number that identifies this SOP Instance. The value shall be unique within a Series.
Content Date	(0008,0023)	2	The date the document content creation was started.
Content Time	(0008,0033)	2	The time the document content creation was started.
Acquisition DateTime	(0008,002A)	2	The date and time that the original generation of the data in the document started.
Image Laterality	(0020,0062)	3	Laterality of the (possibly paired) body part that is the subject of the encapsulated document. Enumerated Values: **R** right **L** left **U** unpaired **B** both left and right If Modality (0008,0060) is M3D, then values for this Attribute shall refer to the intended placement of the created object regardless of how it was generated (see also Section C.35.1 “Manufacturing 3D Model Module”).
Burned In Annotation	(0028,0301)	1	Indicates whether or not the encapsulated document contains sufficient burned in annotation to identify the patient and date the data was acquired. Enumerated Values: **YES** **NO** Identification of patient and date as text in an encapsulated document (e.g., in an XML attribute or element) is equivalent to "burned in annotation". A de-identified document may use the value NO. If Modality (0008,0060) is M3D, the presence of identifying information embossed or engraved on any part of the model shall be indicated by a value of YES.
Recognizable Visual Features	(0028,0302)	3	Indicates whether or not the Instance contains sufficiently recognizable visual features to allow the Instance or a reconstruction from a set of Instances to identify the patient. Enumerated Values: **YES** **NO** If this Attribute is absent, then the Instance may or may not contain recognizable visual features.

Attribute Name	Tag	Type	Attribute Description
Source Instance Sequence	(0042,0013)	1C	A Sequence that identifies the set of Instances that were used to derive the encapsulated document. One or more Items shall be included in this Sequence. Required if derived from one or more DICOM Instances. May be present otherwise. Note Unlike other uses of Source Instance Sequence (0042,0013), such as in the General Reference Module, references to images are permitted in this Module. This Module does not include the Source Image Sequence (0008,2112). The Defined Context Group for Purpose of Reference Code Sequence (0040,A170) includes an appropriate concept.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040,A170)	3	Describes the purpose for which the reference is made, that is what role the source Instances played in the derivation of this encapsulated document Only a single Item single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7060 "Encapsulated Document Source Purposes of Reference".*
Referenced Image Sequence	(0008,1140)	3	The set of Image Instances referenced in the encapsulated document. One or more Items are permitted in this Sequence.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Relative URI Reference Within Encapsulated Document	(0068,7005)	1C	The relative URI reference used in the encapsulated document to reference the Image Instance in this Item. This may be used to maintain referential integrity between a set of related encapsulated documents. Required if the Encapsulated Document (0008,114A) contains a reference to the Image Instance in this Item. See Section C.24.2.4.
Referenced Instance Sequence	(0008,114A)	3	The set of non-image SOP Instances referenced in the encapsulated document. One or more Items are permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Relative URI Reference Within Encapsulated Document	(0068,7005)	1C	The relative URI reference used in the encapsulated document to reference the SOP Instance in this Item. This may be used to maintain referential integrity between a set of related encapsulated documents. Required if the Encapsulated Document (0008,114A) contains a reference to the SOP Instance in this Item. See Section C.24.2.4.

Attribute Name	Tag	Type	Attribute Description
Document Title	(0042,0010)	2	The title of the document. Note In the case of a PDF encapsulated document, this may be the value of the "Title" entry in the "Document Information Directory" as encoded in the PDF data.
Concept Name Code Sequence	(0040,A043)	2	A coded representation of the document title. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*For documents with Modality (0008,0060) equal to M3D, BCID 7061 “Model Document Titles”.* *For all other Encapsulated documents, BCID 7020 “Document Titles”.*
Document Class Code Sequence	(0040,E008)	3	Additional classifications of the document, beyond the title represented in Concept Name Code Sequence. May be equivalent to HL7 v2.x TXA-2. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Verification Flag	(0040,A493)	3	Indicates whether the Encapsulated Document is Verified. Enumerated Values: **UNVERIFIED** Not attested by a legally accountable person. **VERIFIED** Attested to (signed) by a Verifying Observer or Legal Authenticator named in the document, who is accountable for its content.
HL7 Instance Identifier	(0040,E001)	1C	Instance Identifier of the encapsulated HL7 Structured Document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier). Required if encapsulated document is a CDA document.
Predecessor Documents Sequence	(0040,A360)	3	References to SOP Instances whose content has been wholly or partially included in this document with or without modification. One or more Items are permitted in this Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			*Purpose of Reference Code Sequence in the Hierarchical SOP Instance Reference Macro DCID 7062 “Purpose of Reference to Predecessor 3D Model” if Modality (0008,0060) is M3D; otherwise, DCID 7009 “Purpose of Reference to Predecessor Report”.*
Identical Documents Sequence	(0040,A525)	3	Duplicates of this document, stored with different SOP Instance UIDs. One or more Items are permitted in this Sequence. See Section C.17.2.2 for further explanation.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
MIME Type of Encapsulated Document	(0042,0012)	1	The type of the encapsulated document stream described using the MIME Media Type (see RFC 2046).

Attribute Name	Tag	Type	Attribute Description
List of MIME Types	(0042,0014)	1C	MIME Types of subcomponents of the encapsulated document. Required if the encapsulated document incorporates subcomponents with MIME types different than the primary MIME Type of the encapsulated document. Note An Encapsulated CDA that includes an embedded JPEG image and an embedded PDF would list "image/jpeg\application/pdf".
Encapsulated Document	(0042,0011)	1	Encapsulated Document stream, containing a document encoded according to the MIME Type.
Encapsulated Document Length	(0042,0015)	3	The length of the Encapsulated Document stream, not including any trailing padding added for encapsulation as a DICOM object. If present, shall be equal to the Value Length if even, or one less than the Value Length if odd. Note In the absence of this Attribute, the value of Encapsulated Document (0042,0011) may have been padded to even length as required for all DICOM Data Element Values, so it would not be possible to extract the original unpadded document if it were of odd length.
Value Type	(0040,A040)	1C	The type of the value encoded in this Content Item. Enumerated Values: **CONTAINER** Required if Content Sequence (0040,A730) is present
Content Sequence	(0040,A730)	3	A potentially recursively nested Sequence of Items that conveys structured content. One or more Items are permitted in this Sequence. See Section C.17.3.2.4 and Section C.24.2.2 for further explanation.
>Relationship Type	(0040,A010)	1	The type of relationship between the (enclosing) Source Content Item and the Target Content Item. IODs specify additional constraints on Relationships (including lists of Enumerated Values). Enumerated Values: **CONTAINS** **HAS OBS CONTEXT** **HAS ACQ CONTEXT** **HAS CONCEPT MOD** See Section C.17.3.2.4 for further explanation.
>Include Table C.17-6 “Document Relationship Macro Attributes”			
>Include Table C.17-5 “Document Content Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Continuity of Content	(0040,A050)	1C	This flag specifies for a CONTAINER whether or not its contained Content Items are logically linked in a continuous textual flow, or are separate Items. Enumerated Values: **SEPARATE** **CONTINUOUS** See Section C.18.8.1.1 for further explanation. Required if Content Sequence (0040,A730) is present.
Content Template Sequence	(0040,A504)	1C	Template that describes the content of this Content Item and its subsidiary Content Items. Only a single Item shall be included in this Sequence. Required if Content Sequence (0040,A730) is present and if a template defined and known to the implementation at the time of encoding was used to define the content of this Item, and the template consists of a single CONTAINER with nested content, and it is the outermost invocation of a set of nested templates that start with the same CONTAINER (see Section C.18.8.1.2).
>Mapping Resource	(0008,0105)	1	Mapping Resource that defines the template. See Section 8.4. Defined Terms: **DCMR** DICOM Content Mapping Resource
>Mapping Resource UID	(0008,0118)	3	Uniquely identifies the Mapping Resource that defines the template. Note The unique identifier for the DICOM Content Mapping Resource "DCMR" is defined in PS3.6.
>Template Identifier	(0040,DB00)	1	Template identifier.

Note

1. One could distinguish four stages in the creation of the Encapsulated Document Object, identified by the following Attributes:

    1. Measurement and/or data collection, identified by Acquisition DateTime (0008,002A) in the Encapsulated Document Module.

    2. Creation of the original documentation of the data collection, identified by Content Date (0008,0023) and Content Time (0008,0033).

    3. Rendering of the original documentation into the format that will be encapsulated, e.g., a PDF document. The rendering time is not captured by any DICOM Attribute, but may be encoded in the rendering.

    4. Encapsulation of the rendering into a DICOM Object, identified by Instance Creation Date (0008,0012) and Instance Creation Time (0008,0013) in the SOP Common Module.

2. DICOM does not specify requirements for consistency between DICOM Attribute values and data in the encapsulated document. It is expected that applications will ensure consistency in a manner appropriate to the application. For example, the Patient ID in an encapsulated CDA document may be that of a different institution, which originated the document, and it may be appropriate for the DICOM Attribute value to be different.

C.24.2.1 Attribute Requirements for Encapsulated CDA Document

For an Encapsulated CDA Document, Document Title (0042,0010) shall have the value of the CDA Document Title, if one is present in the encapsulated document.

Concept Name Code Sequence (0040,A043) shall have the value of the CDA Document Type Code, with transcoding as necessary for converting the HL7 CE Data Type to the DICOM Code Sequence Item.

Enumerated Values for MIME Type of Encapsulated Document (0042,0012):

text/XML

C.24.2.2 Content Sequence

Content Sequence (0040,A730) encodes structured content relevant to the Encapsulated Document (0042,0011). This allows structured data in DICOM encoded form to accompany or describe some or all of the contents of the otherwise opaque encapsulated document, and enables receiving implementations to extract that data, e.g., to tabulate numeric measurements, provide them as merge fields for dictation, or store them in a database.

> Note
>
> Some encapsulated document formats may themselves have some structured content, e.g., the non-narrative part of an HL7 CDA object, or the XMP metadata of a PDF object. This mechanism allows a DICOM-aware system to extract data without needing to parse or understand what is encapsulated.

There is no expectation that all of the narrative or visually rendered content in the encapsulated document be replicated in a structured form in the Content Sequence (0040,A730), nor is it expected that all of the information in the Content Sequence (0040,A730) be present in the encapsulated document. E.g., the structured content might contain codes describing the encapsulated document, or the encapsulated document may contain observations that are not replicated in the structured content.

The use of the Content Sequence (0040,A730) follows the pattern established for Structured Reports, and each Item of the Sequence in the top level Data Set is a Content Item (see Section C.17.3.2 “Content Item Attributes”).

Each Item of the Sequence in the top level Data Set may, for instance, be a numeric measurement content item (see Section C.18.1 “Numeric Measurement Macro”). E.g.:

- NUM (8821-1, LN, "Left Ventricular ED Volume") = 98 (mm3, UCUM, "mm3")
- NUM (8808-8, LN, "Left Ventricular Ejection Fraction by Angiography") = 65 (%, UCUM, "Percent")

Alternatively, nested content items may be used in the manner of a typical Structured Report, and an appropriate template from PS3.16 invoked (e.g., the TID 1500 Measurement Report template), in which case the Concept Name Code Sequence (0040,A043) serves as Document Title and the name of the top level CONTAINER content item of the Structured Report, and such Content Items as measurements are nested within containers, may be related to regions of interest, given tracking identifiers, etc.

C.24.2.3 Security Considerations for Encapsulated Documents (Informative)

The encapsulated documents may conform to another standard, e.g., PDF, or may be in a proprietary format. Many of these formats have had their own security issues, both with the format itself and with common implementations for processing the format.

Implementations that support encapsulated documents may need to:

- Perform input validation and sanitation to detect and perhaps remove invalid or malicious content.
- Perform output validation to ensure safe compliance with format specification.
- Monitor library implementations for vulnerability reports, updates, and have a process for managing these updates.

Tracking, notification, and remediation of these security problems will normally be in the context of the encapsulated format and not in the context of DICOM. This means those implementing and deploying the encapsulated format must consider security issues from those other contexts.

C.24.2.4 Relative URI Reference Within Encapsulated Document

The relative URI reference within encapsulated document value shall be encoded as a relative URI reference [RFC3986], with the following restrictions:

- The base path (URI) to which the reference is relative is the location where the referencing file would hypothetically be written, were it to be unencapsulated and written to a file, such that the set of related encapsulated documents share the same base path.
- The path shall not begin with a slash or two slashes.
- The path shall not refer to a higher level in the file system hierarchy (i.e., use of ".." is not permitted).
- File name extensions corresponding to executable file types (exe, dll, etc.) are not permitted.
- Embedded white space is not permitted.

The following are examples of valid relative URI references:

- "matlist.mtl"
- "materials/matlist.mtl"
- "./materials/matlist.mtl"
- "file:///matlist.mtl" (not a relative reference)
- "/matlist.mtl" (initial slash not permitted)
- "//matlist.mtl" (initial slashes not permitted)
- "c:/matlist.mtl" (not a relative reference)
- "../matlist.mtl" (".." not permitted)
- "mat list.mtl" (embedded spaces not permitted)
- "materials\matlist.mtl" (backslash not permitted)

C.25 Real World Value Mapping Modules

C.25.1 Real World Value Mapping Series Module

Table C.25.1-1 defines the general Attributes of the Real World Value Mapping Series Module.

Table C.25.1-1. Real World Value Mapping Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Modality type. Enumerated Values: RWV

C.25.2 Real World Value Mapping Module

Table C.25.2-1 defines the general Attributes of the Real World Value Mapping Module.

Table C.25.2-1. Real World Value Mapping Module Attributes

Attribute Name	Tag	Type	Attribute Description
Content Date	(0008,0023)	1	The date the content creation started.

Attribute Name	Tag	Type	Attribute Description
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 "Content Identification Macro Attributes"			
Referenced Image Real World Value Mapping Sequence	(0040,9094)	1	A Sequence of real world value mapping Items. Each Item defines a single mapping and a list of images to which the mapping applies. One or more Items shall be included in this Sequence.
~~>*Include* Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"~~			~~*Measurement Units Code Sequence D*CID 83 "Units for Real World Value Mapping".~~
>*Include* Table C.7.6.16-12 "Real World Value Mapping Macro Attributes"			*Measurement Units Code Sequence D*CID 83 "Units for Real World Value Mapping".
>Referenced Image Sequence	(0008,1140)	1	A Sequence listing the images to which the mapping applies. One or more Items shall be included in this Sequence.
>>*Include Table 10-3 "Image SOP Instance Reference Macro Attributes"*			

C.26 Substance Administration Modules

C.26.1 Product Characteristics Module

Table C.26-1 specifies the Attributes used to convey the characteristics or parameters of a contrast agent, drug, or device.

Table C.26-1. Product Characteristics Module Attributes

Attribute Name	Tag	Attribute Description
Product Package Identifier	(0044,0001)	Identifier of the contrast agent, drug, or device being characterized, typically from a package bar code, RFID, or other materials management ID. This ID might not be globally unique and might conflict with other IDs used within the scope of the institution.
Manufacturer	(0008,0070)	Manufacturer of product.
Product Type Code Sequence	(0044,0007)	Coded type of product. Only a single Item shall be included in this Sequence.
>*Include Table 8.8-1 "Code Sequence Macro Attributes"*		For drugs, a coded terminology in the US is RxNorm For devices, a coded terminology in the US is the FDA CDRH Product Code Classification
Product Name	(0044,0008)	Trade or generic name of product. Note May be multi-valued.
Product Description	(0044,0009)	Further description in free form text describing the drug or device. Note This Attribute is limited by the LT Value Representation to 10240 characters. Larger text descriptions, or graphical descriptions, may be referenced in the Pertinent Documents Sequence (0038,0100).

Attribute Name	Tag	Attribute Description
Product Lot Identifier	(0044,000A)	Identifier of the manufacturing batch of which this product is part.
Product Expiration DateTime	(0044,000B)	The date and time after which the manufacturer no longer ensures the safety, quality, and/or proper functioning of the material.
Product Parameter Sequence	(0044,0013)	Parameters of the product. Zero or more Items shall be included in this Sequence.
>Include Table 10-2 "Content Item Macro Attributes Description"		*For drugs or contrast agents, for Concept Name Code Sequence, BCID 4050 "Drug or Contrast Agent Characteristics"* *For devices, for Concept Name Code Sequence, BCID 3423 "Numeric Device Characteristics"*
Pertinent Documents Sequence	(0038,0100)	Reference to a Product Label document for the product. Zero or more Items shall be included in this Sequence.
>Referenced SOP Class UID	(0008,1150)	Unique identifier for the class of an HL7 Structured Product Label document.
>Referenced SOP Instance UID	(0008,1155)	Unique identifier for the HL7 Structured Product Label Document as used in DICOM Instance references (see Section C.12.1.1.6)
>HL7 Instance Identifier	(0040,E001)	Instance Identifier of the referenced HL7 Structured Document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier).
>Retrieve URI	(0040,E010)	Retrieval access path to Product Label Document. Includes fully specified scheme, authority, path, and query in accordance with [RFC3986] Note The VR of this Data Element has changed from UT to UR.

C.26.2 Substance Approval Module

Table C.26-2 specifies the Attributes used to approve the administration of a contrast agent, drug, or device to a patient.

Table C.26-2. Substance Approval Module Attributes

Attribute Name	Tag	Attribute Description
Substance Administration Approval	(0044,0002)	Status of request for substance administration. Enumerated Values: **APPROVED** Use of the substance for the patient is approved, with related notes (e.g., appropriate dose for age/weight) in Approval Status Further Description (0044,0003) **WARNING** The substance may be used for the patient subject to warnings described in Approval Status Further Description (0044,0003) **CONTRA_INDICATED** The substance should not be used for the patient for the reasons described in Approval Status Further Description (0044,0003)
Approval Status Further Description	(0044,0003)	Description of warning or contra-indication, or notes on approval.
Approval Status DateTime	(0044,0004)	Timestamp for the Substance Administration Approval response

C.26.3 Substance Administration Module

Table C.26-3 specifies the Attributes used to describe the act of administration of a contrast agent, drug, or device to a patient.

Table C.26-3. Substance Administration Module Attributes

Attribute Name	Tag	Attribute Description
Administration Route Code Sequence	(0054,0302)	Route of administration for drug or contrast. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 11 "Route of Administration".*

C.26.4 Substance Administration Log Module

Table C.26-4 specifies the Attributes used to record the act of administration of a contrast agent, drug, or device to a patient.

Table C.26-4. Substance Administration Log Module Attributes

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full name
Patient ID	(0010,0020)	Primary identification number or code for the patient.
Include Table 10-18 "Issuer of Patient ID Macro Attributes"		
Admission ID	(0038,0010)	Identification number of the Visit as assigned by the healthcare provider
Issuer of Admission ID Sequence	(0038,0014)	Identifier of the Assigning Authority that issued the Admission ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
Product Package Identifier	(0044,0001)	Identifier of the contrast agent, drug, or device administered, typically from a package bar code, RFID, or other materials management ID. This ID might not be globally unique and might conflict with other IDs used within the scope of the institution.
Product Name	(0044,0008)	Trade or generic name of product. Note May be multi-valued.
Product Description	(0044,0009)	Text description of the contrast agent, drug, or device administered.
Substance Administration DateTime	(0044,0010)	Date and Time of Substance Administration
Substance Administration Notes	(0044,0011)	Comments provided by the operator responsible for the substance administration.
Substance Administration Device ID	(0044,0012)	Identifier for a device that controls substance administration, e.g., injector, infusion pump, etc.
Administration Route Code Sequence	(0054,0302)	Route of administration for drug or contrast. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 11 "Route of Administration".*
Substance Administration Parameter Sequence	(0044,0019)	Parameters of the substance as administered to the patient, e.g., volume, quantity. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
~~>*Include* Table 10-2 “Content Item Macro Attributes Description”~~		~~*For administration of drugs or contrast agents, Concept Name Code Sequence B*CID 3410 “Numeric Parameters of Drugs/Contrast”.~~
>*Include* Table 10-2 “Content Item Macro Attributes Description”		*For administration of drugs or contrast agents, Concept Name Code Sequence B*CID 3410 “Numeric Parameters of Drugs/Contrast”.
Operator Identification Sequence	(0008,1072)	Person administering the substance to the patient, or legally responsible for the administration, and authorized to add an entry to the Medication Administration Record. One or more Items shall be included in this Sequence.
>Person Identification Code Sequence	(0040,1101)	Coded identifier of the person administering the contrast agent, drug, or device. Only a single Item shall be included in this Sequence.
>>*Include Table 8.8-1 “Code Sequence Macro Attributes”*		*No Baseline CID is defined.* The Coding Scheme Designator Attribute may indicate a local coding scheme (e.g., with value "L") when it is implicitly that of the institution's employee identifier system. The Code Meaning Attribute, though it is encoded with a VR of LO, may be encoded according to the rules of the PN VR (see Section 10.1).

C.27 Common Surface IE Modules

This section describes the specific Modules for the Surface IE.

C.27.1 Surface Mesh Module

Table C.27-1 specifies the Attributes of the Surface Mesh Module.

Table C.27-1. Surface Mesh Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Surfaces	(0066,0001)	1	Number of surfaces contained in the Instance. Shall be 1 or more. Shall be the same as the number of Items in Surface Sequence (0066,0002).
Surface Sequence	(0066,0002)	1	The surfaces that are described within the data. One or more Items shall be included in this Sequence. There shall be Number of Surfaces (0066,0001) Items in the Sequence. See Section C.27.1.1.1.
>Surface Number	(0066,0003)	1	Identification number of the surface. Uniquely identifies a surface within this SOP Instance. Shall start at a value of 1, and increase monotonically by 1.
>Surface Comments	(0066,0004)	3	User-defined comments describing the surface.
>Segmented Property Category Code Sequence	(0062,0003)	3	Sequence defining the general category of the property the surface represents. Only a single Item is permitted in this Sequence.
>>*Include Table 8.8-1 “Code Sequence Macro Attributes”*			*BCID 7150 “Segmentation Property Categories”.*

Attribute Name	Tag	Type	Attribute Description
>Segmented Property Type Code Sequence	(0062,000F)	3	Sequence defining the specific property the surface represents. Note "Property" is used in the sense of meaning "what the surface represents", whether it be a physical or biological object, be real or conceptual, having spatial, temporal or functional extent or not. I.e., it is what the segment "is" (as opposed to some feature, attribute, quality, or characteristic of it, like color or shape or size). Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7151 "Segmentation Property Types".*
>Surface Processing	(0066,0009)	2	Specifies whether the surface has been modified subsequent to the original generation of the surface. Enumerated Values: **YES** **NO** See Section C.27.1.1.2.
>Surface Processing Ratio	(0066,000A)	2C	The Ratio of Remaining points to Original points after processing. Required if Surface Processing (0066,0009) is YES.
>Surface Processing Description	(0066,000B)	3	A textual description of the surface processing performed.
>Surface Processing Algorithm Identification Sequence	(0066,0035)	2C	Describes the processing method. Zero or one Item shall be included in this Sequence. Required if Surface Processing (0066,0009) is YES.
>>Include Table 10-19 "Algorithm Identification Macro Attributes"			*Algorithm Family Code Sequence (0066,002F) BCID 7162 "Surface Processing Algorithm Families".*
>Recommended Display Grayscale Value	(0062,000C)	1	A default single gray unsigned value in which it is recommended that the maximum pixel value in this surface be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Recommended Display CIELab Value	(0062,000D)	1	A default triplet value in which it is recommended that the surface be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1
>Recommended Presentation Opacity	(0066,000C)	1	Specifies the opacity in which it is recommended that the surface be rendered. See Section C.27.1.1.3.
>Recommended Presentation Type	(0066,000D)	1	Specifies the presentation type in which it is recommended that the surface be rendered. See Section C.27.1.1.3.

Attribute Name	Tag	Type	Attribute Description
>Recommended Point Radius	(0066,0037)	3	Specifies the radius of the vertex points defined in the Long Vertex Point Index List (0066,0043) with which it is recommended that the point be rendered. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
>Recommended Line Thickness	(0066,0038)	3	Specifies the thickness of each edge or line defined in the Long Edge Point Index List (0066,0042) or Line Sequence (0066,0028) with which it is recommended that the line be rendered. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
>Finite Volume	(0066,000E)	1	Indicates, whether the surface represents a solid ("waterproof") object with an outside and an inside. Enumerated Values: **YES** Contains a finite volume **NO** Does not contain a finite volume **UNKNOWN** Might or might not contain a finite volume See Section C.27.1.1.4.
>Manifold	(0066,0010)	1	Indicates whether the surface is describing an n-1 dimensional manifold in the underlying n-dimensional vector space. Enumerated Values: **YES** Manifold in every point **NO** Does contain non-manifold points **UNKNOWN** Might or might not contain non-manifold points See Section C.27.1.1.5.
>Surface Points Sequence	(0066,0011)	1	The point positions representing vertices of the surface. Only a single Item shall be included in this Sequence.
>>Include Table C.27-2 “Points Macro Attributes”			
>Surface Points Normals Sequence	(0066,0012)	2	The normals on the surface for each point. Zero or one Item shall be included in this Sequence. See Section C.27.1.1.6.
>>Include Table C.27-3 “Vectors Macro Attributes”			*Number of Vectors (0066,001E) shall equal Number of Surface Points (0066,0015) in this Surface Sequence (0066,0002) Item.* *Vector Dimensionality (0066,001F) shall be 3.* *If Finite Volume (0066,000E) is YES, the normals of the vertices shall point toward the outside of the object. If Finite Volume (0066,000E) is not YES, the direction of the normals shall be consistent where possible.*
>Surface Mesh Primitives Sequence	(0066,0013)	1	Only a single Item shall be included in this Sequence.
>>Include Table C.27-4 “Surface Mesh Primitives Macro Attributes”			*The primitives' indices shall not exceed Number of Surface Points (0066,0015) in this Surface Sequence (0066,0002) Item.*

C.27.1.1 Surface Mesh Module Attribute Descriptions

C.27.1.1.1 Surface Sequence

Surface Sequence (0066,0002) describes individual surfaces. There is no requirement that a surface be contiguous. For example, both kidneys could be described as a single surface consisting of 2 non-contiguous areas.

C.27.1.1.2 Surface Processing

Surface Processing refers to methods of surface modification such as smoothing operations, which remove redundant vertices, or decimation, which will modify the resolution of the surface. If a surface has been subject to processing, a description of the process may be provided in Surface Processing Description (0066,000B).

C.27.1.1.3 Recommended Presentation

Recommended Presentation Opacity (0066,000C) is a fraction between 0.0 and 1.0 encoded as a float value representing the blending proportion of the rendering of the surface relative to underlying features. A value of 0.0 is interpreted as complete transparency, while a value of 1.0 is interpreted as fully opaque.

The Recommended Presentation Type (0066,000D) Attribute provides guidance as to the default presentation of the Surface.

Defined Terms:

SURFACE Render the surface as a solid, applying the opacity as specified in the Recommended Presentation Opacity (0066,000C) Attribute.
WIREFRAME Represent the surface as a series of lines connecting the vertices to form the defined primitive faces.
POINTS Represent the surface as a cloud of points.

C.27.1.1.4 Finite Volume

The Finite Volume (0066,000E) Attribute shall be YES when the surface mesh generated by the primitives is topologically closed and has an inside and an outside. A surface mesh is closed if it has no rim (every facet has a neighboring facet along each edge). Figure C.27.1.1-1 shows a surface that is not closed on the left, and a closed and waterproof version of the same shape on the right:

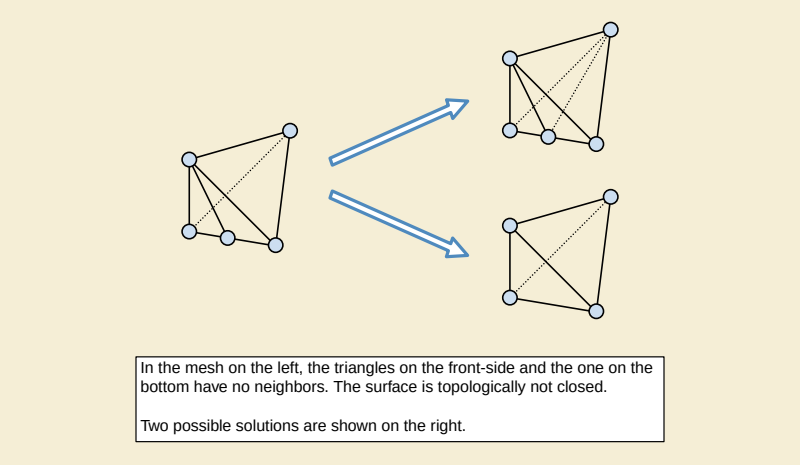


Figure C.27.1.1-1. Finite Volume Illustration

Not all closed surfaces contain a finite volume, for example if the surface self-intersects. Such surfaces do not contain a finite volume. A surface is not required to be contiguous.

A value of NO indicates that the surface is not closed.

A value of UNKNOWN indicates that the transmitting application did not determine if the surface is closed.

C.27.1.1.5 Manifold

The Manifold (0066,0010) Attribute shall be YES when the surface mesh is a manifold.

A surface embedded into an n-dimensional vector space is called an n-1 manifold if it resembles an n-1 dimensional Euclidean space in a neighborhood of every point lying on the surface. This means that every point has a neighborhood for which there exists a homeomorphism mapping that neighborhood to the n-1 dimensional Euclidean space.

A sphere in 3-space is a 2-dimensional manifold: Every point has a neighborhood that looks like a plane.

Figure C.27.1.1-2 shows examples of a surface that is not a manifold is given below:

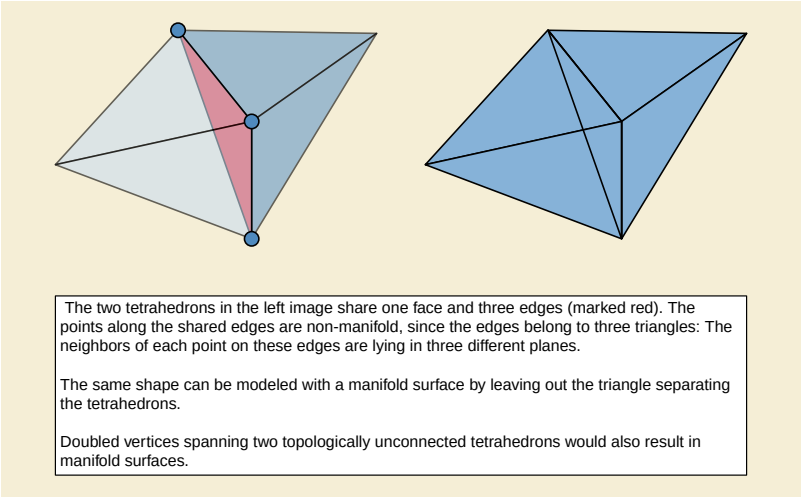


Figure C.27.1.1-2. Manifold Illustration

A value of NO indicates that the surface is not a manifold.

A value of UNKNOWN indicates that the transmitting application did not determine if the surface is a manifold.

C.27.1.1.6 Surface Points Normals Sequence

Surface Points Normals Sequence (0066,0012) provides an explicit normal vector for each point in Surface Points Sequence (0066,0011) in Point Coordinates Data (0066,0016).

If an Item of Surface Points Normals Sequence (0066,0012) is present the normal for a primitive may be computed by combining the normals for each vertex making up the primitive.

If an Item of Surface Points Normals Sequence (0066,0012) is not present the normal for a primitive shall be computed by computing the cross product of two segments of the primitive. The segments shall be formed using the primitive definitions as specified within the Surface Mesh Primitives Sequence (0066,0013). The primitive vertices are taken in the order specified within Long Primitive Point Index List (0066,0040). Figure C.27.1.1-3 shows the method to compute the normal:

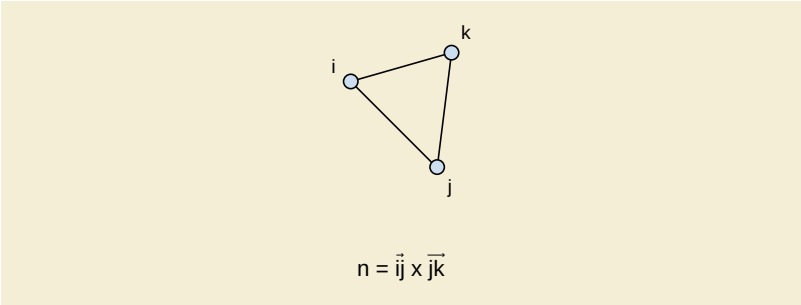


Figure C.27.1.1-3. Triangle Normal Computation

The computed normal shall point in the direction of the outside of the surface.

For Triangle Strip or Triangle Fan primitives (see Section C.27.4), the normal direction is determined by the order of the points referenced by the first triangle in the strip or fan. When constructing a list of triangles from a triangle strip, the order of the points must be flipped for every second triangle to maintain consistency in the normal directions for the triangle.

C.27.2 Points Macro

Table C.27-2 specifies the Attributes of the Points Macro.

Table C.27-2. Points Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number Of Surface Points	(0066,0015)	1	Specifies the number of points in the point set. See Section C.27.2.1.1.
Point Coordinates Data	(0066,0016)	1	See Section C.27.2.1.1
Point Position Accuracy	(0066,0017)	3	A single standard deviation of the error for all the points' spatial positions. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
Mean Point Distance	(0066,0018)	3	The mean point distance of the point set. It is given by the mean of the distances to the nearest neighbor over all points. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
Maximum Point Distance	(0066,0019)	3	The maximum distance of one point to its nearest neighbor. The units shall be the same as the units of the coordinate system in which the point coordinates are specified.
Points Bounding Box Coordinates	(0066,001A)	3	Two 3D locations defining the cuboid bounding box, parallel to the coordinate system axes, encompassing the point set.
Axis of Rotation	(0066,001B)	3	A 3D location that combined with Center of Rotation (0066,001C) specifies the preferred axis of rotation of this object.
Center of Rotation	(0066,001C)	1C	A 3D location defining the preferred center of rotation for this point set. Required if Axis of Rotation (0066,001B) is present. May be present otherwise.

C.27.2.1 Points Macro Attribute Descriptions

All Attributes within this Module containing points or vectors are in x-y-z order. If multiple elements are encoded, the ordering is $x_1,y_1,z_1,\ldots,x_n,y_n,z_n$.

The points are in the coordinate system identified by the Frame of Reference UID (0020,0052). To map these points into the coordinate system of another SOP Instance a Spatial Registration Instance can be used.

C.27.2.1.1 Point Coordinates Data

When referencing individual points the index of the first point shall be 1.

C.27.3 Vectors Macro

Table C.27-3 specifies the Attributes of the Vectors Macro.

Table C.27-3. Vectors Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Vectors	(0066,001E)	1	The number of vectors in the Vector Coordinate Data (0066,0021). See Section C.27.3.1.
Vector Dimensionality	(0066,001F)	1	The dimensionality of the underlying vector field. See Section C.27.3.1.
Vector Accuracy	(0066,0020)	3	A single standard deviation for all the vectors' coordinates. The units shall be the same as the units of the coordinate system in which the vector coordinates are specified. See Section C.27.3.1.
Vector Coordinate Data	(0066,0021)	1	A data stream of coordinates encoded as floats. See Section C.27.3.1.

C.27.3.1 Vectors Macro Attribute Descriptions

All Attributes within this Module containing points or vectors are encoded as multi-valued floats in an x-y-z ordering. If multiple elements are encoded, the ordering is $x_1,y_1,z_1,\ldots,x_n,y_n,z_n$.

The vectors encoded in this Macro can be anything from 1D to nD objects. The vectors are encoded as a stream of values in the Vector Coordinate Data (0066,0021) Attribute. Vector Dimensionality (0066,001F) defines how many subsequent entries in Vector Coordinate Data (0066,0021) describe one element. Vector Coordinate Data (0066,0021) shall have (Number of Vectors) x (Vector Dimensionality) values.

For measured vectors, Vector Accuracy (0066,0020) describes the error per dimension in a multi-valued float Attribute.

Note

The vectors are located at the points specified by the table including this Macro.

C.27.4 Surface Mesh Primitives Macro

Table C.27-4 specifies the Attributes of the Surface Mesh Primitives Macro.

Table C.27-4. Surface Mesh Primitives Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Long Vertex Point Index List	(0066,0043)	2	A list of point indices. Contains n point indices describing Vertices. See Section C.27.4.1.
Long Edge Point Index List	(0066,0042)	2	A list of point indices. Contains 2n point indices describing unconnected Edges. See Section C.27.4.1.
Long Triangle Point Index List	(0066,0041)	2	A list of point indices. Contains 3n point indices describing unconnected Triangles. See Section C.27.4.1.

Attribute Name	Tag	Type	Attribute Description
Triangle Strip Sequence	(0066,0026)	2	All Triangle Strips in this Surface. Zero or more Items shall be included in this Sequence.
>Long Primitive Point Index List	(0066,0040)	1	A list of point indices. See Section C.27.4.1.
Triangle Fan Sequence	(0066,0027)	2	All Triangle Fans in this Surface. Zero or more Items shall be included in this Sequence.
>Long Primitive Point Index List	(0066,0040)	1	A list of point indices. See Section C.27.4.1.
Line Sequence	(0066,0028)	2	All Lines in this Surface. Zero or more Items shall be included in this Sequence.
>Long Primitive Point Index List	(0066,0040)	1	A list of point indices. See Section C.27.4.1.
Facet Sequence	(0066,0034)	2	All Facets in this Surface. Each Item describes one facet. Zero or more Items shall be included in this Sequence.
>Long Primitive Point Index List	(0066,0040)	1	A list of point indices. See Section C.27.4.1.

C.27.4.1 Surface Mesh Primitives Macro Attribute Descriptions

The Surface Mesh Primitives Macro uses 32-bit long integer point indices to reference the point rather than repeating point coordinates. All of the point coordinates used are specified within the Surface Points Sequence (0066,0011) of the same Surface Sequence (0066,0002) Item. Point indices are described in Section C.27.2.1.1.

Note

In a previous edition, other Attributes were used that had an OW VR and a limitation to no more than 65535 points per surface. These have been retired and replaced with new Attributes. See PS 3.3 2014a.

A Surface Mesh shall contain one or more of the following primitive types:

Vertex A single Vertex, referencing a single point

Edge An Edge, referencing two points

Line A series of connected points describing a path

Triangle A Triangle, referencing three points:

Triangle Strip A Triangle Strip with n triangles, referencing n+2 points. The first three referenced points describe the first triangle, the second, third and fourth referenced points describe the second triangle.

Triangle Fan A Triangle Fan with n triangles, referencing n+2 points. The first referenced point is in the center of the fan. Together with two subsequent referenced points, it describes a complete triangle.

Facet A closed planar polygon, referencing n points. The final point in the point index list shall be connected to the first point in the point index list to close the facet.

If the Surface Points Normals Sequence (0066,0012) is not present, the default normals can be derived from the Surface Mesh Primitives.

For the Triangle Strip, Triangle Fan and Facet the Long Primitive Point Index List (0066,0040) the ordering of the point references implies the direction of the primitive's normal: The normal points in the direction from which the referenced points are specified in a counterclockwise order. For finite volumes this shall be the outward direction.

For the Line primitive, the ordering of the point references defines a directed path, starting with the first point and ending with the last point referenced in each Long Primitive Point Index List (0066,0040).

For Primitives of type Triangle Strip or Triangle Fan, the orientation of the normals is given by the order of the points in the first triangle.

Note

These points may be used to compute normals to the primitive. (see Section C.27.1.1.6.) The order these point references are presented in the Long Primitive Point Index List (0066,0040) will affect the direction the computed normal points. If the order of the point references is reversed, the direction of the normals will be reversed as well.

C.27.5 Point Cloud Module

Table C.27.5-1 specifies the Attributes of the Point Cloud Module.

Table C.27.5-1. Point Cloud Module Attributes

Attribute Name	Tag	Type	Attribute Description
Surface Points Sequence	(0066,0011)	1	The point positions representing vertices of the surface. Only one Item shall be included in the Sequence.
>Include Table C.27-2 “Points Macro Attributes”			
>Segmented Property Category Code Sequence	(0062,0003)	3	Sequence defining the general category of the property the surface point set represents. Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7150 “Segmentation Property Categories”.*
>Segmented Property Type Code Sequence	(0062,000F)	3	Sequence defining the specific property the surface point set represents. Note "Property" is used in the sense of meaning "what the surface represents", whether it be a physical or biological object, be real or conceptual, having spatial, temporal or functional extent or not. I.e., it is what the segment "is" (as opposed to some feature, attribute, quality, or characteristic of it, like color or shape or size). Only a single Item is permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Surface Point Presentation Value Data	(0080,0006)	3	Contains a vector of P-Values to assign a gray value to each point. The number of values shall be equal to the value of Number Of Surface Points (0066,0015) in the Points Macro. Each value shall correspond to the respective point in the Point Coordinates Data (0066,0016).
Surface Point Color CIELab Value Data	(0080,0007)	3	Contains a vector of color triplets to assign colors to each point. The number of triplets shall be equal to the value of Number Of Surface Points (0066,0015) in the Points Macro. The units are PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1. Each triplet shall correspond to the respective point in the Point Coordinates Data (0066,0016).

C.27.6 UV Mapping Module

Table C.27.6-1 specifies the Attributes of the UV Mapping Module.

Table C.27.6-1. UV Mapping Module Attributes

Attribute Name	Tag	Type	Attribute Description
UV Mapping Sequence	(0080,0008)	1	Maps each point of the Surface Points Sequence (0066,0011) in the Point Cloud Module or the Surface Mesh Module to the coordinates of a VL Photographic Image Instance. One or more Items shall be included in this Sequence.
>Texture Label	(0080,0009)	1	Contains a label that uniquely identifies this UV map to distinguish it from other Items in the Sequence.
>U Value Data	(0080,0010)	1	Contains a vector of column offsets. Each value is normalized to the range of 0.0 to 1.0 pointing in the pixel data of the referenced textures Sequence image. Each value shall correspond to the respective point in the Point Coordinates Data (0066,0016). The number of values must be equal to the number of points of the Point Cloud or the Surface Mesh.
>V Value Data	(0080,0011)	1	Contains a vector of row offsets. Each value is normalized to the range of 0.0 to 1.0 pointing in the pixel data of the referenced textures Sequence image. Each value shall correspond to the respective point in the Point Coordinates Data (0066,0016). The number of values must be equal to the number of points of the Point Cloud or the Surface Mesh.
>Referenced Texture Sequence	(0080,0012)	1	The image that is being mapped to the point cloud or the surface mesh. Only one Item shall be included in the Sequence.
>>Include Table 10-3b "Referenced Instances and Access Macro Attributes"			

C.27.6.1 UV Mapping Attribute Description

C.27.6.1.1 U Value Data and V Value Data

UV texturing allows a 3D object to be colored with the color from a 2D image. The 2D image therefore is called texture map. During the UV mapping process pixels from the 2D image are assigned to each point in the point cloud or the surface mesh of the object. The 2D image shall fully cover the space of the scanned object. If more than one texture with different resolutions or different exposures is required separate SOP Instances shall be created.

The term U and V is used because X, Y and Z are already assigned to the coordinates of the points of the scanned object.

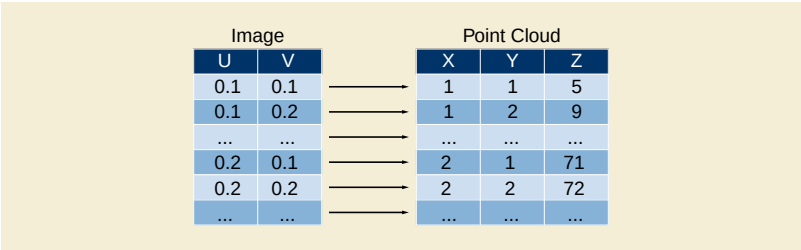


Figure C.27.6.1.1-1. Example of mapping textures to point coordinates.

C.28 Color Palette Modules

C.28.1 Color Palette Definition Module

Table C.28.1-1 specifies the Attributes that describe and identify a Color Palette.

Table C.28.1-1. Color Palette Definition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10-12 “Content Identification Macro Attributes”			See Section C.28.1.1.1.

C.28.1.1 Attribute Descriptions

C.28.1.1.1 Content Identification

Content Label (0070,0080) is intended to be a short human-readable label for a palette, suitable for rendering in a pick-list for the user to choose from. For standard palettes with well-known SOP Instance UIDs, values for this Attribute are pre-defined by the Standard.

Descriptions of the palette may also be encoded. A means for providing alternate representations of descriptions for use in specific languages is also provided.

C.29 Implant Modules

C.29.1 Generic Implant Template Modules

This section describes the specific Modules for the Generic Implant Template IOD.

C.29.1.1 Generic Implant Template Description Module

Table C.29.1.1-1 defines the general Attributes of the Generic Implant Template Description Module.

Table C.29.1.1-1. Generic Implant Template Description Module Attributes

Attribute Name	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	1	Name of the manufacturer that produces the implant.
Frame of Reference UID	(0020,0052)	1	Defines a 3D Frame of Reference for this component.
Implant Name	(0022,1095)	1	The (product) name of the implant.
Implant Size	(0068,6210)	1C	The size descriptor of the component. Required if the component exists in different sizes and the size number is not part of the name or identifier. May be present otherwise. See Section C.29.1.1.1.1 for details.
Implant Part Number	(0022,1097)	1	The (product) identifier of the implant.
Implant Template Version	(0068,6221)	1	The version code of the implant template. If Implant Type (0068,6223) is DERIVED, this shall have the same value as the Implant Template Version (0068,6221) of the manufacturer's implant template from which this Instance was derived.

Attribute Name	Tag	Type	Attribute Description
Replaced Implant Template Sequence	(0068,6222)	1C	Reference to the Implant Template that is replaced by this template. Only a single Item shall be included in this Sequence. Required if this Instance replaces another Instance.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Implant Type	(0068,6223)	1	Indicates whether the Implant Template is derived from another Implant Template. Enumerated Values: **ORIGINAL** **DERIVED**
Original Implant Template Sequence	(0068,6225)	1C	Reference to the Implant Template Instance with Implant Type (0068,6223) ORIGINAL from which this Instance was ultimately derived. Only a single Item shall be included in this Sequence. Required if Implant Type (0068,6223) is DERIVED.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Derivation Implant Template Sequence	(0068,6224)	1C	Reference to Implant Template Instance from which this Instance was directly derived. Only a single Item shall be included in this Sequence. Required if Implant Type (0068,6223) is DERIVED.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Effective DateTime	(0068,6226)	1	Date and time from which this Instance is or will be valid.
Implant Target Anatomy Sequence	(0068,6230)	3	Sequence that identifies the anatomical region the implant is to be implanted to. One or more Items are permitted in this Sequence.
>Anatomic Region Sequence	(0008,2218)	1	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7304 "Implant Target Anatomy".*
Notification From Manufacturer Sequence	(0068,6265)	1C	Information from the manufacturer concerning a critical notification, recall, or discontinuation of the implant or implant template. One or more Items shall be included in this Sequence. Required if such information has been issued.
>Information Issue DateTime	(0068,6270)	1	Date and Time the information was issued.
>Information Summary	(0068,6280)	1	Summary of the information.
>Encapsulated Document	(0042,0011)	3	The complete manufacturer notification describing the template. Encapsulated Document stream, containing a document encoded according to the MIME Type.

Attribute Name	Tag	Type	Attribute Description
>MIME Type of Encapsulated Document	(0042,0012)	1C	The type of the encapsulated document stream described using the MIME Media Type (see RFC 2046). Required if Encapsulated Document (0042,0011) is present in this Sequence Item. Enumerated Values: **application/pdf**
Information From Manufacturer Sequence	(0068,6260)	3	Information from Manufacturer other than described in Notification From Manufacturer Sequence (0068,6265). One or more Items shall be included in this Sequence.
>Information Issue DateTime	(0068,6270)	1	Date and Time the information was issued.
>Information Summary	(0068,6280)	1	Summary of the information.
>Encapsulated Document	(0042,0011)	3	Encapsulated Document stream, containing a document encoded according to the MIME Type. The complete manufacturer information.
>MIME Type of Encapsulated Document	(0042,0012)	1C	The type of the encapsulated document stream described using the MIME Media Type (see RFC 2046). Required if Encapsulated Document (0042,0011) is present in this Sequence Item. Enumerated Values: **application/pdf**
Implant Regulatory Disapproval Code Sequence	(0068,62A0)	1C	Sequence containing countries and regions in which the implant is not approved for usage. One or more Items shall be included in this Sequence. Required if the implant has been disapproved in a country or a region.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 5001 “Countries”.*
Overall Template Spatial Tolerance	(0068,62A5)	2	Tolerance in mm applying to all distance measurements and spatial locations in this Implant Template.
Materials Code Sequence	(0068,63A0)	1	A Code Sequence specifying the materials the implant was built from. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7300 “Implant Materials”.*
Coating Materials Code Sequence	(0068,63A4)	1C	A Code Sequence specifying the materials the implant is coated with. One or more Items shall be included in this Sequence. Required if the implant is coated.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7300 “Implant Materials”.*
Implant Type Code Sequence	(0068,63A8)	1	Sequence containing a coded description of the type of implant the template reflects. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7307 "Implant Component Types".*
Fixation Method Code Sequence	(0068,63AC)	1	The method that will be used to fixate the implant in the body. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7310 "Implant Fixation Method".*

C.29.1.1.1 Generic Implant Template Description Attribute Descriptions

C.29.1.1.1.1 Implant Size

Implant Size (0068,6210) is the descriptor defined by the manufacturer to distinguish between different sizes of one kind of implant, e.g., size S/M/L/XL.

C.29.1.1.1.2 Frame of Reference

The Frame of Reference UID (0020,0052) Attribute is used as an identifier for spatial registration in 3D. The Frame Of Reference UID uniquely identifies the spatial Frame of Reference of all 3D models contained in an Implant Template UID Instance.

If the Frame Of Reference UIDs in two Instances are identical, the contained 3D Models are defined in the same 3D space, i.e., require no additional registration.

C.29.1.2 Generic Implant Template 2D Drawings Module

Table C.29.1.2-1 defines the general Attributes of the Generic Implant Template 2D Drawings Module. This Module contains all Attributes required for the inclusion of technical 2D drawings in an IOD, e.g., the Implant Template IOD. The Module specification contains the definition of a subset of the HPGL plotter language that is used for the graphical definition of the drawings.

Table C.29.1.2-1. Generic Implant Template 2D Drawings Module Attributes

Attribute Name	Tag	Type	Attribute Description
HPGL Document Sequence	(0068,62C0)	1	The 2D template representations of this implant. One or more Items shall be included in this Sequence.
>HPGL Document ID	(0068,62D0)	1	Identification number of the HPGL Document. Uniquely identifies an HPGL Document within this SOP Instance. The value shall start at 1, and increase monotonically by 1.
>HPGL Document Label	(0068,62D5)	3	Label describing the document.
>View Orientation Code Sequence	(0068,62E0)	1	Coded description of the direction of view represented by this 2D template. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7302 "Implant Templates View Orientations".*
>View Orientation Modifier Code Sequence	(0068,62F0)	3	View Orientation Modifier.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7303 "Implant Templates Modified View Orientations".*
>HPGL Document Scaling	(0068,62F2)	1	Conversion factor (real world mm/printed mm) See Section C.29.1.2.1.1.
>HPGL Document	(0068,6300)	1	The HPGL document as a byte stream. See Section C.29.1.2.1.2.
>HPGL Contour Pen Number	(0068,6310)	1	Numeric ID of the pen used in the encapsulated HPGL document for outlines.

Attribute Name	Tag	Type	Attribute Description
>HPGL Pen Sequence	(0068,6320)	1	Labels for each pen used in the encapsulated HPGL Document. One or more Items shall be included in this Sequence. Shall contain one Item per pen used in the HPGL document.
>>HPGL Pen Number	(0068,6330)	1	Numeric ID of the pen in the HPGL document
>>HPGL Pen Label	(0068,6340)	1	Label of the pen.
>>HPGL Pen Description	(0068,6345)	3	Description of the kind of information drawn with the pen.
>Recommended Rotation Point	(0068,6346)	1	Point around which the 2D template is rotated in manual planning, in HPGL coordinates.
>Bounding Rectangle	(0068,6347)	1	HPGL coordinates of the smallest rectangle parallel to the paper axes that contains the whole drawing.

C.29.1.2.1 Generic Implant Template 2D Drawings Attribute Descriptions

C.29.1.2.1.1 HPGL Document Scaling and Coordinate System

HPGL Documents use integer coordinates based on a 25µm grid in the printing space - i.e., the paper to print on - rather than the object space. HPGL Document Scaling (0068,62F2) is used to scale the printed dimensions measured in millimeters to match the real dimensions of the implant measured in millimeters.

Note

1. For example, if HPGL Document Scaling is 2.5, then a line in HPGL that goes from (0,0) to (0,500) that is 12.5 mm long when printed represents 31.25 mm in the real world.
2. In HPGL, the origin of the printing space is placed in the lower left corner with the x-axis pointing to the right. No negative coordinates are allowed.

This Attribute does not compensate for any radiographic geometric magnification effect caused by the diverging X-Ray beam in the projection patient images used for planning. Such compensation is the responsibility of the application based on calibration of the imaging process.

C.29.1.2.1.2 HPGL Document

The HPGL files encapsulated in the Attribute HPGL Document (0068,6300) is restricted to a subset of HPGL commands called DICOM-HPGL specified in this section.

C.29.1.2.1.2.1 Scope

The aim of DICOM-HPGL is to facilitate the storage of 2D template graphics in DICOM implant objects. DICOM-HPGL is a subset of HPGL-2 that is kept as minimal as possible to comply with the needs of 2D implant templates.

C.29.1.2.1.2.2 Syntax

DICOM-HPGL documents consist of valid HPGL commands terminated by a semicolon. Commands consist of a two-letter mnemonic and zero or more numeric parameters separated by commas. To separate between commands, line breaks (x0D, x0A or x0Dx0A) or whitespaces (x20) may be used but are not mandatory.

Only the following commands shall be used in a DICOM-HPGL document

Table C.29.1.2-2. Permitted HPGL Commands

Command	Parameter	Meaning
IN	-	Initialize.

Command	Parameter	Meaning
PA	[X,Y]	Plot Absolute. The optional parameter assigns an initial position for the pen.
PC	Pen Number, Red, Green, Blue	Set Color of Pen with the given Pen Number. Colors are in RGB, intensities are encoded 0…255. The colors for pen number 0 shall be white and the color for pen number 1 shall be black. It is recommended to use only the pen numbers up to 255 to ensure compatibility with older HPGL viewers.
SP	Pen Number	Select Pen It is recommended to use only the pen numbers up to 255 to ensure compatibility with older HPGL viewers. Only pen numbers shall be used to which a color has been specified in a precedent PC command.
PU	[X,Y,…[,X,Y]]	Pen Up. The optional sequence of paired parameters describe subsequent pen motions after lifting the pen.
PD	[X,Y,…[,X,Y]]	Pen Down. The optional sequence of paired parameters describe subsequent pen motions after lowering the pen.

According to the parameter definition in HPGL, [] indicate optional parameters. The expression [X,Y,…[,X,Y]] indicates a sequence of arbitrary length of paired parameters X and Y. The commands and their parameters shall be interpreted as specified in the HP PCL/PJL Reference.

Note

This document can be obtained from URL: http://h20000.www2.hp.com/bc/docs/support/SupportManual/bpl13211/bpl13211.pdf

The coordinates in a DICOM-HPGL document are absolute values with respect to the lower left corner of the drawing space. The units of length within HPGL are 25 µm with respect to pen movements in the drawing space.

The DICOM-HPGL Document shall be structured as shown in Figure C.29.1.2-1.

Figure C.29.1.2-2 shows an example for a DICOM-HPGL Document in plain text (as byte stream), and plotted.

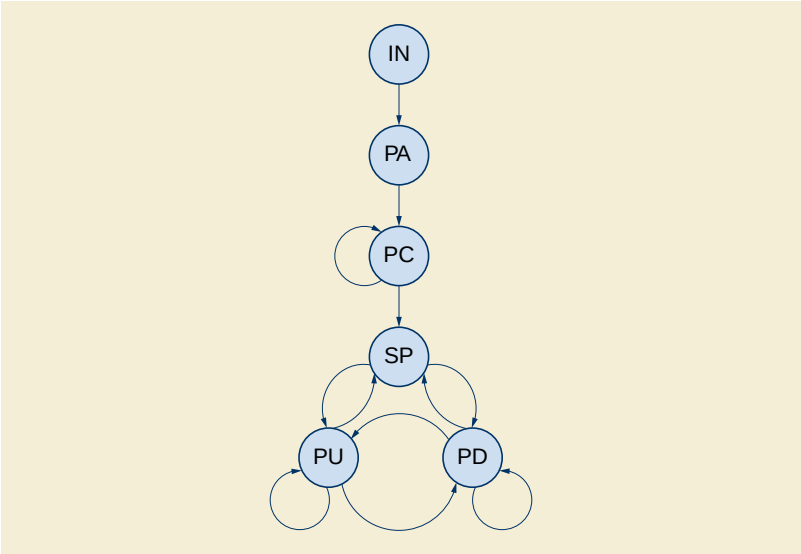


Figure C.29.1.2-1. DICOM-HPGL Document

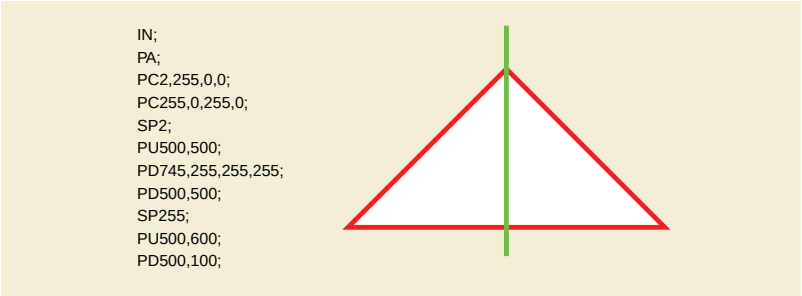


Figure C.29.1.2-2. DICOM-HPGL Document - Example

C.29.1.3 Generic Implant Template 3D Models Module

Table C.29.1.3-1 defines the general Attributes of the Generic Implant Template 3D Models Module. This Module contains Attributes that add context and scaling information to surfaces specified in the Surface Mesh Module, for 3D Models in an Implant Template Instance.

Table C.29.1.3-1. Generic Implant Template 3D Models Module Attributes

Attribute Name	Tag	Type	Attribute Description
Implant Template 3D Model Surface Number	(0068,6350)	1	Surface Number (0066,0003) of the surface that represents the shape of the entire implant.
Surface Model Description Sequence	(0068,6360)	1	The description of the Surface Model. One or more Items shall be included in this Sequence. Shall contain one Item per Item in Surface Sequence (0066,0002).
>Referenced Surface Number	(0066,002C)	1	Reference to a Surface Number (0066,0003) present in Surface Sequence (0066,0002).
>Surface Model Label	(0068,6380)	1	Label for this surface.
Surface Model Scaling Factor	(0068,6390)	1	Scaling factor (mm/Surface unit) See Section C.29.1.3.1.1.

C.29.1.3.1 Generic Implant Template 3D Models Attribute Descriptions

C.29.1.3.1.1 Surface Model Scaling Factor

Surface Model Scaling Factor (0068,6390) is used to scale dimensions of the surface mesh representation to match the real dimensions of the implant measured in millimeters.

This Attribute does not compensate for any radiographic geometric magnification effect caused by the diverging X-Ray beam in the projection patient images used for planning. Such compensation is the responsibility of the application based on calibration of the imaging process.

C.29.1.4 Generic Implant Template Mating Features Module

Table C.29.1.4-1 defines the general Attributes of the Generic Implant Template Mating Features Module. This Module adds coordinate systems that can be utilized to geometrically constrain mating of Implant Templates when planning the implantation of a modular implant.

Note

An Implant Template may contain 2D drawings of the described implant, 3D surface models of the described implant, or both. In this Module mating features that constrain the geometric matching of implants in multi-component assemblies are

specified. These geometric features (points and axes) can be specified in the 2D drawings as well as the 3D models. Mating features are grouped into mating feature sets (see PS3.17). Based on the existence of 2D drawings and/or 3D models in the Instance, either or both is possible. In this Module, there are a number of conditions on Attribute use to support the following cases:

- Specification of 2D mating features is only possible if at least one 2D drawing is present in the Instance.
- Specification of 3D mating features is only possible if at least one 3D model is present in the Instance.

Table C.29.1.4-1. Generic Implant Template Mating Features Module Attributes

Attribute Name	Tag	Type	Attribute Description
Mating Feature Sets Sequence	(0068,63B0)	3	Mating feature sets used to combine the implant with other implants. One or more Items shall be included in this Sequence.
>Mating Feature Set ID	(0068,63C0)	1	Identification number of the set. Uniquely identifies a mating feature set within this SOP Instance. The value shall start at 1, and increase monotonically by 1 for each Item.
>Mating Feature Set Label	(0068,63D0)	1	Label of the set.
>Mating Feature Sequence	(0068,63E0)	1	The mating features of the set. One or more Items shall be included in this Sequence.
>>Mating Feature ID	(0068,63F0)	1	Numeric ID of the mating feature. Uniquely identifies a mating feature within this Sequence Item.
>>3D Mating Point	(0068,64C0)	1C	Origin of the contact system. Required if 2D Mating Feature Coordinates Sequence (0068,6430) is not present and Implant Template 3D Model Surface Number (0068,6350) is present. May be present if 2D Mating Feature Coordinates Sequence (0068,6430) is present and Implant Template 3D Model Surface Number (0068,6350) is present. See Section C.29.1.4.1.1
>>3D Mating Axes	(0068,64D0)	1C	The Axes of contact described as direction cosines in the 3D coordinate system defined by the Frame Of Reference UID. Required if 3D Mating Point (0068,64C0) is present. See Section C.29.1.4.1.1
>>2D Mating Feature Coordinates Sequence	(0068,6430)	1C	Coordinates of the mating feature in the HPGL documents. One or more Items shall be included in this Sequence. Required if 3D Mating Point (0068,64C0) is not present and HPGL Document Sequence (0068,62C0) is present. May be present if 3D Mating Point (0068,64C0) is present and HPGL Document Sequence (0068,62C0) is present.
>>>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) that contains the 2D Drawing including the Mating Feature. Shall be unique within the Sequence.

Attribute Name	Tag	Type	Attribute Description
>>>2D Mating Point	(0068,6450)	1	Origin of the contact system, in HPGL coordinates. See Section C.29.1.4.1.1
>>>2D Mating Axes	(0068,6460)	1	Direction cosines of the contact system. See Section C.29.1.4.1.1
>>Mating Feature Degree of Freedom Sequence	(0068,6400)	3	Degrees of freedom in this mating feature. One or more Items are permitted in this Sequence. See Section C.29.1.4.1.2.
>>>Degree of Freedom ID	(0068,6410)	1	Numeric ID of the degree of freedom. Uniquely identifies a degree of freedom within this Sequence Item. The value shall start at 1, and increase monotonically by 1 for each Item.
>>>Degree of Freedom Type	(0068,6420)	1	Indicates the type of the degree of freedom. Enumerated Values: **TRANSLATION** **ROTATION** See Section C.29.1.4.1.2.
>>>2D Degree of Freedom Sequence	(0068,6470)	1C	Geometric specifications of the degrees of freedom for this HPGL Document. One or more Items shall be included in this Sequence. Required if 2D Mating Feature Coordinates Sequence (0068,6430) is present. See Section C.29.1.4.1.2.
>>>>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) that contains the 2D Drawing including the Mating Feature. See Section C.29.1.4.1.2. Shall be unique within the Sequence.
>>>>2D Degree Of Freedom Axis	(0068,64F0)	1	Direction cosines of the axis of the degree of freedom. See Section C.29.1.4.1.2.
>>>>Range of Freedom	(0068,64A0)	1	Interval of freedom for this degree of freedom. See Section C.29.1.4.1.2.
>>>3D Degree Of Freedom Axis	(0068,6490)	1C	Direction cosines of the axis of the degree of freedom in the Frame of Reference of the template. See Section C.29.1.4.1.2. Required if 3D Mating Point (0068,64C0) is present.
>>>Range of Freedom	(0068,64A0)	1C	Two floating point numbers defining a value range for this degree of freedom. See Section C.29.1.4.1.2. Required if 3D Mating Point (0068,64C0) is present.

C.29.1.4.1 Generic Implant Template 2D Drawings Attribute Descriptions

C.29.1.4.1.1 Mating Features

These Attributes establish a Cartesian coordinate system relative to the Frame of Reference of the implant. When two implants are assembled using a pair of mating features, a rigid spatial registration can be established, that transforms one Frame of Reference so that the mating features align.

C.29.1.4.1.2 Degrees of Freedom

Mating Feature Degree of Freedom Sequence (0068,6400) is used to specify that a mating feature allows mating with another implant not only in one defined pose, but within a certain range of freedom. One Sequence Item specifies one degree of freedom that may be a rotation around or a translation along an arbitrary axis. The Degree of Freedom Type (0068,6420) specifies whether the degree of freedom describes a rotation or a translation.

The 3D coordinates of the axis of translation or rotation is specified by 3D Degree Of Freedom Axis (0068,6490) with respect to the Implant Template's Frame of Reference as three-dimensional vector in x-y-z order. Range Of Freedom (0068,64A0) specifies an interval, in millimeters or degrees, by which this 3D coordinate system mating feature may be moved along or around the axis.

For each HPGL Document, the 2D Degree Of Freedom Axis (0068,64F0) may be specified as a 3D vector encoded in x-y-z order, where the z-coordinate is equal to the direction of projection, i.e., equal to the cross product of the x- and y-axis of the printing space. Range Of Freedom (0068,64A0) specifies an interval, in millimeters or degrees, by which the 3D coordinate system of this mating feature may be moved along or around the axis.

C.29.1.5 Generic Implant Template Planning Landmarks Module

Table C.29.1.5-1 defines the general Attributes of the Generic Implant Template Planning Landmarks Module. This Module adds planning landmarks, i.e., geometric annotations that constrain implant template registration to anatomical features, to the Implant Template IOD.

Note

An Implant Template may contain 2D drawings from several viewpoints, 3D surface models, or both. The planning landmarks that are specified with this Module may occur in all of these, but may also only occur in some of these (due to their invisibility or irrelevance in some drawings or the 3D representation). Each 2D drawing specifies its own 2D drawing space, which requires a separate geometric description for each drawing. The 3D models share one Frame of Reference. Thus, each landmark needs only one 3D representation that then applies to all 3D models contained in one Instance. The Attribute Descriptions of the Attributes that geometrically define landmarks (in Table C.29.1.5-2 and Table C.29.1.5-3 and Table C.29.1.5-4) contain complicated Conditions that express the following constraints:

- If 2D drawings are present in an Implant Template Instance, there may be 2D specifications of landmarks present in this Implant Template Instance.
- 2D specifications of landmarks will refer to HPGL Document Numbers (0068,62D0) that are present in an Implant Template Instance.
- Landmarks are not required to be geometrically defined in all existing HPGL documents.
- If 3D models are present in a Implant Template Instance, there may be 3D specifications of landmarks present in this Implant Template Instance
- 2D and 3D specifications may be present for one landmark in an Instance if both, 2D drawings and 3D models are contained in the Instance.

Table C.29.1.5-1. Generic Implant Template Planning Landmarks Module Attributes

Attribute Name	Tag	Type	Attribute Description
Planning Landmark Point Sequence	(0068,6500)	3	Point landmarks for planning. One or more Items are permitted in this Sequence.
>Include Table C.29.1.5-2 “Planning Landmark Point Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Planning Landmark ID	(0068,6530)	1	Numeric ID of the planning landmark. Uniquely identifies a planning landmark within the SOP Instance. The value shall start at 1, and increase monotonically by 1 for each Item.
>Planning Landmark Description	(0068,6540)	3	Purpose or intended use of the landmark.
>Planning Landmark Identification Code Sequence	(0068,6545)	2	Coded Description of the real-world point that is represented by the landmark. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7305 "Implant Planning Landmarks"*
Planning Landmark Line Sequence	(0068,6510)	3	Line landmarks for planning. One or more Items are permitted in this Sequence.
>Include Table C.29.1.5-3 "Planning Landmark Line Macro Attributes"			
>Planning Landmark ID	(0068,6530)	1	Numeric ID of the planning landmark. Uniquely identifies the planning landmark within the SOP Instance. The value shall start at 1, and increase monotonically by 1 for each Item.
>Planning Landmark Description	(0068,6540)	3	Purpose or intended use of this landmark.
>Planning Landmark Identification Code Sequence	(0068,6545)	2	Coded Description of the real-world line that is represented by this landmark. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7305 "Implant Planning Landmarks"*
Planning Landmark Plane Sequence	(0068,6520)	3	Plane landmarks for planning. One or more Items are permitted in this Sequence.
>Include Table C.29.1.5-4 "Planning Landmark Plane Macro Attributes"			
>Planning Landmark ID	(0068,6530)	1	Numeric ID of the planning landmark. Uniquely identifies the planning landmark within the SOP Instance. The value shall start at 1, and increase monotonically by 1 for each Item.
>Planning Landmark Description	(0068,6540)	3	Purpose or intended use of the landmark.
>Planning Landmark Identification Code Sequence	(0068,6545)	2	Coded Description of the real-world plane that is represented by this landmark. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7305 "Implant Planning Landmarks"*

C.29.1.5.1 Planning Landmark Macros

Table C.29.1.5-2, Table C.29.1.5-3 and Table C.29.1.5-4 contain Macros for the definition of landmarks that can be used during planning to align an implant template with patient geometry.

All Attributes within these Macros that contain 3D points or vectors are in x, y, z order. If multiple elements are encoded, the ordering is x_1y_1z, …, $x_ny_nz_n$, The points are in the coordinate system identified by the Frame of Reference UID 0020,0052.

Table C.29.1.5-2. Planning Landmark Point Macro Attributes

Attribute Name	Tag	Type	Attribute Description
2D Point Coordinates Sequence	(0068,6550)	1C	2D coordinates of the point in the HPGL documents. One or more Items shall be included in this Sequence. Required if 3D Point Coordinates (0068,6590) is not present and HPGL Document Sequence (0068,62C0) is present. May be present if 3D Point Coordinates (0068,6590) is present and HPGL Document Sequence (0068,62C0) is present.
>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) that contains the 2D Drawing including the planning landmark. Shall be unique within the Sequence.
>2D Point Coordinates	(0068,6560)	1	Coordinates of the point in the HPGL document. Coordinates are measured in millimeters of the printing space. See Section C.29.1.2.1.1.
3D Point Coordinates	(0068,6590)	1C	3D Coordinates of the point. Required if 2D Point Coordinates Sequence (0068,6550) is not present and Implant Template 3D Model Surface Number (0068,6350) is present. May be present if 2D Point Coordinates Sequence (0068,6550) is present and Implant Template 3D Model Surface Number (0068,6350) is present.

Table C.29.1.5-3. Planning Landmark Line Macro Attributes

Attribute Name	Tag	Type	Attribute Description
2D Line Coordinates Sequence	(0068,65A0)	1C	2D coordinates of the line in the HPGL documents. One or more Items shall be included in this Sequence. Required if 3D Line Coordinates (0068,65D0) is not present and HPGL Document Sequence (0068,62C0) is present. May be present if 3D Line Coordinates (0068,65D0) is present and HPGL Document Sequence (0068,62C0) is present.
>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) that contains the 2D Drawing including the planning landmark. Shall be unique within the Sequence.
>2D Line Coordinates	(0068,65B0)	1	Coordinates of the line in the HPGL document. Coordinates are measured in millimeters of the printing space. See Section C.29.1.2.1.1.
3D Line Coordinates	(0068,65D0)	1C	3D Coordinates of the line. Required if 2D Line Coordinates Sequence (0068,65A0) is not present and Implant Template 3D Model Surface Number (0068,6350) is present. May be present, if 2D Line Coordinates Sequence (0068,65A0) is present and Implant Template 3D Model Surface Number (0068,6350) is present.

Table C.29.1.5-4. Planning Landmark Plane Macro Attributes

Attribute Name	Tag	Type	Attribute Description
2D Plane Coordinates Sequence	(0068,65E0)	1C	2D coordinates of the plane's intersection with the HPGL documents. One or more Items shall be included in this Sequence. Required if 3D Plane Origin (0068,6610) is not present and HPGL Document Sequence (0068,62C0) is present. May be present if 3D Plane Origin (0068,6610) is present and HPGL Document Sequence (0068,62C0) is present.
>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) that contains the 2D Drawing including the planning landmark. Shall be unique within the Sequence.
>2D Plane Intersection	(0068,65F0)	1	2D Coordinates of the intersection of the plane with the projection plane. Coordinates are measured in Millimeters of the printing space. See Section C.29.1.2.1.1.
3D Plane Origin	(0068,6610)	1C	3D Coordinates of the plane origin. Required if 2D Plane Coordinates Sequence (0068,65E0) is not present and Implant Template 3D Model Surface Number (0068,6350) is present. May be present if 2D Plane Coordinates Sequence (0068,65E0) is present and Implant Template 3D Model Surface Number (0068,6350) is present.
3D Plane Normal	(0068,6620)	1C	3D Coordinates of the plane normal. Required if 3D Plane Origin (0068,6610) is present.

C.29.1.5.1.1 Planning Landmark Macros Attribute Descriptions

C.29.1.5.1.1.1 2D Coordinates Sequences

The 2D Point Coordinates Sequence (0068,6550) and 2D Line Coordinates Sequence (0068,65A0) contain the positions of point, line or plane landmarks in 2D templates. Each Sequence Item consists of a reference to one of the 2D templates and the point co-ordinates of the landmark with respect to that template. The Coordinates are with respect to the origin of the HPGL Document and are specified in Millimeters of the printing space.

C.29.2 Implant Assembly Template

This section describes the specific Modules for the Implant Assembly Template IOD. This IOD references Instances of the Implant Template IOD.

C.29.2.1 Implant Assembly Template Module

Table C.29.2-1 defines the general Attributes of the Implant Assembly Template Module.

Table C.29.2-1. Implant Assembly Template Module Attributes

Attribute Name	Tag	Type	Attribute Description
Effective DateTime	(0068,6226)	1	Date and time from which on this Instance is valid.
Implant Assembly Template Name	(0076,0001)	2	A name given to the assembly described in this Instance.
Implant Assembly Template Issuer	(0076,0003)	1	The person or organization who issued the assembly template.

Attribute Name	Tag	Type	Attribute Description
Implant Assembly Template Version	(0076,0006)	2	The version code of the Implant Assembly Template.
Replaced Implant Assembly Template Sequence	(0076,0008)	1C	Reference to the Implant Assembly Template that is replaced by this Instance. Only a single Item shall be included in this Sequence. Required if the Instance replaces another Instance.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Implant Assembly Template Type	(0076,000A)	1	Indicates whether the Implant Assembly Template is derived from another Instance. Enumerated Values: **ORIGINAL** **DERIVED**
Original Implant Assembly Template Sequence	(0076,000C)	1C	Reference to the Implant Assembly Template Instance with Implant Assembly Template Type (0076,000A) ORIGINAL from which this Instance was ultimately derived. Only a single Item shall be included in this Sequence. Required if Implant Assembly Template Type (0076,000A) is DERIVED.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Derivation Implant Assembly Template Sequence	(0076,000E)	1C	Reference to the Implant Template Instance from which this Instance was directly derived. Only a single Item shall be included in this Sequence. Required if Implant Assembly Template Type (0076,000A) is DERIVED.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
Implant Assembly Template Target Anatomy Sequence	(0076,0010)	1	Identifies the anatomical region the implant assembly is to be implanted to. One or more Items shall be included in this Sequence.
>Anatomic Region Sequence	(0008,2218)	1	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7304 "Implant Target Anatomy".*
Procedure Type Code Sequence	(0076,0020)	1	Coded description of the procedure by which the assembly is implanted. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7301 "Intervention Types".*
Surgical Technique	(0076,0030)	3	The surgical technique associated with this assembly template.
MIME Type of Encapsulated Document	(0042,0012)	2	The type of the encapsulated document stream described using the MIME Media Type (see RFC 2046). Enumerated Values: **application/pdf**

Attribute Name	Tag	Type	Attribute Description
Encapsulated Document	(0042,0011)	2	Encapsulated Document stream, containing a document encoded according to the MIME Type. PDF description of the surgical technique.
Component Types Sequence	(0076,0032)	1	Sets of components of which the assembly is constructed. One or more Items shall be included in this Sequence.
>Component Type Code Sequence	(0076,0034)	1	Label assigned to that type of component. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7307 “Implant Component Types”.*
>Exclusive Component Type	(0076,0036)	1	Indicates that only one component of this Component Type shall be used in an assembly. Defined Terms: **YES** **NO**
>Mandatory Component Type	(0076,0038)	1	Indicates that at least one component of this Component Type has to be used in an assembly. Defined Terms: **YES** **NO**
>Component Sequence	(0076,0040)	1	References to implant template components used in the assembly. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>>Component ID	(0076,0055)	1	Numeric ID of the Implant Template. Uniquely identifies the Implant Template within the SOP Instance. The value shall start at 1, and increase monotonically by 1 for each Item.
Component Assembly Sequence	(0076,0060)	3	Information about how to connect the implants from the component groups. One or more Items are permitted in this Sequence. See Section C.29.2.1.1.1 for details.
>Component 1 Referenced ID	(0076,0070)	1	Value of Component ID (0076,0055) present in Component Sequence (0076,0040) that contains the assembly implant components. The ID selects the first component of the connection.
>Component 1 Referenced Mating Feature Set ID	(0076,0080)	1	Value of the Mating Feature Set ID (0068,63C0) present in the Mating Feature Set Sequence (0068,63B0) that contains the Mating Feature Sets. The ID selects the Mating Feature Set of the first component of the connection.

Attribute Name	Tag	Type	Attribute Description
>Component 1 Referenced Mating Feature ID	(0076,0090)	1	Value of the Mating Feature ID (0068,63F0) present in the Mating Feature Sequence (0068,63E0) that contains the Mating Features. The ID selects the Mating Feature of the Mating Feature Set of the first component of the connection.
>Component 2 Referenced ID	(0076,00A0)	1	Value of Component ID (0076,0055) present in Component Sequence (0076,0040) that contains the assembly implant components. The ID selects the second component of the connection.
>Component 2 Referenced Mating Feature Set ID	(0076,00B0)	1	Value of the Mating Feature Set ID (0068,63C0) present in the Mating Feature Set Sequence (0068,63B0) that contains the Mating Feature Sets. The ID selects the Mating Feature Set of the second component of the connection.
>Component 2 Referenced Mating Feature ID	(0076,00C0)	1	Value of the Mating Feature ID (0068,63F0) present in the Mating Feature Sequence (0068,63E0) that contains the Mating Features. The ID selects the Mating Feature of the Mating Feature Set of the second component of the connection.

C.29.2.1.1 Implant Assembly Template Module Attribute Description

C.29.2.1.1.1 Component Assembly Sequence

This Sequence defines a table that establishes relations between Mating Features in Implant Templates. This table contains possible connections for the surgical technique described in an Instance.

C.29.3 Implant Template Group Module

This section describes the specific Modules for the Implant Template Group IOD.

C.29.3.1 Implant Template Group Module

Table C.29.3-1 contains the Attributes of the Implant Template Group Module.

Table C.29.3-1. Implant Template Group Module Attributes

Attribute Name	Tag	Type	Attribute Description
Effective DateTime	(0068,6226)	1	Date and time from which on this Instance is valid.
Implant Template Group Name	(0078,0001)	1	Name of this group
Implant Template Group Description	(0078,0010)	3	Purpose or intent of this group.
Implant Template Group Issuer	(0078,0020)	1	Person or Organization that issued this group.
Implant Template Group Version	(0078,0024)	2	The version code of the Implant Template Group.
Replaced Implant Template Group Sequence	(0078,0026)	1C	Reference to the Implant Template Group that is replaced by this Instance. Only a single Item shall be included in this Sequence. Required if this Instance replaces another Instance.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Implant Template Group Target Anatomy Sequence	(0078,0028)	3	Identifies the anatomical region the implant is to be implanted to. One or more Items are permitted in this Sequence.
>Anatomic Region Sequence	(0008,2218)	1	Sequence that identifies the anatomic region of interest in this Instance (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7304 “Implant Target Anatomy”.*
Implant Template Group Members Sequence	(0078,002A)	1	Contains references to all Implant Template SOP Instances that are part of this group. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Implant Template Group Member ID	(0078,002E)	1	Numeric ID of the Implant Template. Uniquely identifies the Implant Template within the Implant Template Group. The value shall start at 1, and increase monotonically by 1 for each Item.
>3D Implant Template Group Member Matching Point	(0078,0050)	1C	3D inter-component Matching Point. May be present if Number of Surfaces (0066,0001) is present in the Instance referenced in the Implant Template Group Members Sequence (0078,002A) Item. See Section C.29.3.1.1.1
>3D Implant Template Group Member Matching Axes	(0078,0060)	1C	Direction cosines of the Matching Point. Required if 3D Implant Template Group Matching Point (0078,0050) is present.
> Implant Template Group Member Matching 2D Coordinates Sequence	(0078,0070)	1C	One or more Items shall be included in this Sequence. May be present if HPGL Document Sequence (0068,62C0) is present in the Instance referenced in the Implant Template Group Members Sequence (0078,002A) Item. See Section C.29.3.1.1.1
>>Referenced HPGL Document ID	(0068,6440)	1	Value of the HPGL Document ID (0068,62D0) present in the HPGL Document Sequence (0068,62C0) of the Instance that is referenced in the Implant Template Group Members Sequence (0078,002A) Item. Shall be unique within the Sequence.
>>2D Implant Template Group Member Matching Point	(0078,0090)	1	2D inter-component Matching Point. See Section C.29.3.1.1.1.
>>2D Implant Template Group Member Matching Axes	(0078,00A0)	1	Direction cosines of the Matching Point. See Section C.29.3.1.1.1.
Implant Template Group Variation Dimension Sequence	(0078,00B0)	1	List of all Variation Dimensions that are covered by this group. One or more Items shall be included in this Sequence. See Section C.29.3.1.1.2.

Attribute Name	Tag	Type	Attribute Description
>Implant Template Group Variation Dimension Name	(0078,00B2)	1	Descriptive name of the variation dimension.
>Implant Template Group Variation Dimension Rank Sequence	(0078,00B4)	1	Order in which the implant group members are sorted according to this dimension. One or more Items shall be included in this Sequence.
>> Referenced Implant Template Group Member ID	(0078,00B6)	1	Value of the Implant Template Group Member ID (0078,002E) present in the Implant Template Group Member Sequence (0078,002A) that contains the Implant Template Group Member Items. Shall be unique within the Sequence.
>>Implant Template Group Variation Dimension Rank	(0078,00B8)	1	The rank of this Implant Template in the Variation Dimension. In one Implant Template Group Variation Dimension Rank Sequence there may be more than one Implant Templates with the same rank.

C.29.3.1.1 Implant Template Group Module Attribute Description

C.29.3.1.1.1 Implant Template Group Member Matching Coordinates

Template Groups are used to facilitate browsing through a set of similar implants. The Template Group Member Matching Coordinates is a coordinate system in the Frame of Reference of every member of the group that is used to place and orient the members of the group in a similar way: When a user or a system positioned one member of the group within the Frame of Reference of the patient, then all other members of the family are placed and oriented so that their Template Group Member Matching Coordinates coincide.

The matching coordinates are applied similar to the mating features during implant template mating. An example is found in part 17, Figure C.29.3.1.1.1-1.

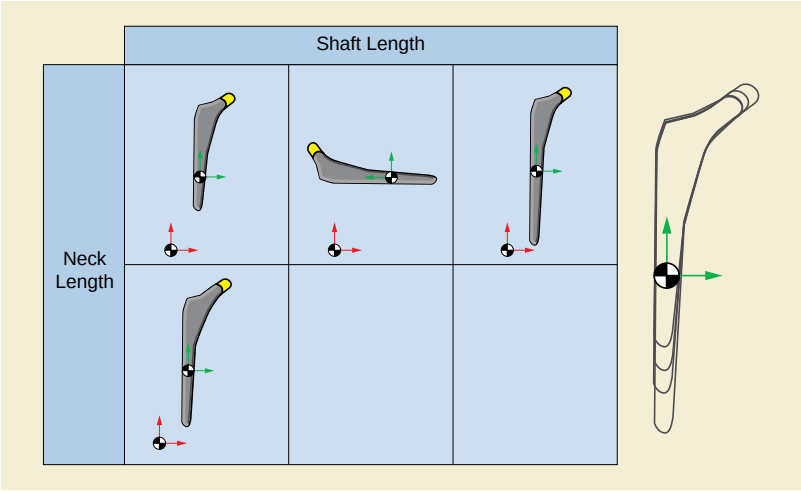


Figure C.29.3.1.1.1-1. Implant Template Groups Example.

C.29.3.1.1.2 Implant Template Groups

Implant templates in the group can be ordered according to several orthogonal dimensions, e.g., width and length. This is intended to facilitate scrolling through the implant template repository by offering references to the next bigger and smaller templates according to multiple criteria. Figure C.29.3.1.1.2-1 shows how the Variation Dimensions may be used for plates that differ in two dimensions: length and number of holes.

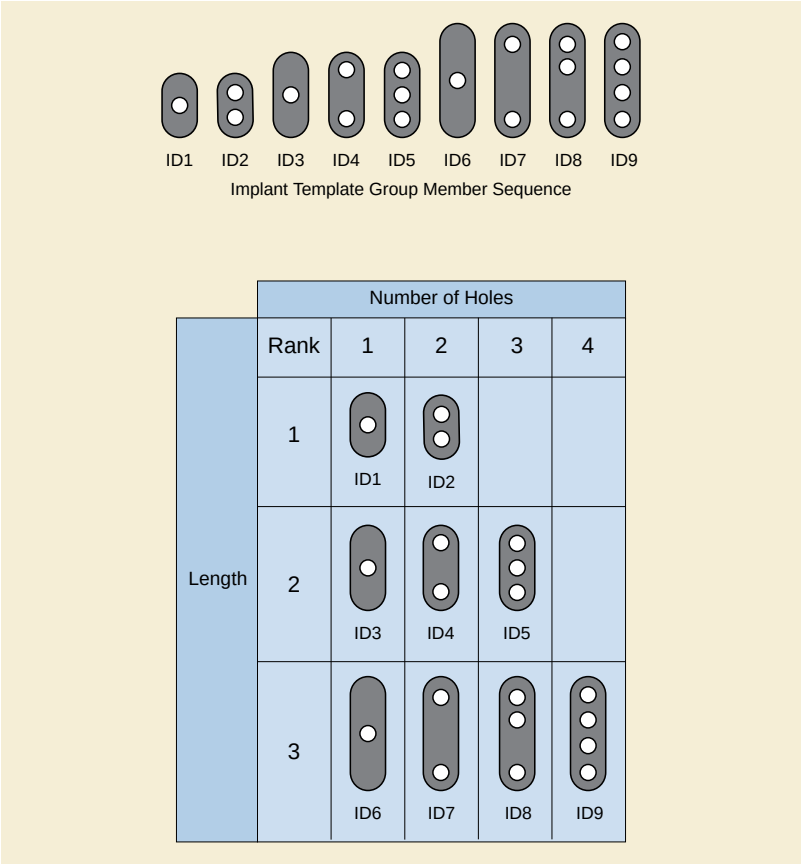


Figure C.29.3.1.1.2-1. Implant Template Group for 2 Dimensions Example

C.30 Unified Procedure Step Specific Modules

The following Sections specify Modules used for Unified Procedure Steps.

C.30.1 Unified Procedure Step Progress Information Module

Table C.30.1-1 specifies the Attributes that describe the progress of a Unified Procedure Step (UPS).

Table C.30.1-1. Unified Procedure Step Progress Information Module Attributes

Attribute Name	Tag	Attribute Description
Procedure Step State	(0074,1000)	State of the Procedure Step. Enumerated Values: **SCHEDULED** **IN PROGRESS** **CANCELED** **COMPLETED** See PS3.4 for details on Unified Procedure Step states.
Progress Information Sequence	(0074,1002)	Information about work progress for the Procedure Step. Zero or one Item shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>Procedure Step Progress	(0074,1004)	A numerical indicator of progress expressed as percentage complete. Note This is primarily for status rendering (e.g., progress bar). The percentage is not necessarily an accurate indication of total time.
>Procedure Step Progress Description	(0074,1006)	A textual description of progress. Note For example, it might contain "Annealing complete".
>Procedure Step Progress Parameters Sequence	(0074,1007)	Additional procedure-specific progress information provided by the performing device while the current Procedure Step is being executed. One or more Items are permitted in this Sequence.
>>Include Table 10-2 “Content Item Macro Attributes Description”		*No Baseline CIDs are defined for Concept Name Code Sequence or Concept Code Sequence.*
>>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Procedure Step Progress Parameter. One or more Items are permitted in this Sequence.
>>>Include Table 10-2 “Content Item Macro Attributes Description”		*No Baseline CIDs are defined for Concept Name Code Sequence or Concept Code Sequence.*
>Procedure Step Communications URI Sequence	(0074,1008)	Contact Information to communicate with performers of the Procedure Step. Zero or more Items shall be included in this Sequence.
>>Contact URI	(0074,100A)	URI to communicate with performer of the procedure in progress. Any URI (telephone number, URL, etc.) is permitted. Note The VR of this Data Element has changed from UT to UR.
>>Contact Display Name	(0074,100c)	Name of the person, department or organization to contact for more information about the performance of the Procedure Step.
>Procedure Step Cancellation DateTime	(0040,4052)	Date and Time at which the procedure step was discontinued.
>Reason For Cancellation	(0074,1238)	A textual description of the reason a procedure step was discontinued.
>Procedure Step Discontinuation Reason Code Sequence	(0074,100e)	Coded Reason(s) for Discontinuing the Procedure Step. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 9300 “Procedure Discontinuation Reasons”.*

C.30.2 Unified Procedure Step Scheduled Procedure Information Module

Table C.30.2-1 specifies the Attributes that describe the Unified Procedure Step (UPS) to be performed. The UPS may or may not be scheduled for a specific time or device, or may simply represent a piece of work that is intended to be performed.

Table C.30.2-1. Unified Procedure Step Scheduled Procedure Information Module Attributes

Attribute Name	Tag	Attribute Description
Scheduled Procedure Step Priority	(0074,1200)	Priority of the scheduled Procedure Step Enumerated Values: **HIGH** used to indicate an urgent or emergent work item, equivalent to a STAT request. **MEDIUM** used to indicate a work item that has a priority less than HIGH and higher than LOW. It can be used to further stratify work items. **LOW** used to indicate a routine or non-urgent work item.
Scheduled Procedure Step Modification Date and Time	(0040,4010)	Date and time when the Scheduled Procedure Information was last modified or first created (whichever is most recent). Note This Attribute should be automatically updated by the worklist management system whenever any modification is made to Unified Procedure Step Scheduled Procedure Information Module Attributes of a Unified Procedure Step.
Worklist Label	(0074,1202)	A label identifying the worklist to which the Procedure Step Instance belongs.
Procedure Step Label	(0074,1204)	A label describing the task of the Procedure Step in text appropriate for displaying in the user selection interface.
Comments on the Scheduled Procedure Step	(0040,0400)	User-defined comments on the scheduled Procedure Step.
Scheduled Station Name Code Sequence	(0040,4025)	Identifying names within the enterprise of the equipment for which the Procedure Step is scheduled. The names conveyed in Code Value (0008,0100) may be the same as the AE Titles, but do not have to be. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Scheduled Station Class Code Sequence	(0040,4026)	Classes of the equipment for which the Procedure Step is scheduled. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Scheduled Station Geographic Location Code Sequence	(0040,4027)	Geographic locations of the equipment for which the Procedure Step is scheduled. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
Scheduled Human Performers Sequence	(0040,4034)	Human performers that are scheduled to be involved or responsible for performing the Procedure Step. Zero or more Items shall be included in this Sequence.
>Human Performer Code Sequence	(0040,4009)	Human performer that is involved or responsible for performing the Procedure Step. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
>Human Performer's Name	(0040,4037)	Name of the human performer.

Attribute Name	Tag	Attribute Description
>Human Performer's Organization	(0040,4036)	Organization to which the human performer is accountable for the activities in the Procedure Step.
Scheduled Procedure Step Start DateTime	(0040,4005)	Date and time at which the Procedure Step is scheduled to start.
Expected Completion DateTime	(0040,4011)	Date and time at which the Procedure Step is expected to be completed.
Scheduled Procedure Step Expiration DateTime	(0040,4008)	Date and time after which the Procedure Step is meaningless or undesirable.
Scheduled Workitem Code Sequence	(0040,4018)	Coded description of the Procedure Step. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 9231 "Workitem Definition".* Note This CID has generic workitems. An implementation may choose to define more specific, detailed workitems.
Scheduled Processing Parameters Sequence	(0074,1210)	Processing parameters to be used by the performing system when carrying out the Procedure Step. Zero or more Items shall be included in this Sequence.
>Include Table 10-2 "Content Item Macro Attributes Description"		
>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Scheduled Processing Parameter Content Item. One or more Items are permitted in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes Description"		
Input Readiness State	(0040,4041)	Readiness state of the Input Information Sequence (0040,4021) and the referenced Instances. Enumerated Values: **INCOMPLETE** The Input Information Sequence is not yet complete and additional Instance references might be added. **UNAVAILABLE** The Input Information Sequence is complete but one or more of the referenced Instances might not yet be available from the referenced source(s). **READY** The Input Information Sequence is complete and the referenced Instances are available from the referenced sources. Note 1. If the Procedure Step does not require input information, the Input Readiness State may be READY when the Input Information Sequence is empty. 2. There is no guarantee that the referenced Instances will still be available at the referenced location when retrieval is attempted. 3. There is no requirement to confirm the presence of referenced media prior to setting the Input Readiness State to READY.

Attribute Name	Tag	Attribute Description
Input Information Sequence	(0040,4021)	References to Information Objects needed to perform the scheduled Procedure Step. Referencing unencapsulated HL7 documents is described further in Section C.12.1.1.6. See also Input Readiness State (0040,4041). Zero or more Items shall be included in this Sequence.
>Include Table 10-3b "Referenced Instances and Access Macro Attributes"		
Study Instance UID	(0020,000D)	Unique Study identification that shall be used for the created Composite SOP Instances resulting from this Unified Procedure Step.
Output Destination Sequence	(0040,4070)	The destination to which the performer is requested to store the output objects generated Zero or more Items shall be included in this Sequence. Each Item constitutes a separate storage request. The performing system might not support the requested storage protocol or not be configured for the desired destination. The performing system may, additionally or as a fallback, be configured to store output objects to a default destination or retain them locally. The actual location(s) to which Instances are successfully stored is recorded in the Output Information Sequence (0040,4033). Whether to report failure of one or more of the storage requests as a failure of the work item is at the discretion of the performing system.
>Include Table 10-3c "Storage Macro Attributes"		

C.30.3 Unified Procedure Step Performed Procedure Information Module

Table C.30.3-1 specifies the Attributes that describe the performance and results of a Unified Procedure Step (UPS).

Table C.30.3-1. Unified Procedure Step Performed Procedure Information Module Attributes

Attribute Name	Tag	Attribute Description
Unified Procedure Step Performed Procedure Sequence	(0074,1216)	Details of the Procedure Step as performed. Zero or one Item shall be included in this Sequence.
>Actual Human Performers Sequence	(0040,4035)	Human performers that are/were actually involved or responsible for performing the Procedure Step. Zero or more Items shall be included in this Sequence. Note Initially this list will be empty. Items may be added to the list at or after the status transition of the Procedure Step State (0074,1000) to "IN PROGRESS"
>>Human Performer Code Sequence	(0040,4009)	Human performer that is involved or responsible for performing the Procedure Step. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>>Human Performer's Name	(0040,4037)	Name of the human performer.

Attribute Name	Tag	Attribute Description
>>Human Performer's Organization	(0040,4036)	Organization to which the human performer is accountable for the activities in the Procedure Step.
>Performed Station Name Code Sequence	(0040,4028)	Names within the enterprise of the equipment that performed the Procedure Step. This name may be the same as the AE Title, but does not have to be. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Performed Station Class Code Sequence	(0040,4029)	Classes of the equipment that created the Procedure Step. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Performed Station Geographic Location Code Sequence	(0040,4030)	Geographic locations of the equipment that created Procedure Step. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Performed Procedure Step Start DateTime	(0040,4050)	Date and Time at which the Procedure Step started.
>Performed Procedure Step Description	(0040,0254)	Institution-generated description or classification of the Procedure Step that was performed.
>Comments on the Performed Procedure Step	(0040,0280)	User-defined comments on the Performed Procedure Step.
>Performed Workitem Code Sequence	(0040,4019)	A Sequence that conveys the type of procedure performed. Zero or more Items shall be present in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 9231 "Workitem Definition".* Note This CID has generic workitems. An implementation may choose to define more specific, detailed workitems.
>Performed Processing Parameters Sequence	(0074,1212)	Parameters used to perform the procedure. Zero or more Items shall be present in this Sequence
>>Include Table 10-2 "Content Item Macro Attributes Description"		No Baseline CIDs are defined for Concept Name Code Sequence or Concept Code Sequence.
>>Content Item Modifier Sequence	(0040,0441)	Sequence that specifies modifiers for a Performed Processing Parameter Content Item. One or more Items are permitted in this Sequence.
>>>Include Table 10-2 "Content Item Macro Attributes Description"		No Baseline CIDs are defined for Concept Name Code Sequence or Concept Code Sequence.
>Performed Procedure Step End DateTime	(0040,4051)	Date and Time at which the Procedure Step ended.
>Output Information Sequence	(0040,4033)	References to information created as part of the Procedure Step. Referencing unencapsulated HL7 documents is described further in Section C.12.1.1.6. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>>Include Table 10-3b "Referenced Instances and Access Macro Attributes"		

C.30.4 Unified Procedure Step Relationship Module

Table C.30.4-1 specifies the Attributes that describe the relationship of a Unified Procedure Step (UPS).

Table C.30.4-1. Unified Procedure Step Relationship Module Attributes

Attribute Name	Tag	Attribute Description
Patient's Name	(0010,0010)	Patient's full legal name.
Patient ID	(0010,0020)	Primary identifier for the patient. Note In the case of imaging a group of small animals simultaneously, the single value of this identifier corresponds to the identification of the entire group. See also Section C.7.1.4.1.1. See Section C.30.4.1
Include Table 10-18 "Issuer of Patient ID Macro Attributes"		
Type of Patient ID	(0010,0022)	The type of identifier in the Patient ID (0010,0020). Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the SOP Common Module, if present.
Other Patient IDs Sequence	(0010,1002)	Identification numbers or codes used to identify the patient, which may or may not be human readable, and may or may not have been obtained from an implanted or attached device such as an RFID or barcode. Zero or more Items shall be included in this Sequence.
>Patient ID	(0010,0020)	An identifier for the patient.
>Include Table 10-18 "Issuer of Patient ID Macro Attributes"		

Attribute Name	Tag	Attribute Description
>Type of Patient ID	(0010,0022)	The type of identifier in the Patient ID (0010,0020) in this Item. Defined Terms: **TEXT** **RFID** **BARCODE** Note 1. The identifier is coded as a string regardless of the type, not as a binary value. 2. When this Attribute has a value of BARCODE, Patient ID (0010,0020) may or may not have the same value as Barcode Value (2200,0005) in the SOP Common Module, if present.
Patient's Birth Date in Alternative Calendar	(0010,0033)	Date of birth of the named patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.
Patient's Death Date in Alternative Calendar	(0010,0034)	Date of death of the named patient in the Alternative Calendar (0010,0035). Note No format is specified for alternative calendar dates so none should be assumed.
Patient's Alternative Calendar	(0010,0035)	The Alternative Calendar used for Patient's Birth Date in Alternative Calendar (0010,0033) and Patient's Death Date in Alternative Calendar (0010,0034). See Section C.7.1.5 for Defined Terms. Required if either Patient's Birth Date in Alternative Calendar (0010,0033) or Patient's Alternative Death Date in Calendar (0010,0034) is present.
Patient's Birth Date	(0010,0030)	Date of birth of the named patient.
Patient's Sex	(0010,0040)	Sex of the named Patient. Enumerated Values: **M** male **F** female **O** other
Referenced Patient Photo Sequence	(0010,1100)	A photo to confirm the identity of a patient. Only a single Item is permitted in this Sequence. See C.2.2.1.1.
>Include Table 10-3b “Referenced Instances and Access Macro Attributes”		

Attribute Name	Tag	Attribute Description
Admission ID	(0038,0010)	Identification number of the Visit as assigned by the healthcare provider Note Visit and Admission are used interchangeably here. In the broader sense, an admission is a type of visit at an institution where there is an admission process for patients.
Issuer of Admission ID Sequence	(0038,0014)	Identifier of the Assigning Authority that issued the Admission ID. Only a single Item shall be included in this Sequence.
>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
Admitting Diagnoses Description	(0008,1080)	Description of admitting diagnosis (diagnoses) for the patient.
Admitting Diagnoses Code Sequence	(0008,1084)	Coded admitting diagnosis (diagnoses) for the patient. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Reason for Visit	(0032,1066)	Reason(s) for this visit by the patient to the facility or provider.
Reason for Visit Code Sequence	(0032,1067)	Coded reason(s) for this visit by the patient to the facility or provider. Note If an HL7 message is available with a PV2 segment corresponding to this visit, potential codes may be found in Admit Reason PV2-3. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
Referenced Request Sequence	(0040,A370)	Requested Procedures to which the Procedure Step contributes. Zero or more Items shall be included in the Sequence.
>Study Instance UID	(0020,000D)	Unique identifier for the Study.
>Accession Number	(0008,0050)	An identifier of the order for the Study.
>Issuer of Accession Number Sequence	(0008,0051)	Identifier of the Assigning Authority that issued the Accession Number. Only a single Item shall be included in this Sequence.
>>Include Table 10-17 "HL7v2 Hierarchic Designator Macro Attributes"		
>Requested Procedure Code Sequence	(0032,1064)	Procedure Type of the Requested Procedure. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*No Baseline CID is defined.*
>Placer Order Number / Imaging Service Request	(0040,2016)	The order number assigned to the Service Request by the party placing the order.
>Order Placer Identifier Sequence	(0040,0026)	Identifier of the Assigning Authority that issued the Placer Order Number. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Attribute Description
>>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
>Filler Order Number / Imaging Service Request	(0040,2017)	The order number assigned to the Service Request by the party filling the order.
>Order Filler Identifier Sequence	(0040,0027)	Identifier of the Assigning Authority that issued the Filler Order Number. Only a single Item shall be included in this Sequence.
>>Include Table 10-17 “HL7v2 Hierarchic Designator Macro Attributes”		
>Requested Procedure ID	(0040,1001)	Identifier of the related Requested Procedure.
>Requested Procedure Description	(0032,1060)	Institution-generated description or classification of the Requested Procedure.
>Reason for the Requested Procedure	(0040,1002)	Reason for requesting this procedure.
> Reason for Requested Procedure Code Sequence	(0040,100A)	Coded reason for requesting this procedure. Zero or more Items shall be included in the Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*No Baseline CID is defined.*
>Requested Procedure Comments	(0040,1400)	User-defined comments on the Requested Procedure.
>Confidentiality Code	(0040,1008)	Confidentiality Constraints on the Requested Procedure by the party filling the order.
>Names of Intended Recipients of Results	(0040,1010)	Names of the physicians, who are intended recipients of results.
>Imaging Service Request Comments	(0040,2400)	User-defined comments on the Service Request.
>Requesting Physician	(0032,1032)	Physician who requested the Service Request.
>Requesting Service	(0032,1033)	Institutional department, unit or service where the request initiated.
>Requesting Service Code Sequence	(0032,1034)	Institutional department, unit or service where the request initiated. Equivalent to HL7 v2.x ORC-17. See Note 1. Only a single Item shall be included in this Sequence.
>Issue Date of Imaging Service Request	(0040,2004)	Date on which the Service Request was issued by the requester.
>Issue Time of Imaging Service Request	(0040,2005)	Time at which the Service Request was issued by the requester.
>Referring Physician's Name	(0008,0090)	The physician who referred the Patient to the physician or service issuing the Service Request. Note This is generally the recipient of any report generated by the Service Request.
Replaced Procedure Step Sequence	(0074,1224)	Canceled procedure step(s) that are replaced by this procedure step. Zero or more Items shall be included in the Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		

Note

1. Both Requesting Service (0032,1033) and Requesting Service Code Sequence (0032,1034) are defined in this table; the latter is preferred, but the former may be copied from an HL7 message whether or not there is also the ability to map it to a coded form (e.g., with only ORC-17 component 1 valued).

C.30.4.1 Patient Identification

For workitems that have a patient as the subject or context, the Patient ID, Issuer of Patient ID, Patient's Name, Patient's Sex and Patient's Birth Date shall have appropriate values.

For workitems that have an identifiable subject that is not a patient, for example a phantom to be scanned or a display to be calibrated, the Patient ID shall be filled with an acceptable pseudo-patient value.

Note

For an object with a hospital asset control number or a manufacturer's serial number, that number might be used as the Patient ID. The Issuer of Patient ID would identify the hospital asset control system or the device manufacturer. Alternatively, it is conceivable that a Patient ID could be generated by the ADT or the local John Doe procedure (to avoid conflicting with an ID assigned to a real patient).

The Patient Name might be set to CT^Phantom or ReadingRoom1Display.

C.31 Radiotherapy Workflow Modules

C.31.1 RT General Machine Verification Module

Table C.31-1 specifies the Attributes used to convey the parameters used in external verification of both conventional radiotherapy (photon or electron) and ion treatment deliveries.

Table C.31-1. RT General Machine Verification Module Attributes

Attribute Name	Tag	Description
Referenced RT Plan Sequence	(300C,0002)	A reference to an RT Plan SOP Class/Instance pair. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”		
Referenced Fraction Group Number	(300C,0022)	Identifier of Fraction Group within referenced RT Plan.
Patient ID	(0010,0020)	Primary identifier for the patient.
Include Table 10-18 “Issuer of Patient ID Macro Attributes”		
Treatment Verification Status	(3008,002C)	Conditions under which treatment was verified by a verification system. Enumerated Values: **VERIFIED** treatment verified **VERIFIED_OVR** treatment verified with at least one out-of-range value overridden **NOT_VERIFIED** treatment failed verification (one or more values out of range and not overridden)
Failed Parameters Sequence	(0074,1048)	List of parameters that failed verification by the MPV. Zero or more Items shall be included in this Sequence. See Section C.31.1.1.
>Include Table 10-20 “Selector Attribute Macro Attributes”		

Attribute Name	Tag	Description
Overridden Parameters Sequence	(0074,104A)	List of parameters that were overridden by the user. Zero or more Items shall be included in this Sequence. See Section C.31.1.1.
>Include Table 10-20 “Selector Attribute Macro Attributes”		
>Operators' Name	(0008,1070)	Name of operator who authorized override of overridden parameter.
>Operator Identification Sequence	(0008,1072)	Identification of the operator who authorized override. Only a single Item is permitted in this Sequence.
>>Include Table 10-1 “Person Identification Macro Attributes Description”		
>Override Reason	(3008,0066)	User-defined description of reason for override of overridden parameter.
General Machine Verification Sequence	(0074,1042)	Sequence containing general machine verification parameters. Zero or one Item shall be included in this Sequence.
>Specified Primary Meterset	(3008,0032)	Desired machine setting of primary Meterset. The units shall match those specified by Primary Dosimeter Unit (300A,00B3) in the plan specified in the Referenced RT Plan Sequence (300C,0002).
>Specified Secondary Meterset	(3008,0033)	Desired machine setting of secondary Meterset. The units shall match those specified for Specified Secondary Meterset (3008,0033) in the plan specified in the Referenced RT Plan Sequence (300C,0002).
>Specified Treatment Time	(3008,003A)	Treatment Time set in seconds.
>Beam Limiting Device Leaf Pairs Sequence	(3008,00A0)	Beam limiting device (collimator) jaw or leaf (element) leaf pair values. One or more Items shall be included in this Sequence.
>>RT Beam Limiting Device Type	(300A,00B8)	Type of beam limiting device (collimator). Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>Number of Leaf/Jaw Pairs	(300A,00BC)	Number of leaf (element) or jaw pairs (equal to 1 for standard beam limiting device jaws).
>Recorded Wedge Sequence	(3008,00B0)	Treatment wedges present during delivered Beam. Zero or more Items shall be included in this Sequence.
>>Wedge Number	(300A,00D2)	Identification number of the Wedge. The value of Wedge Number (300A,00D2) shall be unique within the Wedge Sequence.
>>Wedge ID	(300A,00D4)	User-supplied identifier for wedge.
>>Wedge Angle	(300A,00D5)	Nominal wedge angle delivered in degrees.
>>Wedge Orientation	(300A,00D8)	Orientation of wedge, i.e., orientation of the IEC WEDGE FILTER coordinate system with respect to the IEC BEAM LIMITING DEVICE coordinate system, in degrees.
>>Accessory Code	(300A,00F9)	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>Recorded Compensator Sequence	(3008,00C0)	Treatment compensators associated with current Beam. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Description
>>Compensator ID	(300A,00E5)	User-supplied identifier for compensator.
>>Accessory Code	(300A,00F9)	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Compensator Tray ID	(300A,00EF)	User-supplied identifier for compensator tray.
>>Referenced Compensator Number	(300C,00D0)	Uniquely identifies compensator specified by Compensator Number (300A,00E4) within Beam referenced by Referenced Beam Number (300C,0006).
>Recorded Block Sequence	(3008,00D0)	Blocks associated with current Beam. Zero or more Items shall be included in this Sequence.
>>Block Tray ID	(300A,00F5)	User-supplied identifier for block tray or Electron Insert.
>>Accessory Code	(300A,00F9)	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Referenced Block Number	(300C,00E0)	Uniquely identifies block specified by Block Number (300A,00FC) within Beam referenced by Referenced Beam Number (300C,0006).
>Treatment Machine Name	(300A,00B2)	User-defined name identifying treatment machine to be used for beam delivery. See Section C.8.8.25.2.
>Beam Name	(300A,00C2)	User-defined name for Beam.
>Radiation Type	(300A,00C6)	Particle type of Beam. Enumerated Values: **PHOTON** **ELECTRON** **NEUTRON** **PROTON** **ION**
>Number of Wedges	(300A,00D0)	Number of wedges associated with current Beam.
>Number of Compensators	(300A,00E0)	Number of compensators associated with current Beam.
>Number of Boli	(300A,00ED)	Number of boli used with current Beam.
>Number of Blocks	(300A,00F0)	Number of shielding blocks or Electron Inserts associated with Beam.
>Applicator Sequence	(300A,0107)	Applicators associated with Beam. Zero or more Items shall be included in this Sequence.
>>Accessory Code	(300A,00F9)	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>Applicator ID	(300A,0108)	User or machine supplied identifier for Applicator.
>>Applicator Type	(300A,0109)	Type of Applicator. Enumerated Values: **ELECTRON_SQUARE** square electron applicator **ELECTRON_RECT** rectangular electron applicator **ELECTRON_CIRC** circular electron applicator **ELECTRON_SHORT** short electron applicator **ELECTRON_OPEN** open (dummy) electron applicator **INTRAOPERATIVE** intraoperative (custom) applicator **STEREOTACTIC** stereotactic applicator
>Number of Control Points	(300A,0110)	Number of control points in Beam.

Attribute Name	Tag	Description
>Patient Setup Sequence	(300A,0180)	Patient setup data for current plan. One or more Items are permitted in this Sequence.
>>Patient Setup Number	(300A,0182)	Identification number of the Patient Setup.
>>Fixation Device Sequence	(300A,0190)	Fixation Devices used in Patient Setup. Zero or more Items shall be included in this Sequence.
>>>Accessory Code	(300A,00F9)	An identifier for the accessory intended to be read by a device such as a bar-code reader.
>>>Fixation Device Type	(300A,0192)	Type of Fixation Device used during Patient Setup. Enumerated Values: **BITEBLOCK** **HEADFRAME** **MASK** **MOLD** **CAST** **HEADREST** **BREAST_BOARD** **BODY_FRAME** **VACUUM_MOLD** **WHOLE_BODY_POD** **RECTAL_BALLOON**
>Referenced Beam Number	(300C,0006)	References Beam specified by Beam Number (300A,00C0) in Beam Sequence (300A,00B0) in RT Beams Module of referenced RT Plan or in Ion Beam Sequence (300A,03A2) in RT Ion Beams Module within the referenced RT Ion Plan.
>Referenced Bolus Sequence	(300C,00B0)	Boli associated with Beam. Zero or more Items shall be included in this Sequence.
>>Referenced ROI Number	(3006,0084)	Uniquely identifies ROI representing the Bolus specified by ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) in Structure Set Module within RT Structure Set in Referenced Structure Set Sequence (300C,0060) in RT General Plan Module.
>>Accessory Code	(300A,00F9)	An accessory identifier to be read by a device such as a bar code reader.

C.31.1.1 Failed Parameters and Overridden Parameters

Each Verify Failed Parameter or Overridden Parameter is used to specify a verification Attribute that was either unverified (out of range), or overridden explicitly by the user. To uniquely identify both the context and value item of the Attribute occurrence, a special notation is used, described in Section 10.17.

If a Verify Failed Parameter or Overridden Parameter refers to an Attribute occurrence within a Control Point Sequence, then that Attribute occurrence was failed or overridden during the administration of the beam segment immediately **prior** to the specified control point.

C.31.2 RT Conventional Machine Verification Module

Table C.31-2 specifies the Attributes used to convey the parameters used in external verification of a conventional radiotherapy (photon or electron) treatment delivery.

Table C.31-2. RT Conventional Machine Verification Module Attributes

Attribute Name	Tag	Description
Conventional Machine Verification Sequence	(0074,1044)	Sequence containing conventional machine verification parameters. Zero or one Item shall be included in this Sequence.
>Conventional Control Point Verification Sequence	(0074,104C)	Beam control points for current treatment beam. Only a single Item shall be included in this Sequence.
>>Nominal Beam Energy	(300A,0114)	Nominal Beam Energy at control point.
>>Dose Rate Set	(300A,0115)	Dose Rate to be set on treatment machine for segment beginning at current control point (e.g., MU/min).
>>Wedge Position Sequence	(300A,0116)	Wedge Positions for the current control point. One or more Items shall be included in this Sequence. See Section C.8.8.14.5.
>>>Wedge Position	(300A,0118)	Position of Wedge at current Control Point. Enumerated Values: **IN** **OUT**
>>>Referenced Wedge Number	(300C,00C0)	Uniquely references Wedge described by Wedge Number (300A,00D2) in Wedge Sequence (300A,00D1).
>>Beam Limiting Device Position Sequence	(300A,011A)	Beam limiting device (collimator) jaw or leaf (element) positions. One or more Items shall be included in this Sequence.
>>>RT Beam Limiting Device Type	(300A,00B8)	Type of beam limiting device (collimator). The value of this Attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an Item of Beam Limiting Device Sequence (300A,00B6) Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction
>>>Leaf/Jaw Positions	(300A,011C)	Positions of beam limiting device (collimator) leaf (element) or jaw pairs in mm in the IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) in Beam Limiting Device Sequence (300A,00B6). Values shall be listed in the IEC leaf (element) subscript order 101, 102, … 1N, 201, 202, … 2N.
>>Gantry Angle	(300A,011E)	Gantry angle in degrees of radiation source, i.e., orientation of the IEC GANTRY coordinate system with respect to the IEC FIXED REFERENCE coordinate system.

Attribute Name	Tag	Description
>>Gantry Rotation Direction	(300A,011F)	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Beam Limiting Device Angle	(300A,0120)	Beam Limiting Device angle in degrees, i.e., orientation of the IEC BEAM LIMITING DEVICE coordinate system with respect to the IEC GANTRY coordinate system.
>>Beam Limiting Device Rotation Direction	(300A,0121)	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Patient Support Angle	(300A,0122)	Patient Support angle in degrees, i.e., orientation of the IEC PATIENT SUPPORT (turntable) coordinate system with respect to the IEC FIXED REFERENCE coordinate system.
>>Patient Support Rotation Direction	(300A,0123)	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Eccentric Axis Distance	(300A,0124)	Distance (positive) in mm from the IEC PATIENT SUPPORT vertical axis to the IEC TABLE TOP ECCENTRIC vertical axis.
>>Table Top Eccentric Angle	(300A,0125)	Table Top (non-isocentric) angle, i.e., orientation of the IEC TABLE TOP ECCENTRIC coordinate system with respect to the IEC PATIENT SUPPORT coordinate system, in degrees.
>>Table Top Eccentric Rotation Direction	(300A,0126)	Direction of Table Top Eccentric Rotation when viewing table from above, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Vertical Position	(300A,0128)	Table Top Vertical position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Longitudinal Position	(300A,0129)	Table Top Longitudinal position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Lateral Position	(300A,012A)	Table Top Lateral position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Pitch Angle	(300A,0140)	Table Top Pitch Angle in degrees, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system. See Section C.8.8.25.6.2.

Attribute Name	Tag	Description
>>Table Top Pitch Rotation Direction	(300A,0142)	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	Table Top Roll Angle in degrees, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system. See Section C.8.8.25.6.2.
>>Table Top Roll Rotation Direction	(300A,0146)	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Referenced Control Point Index	(300C,00F0)	Uniquely identifies Control Point specified by Control Point Index (300A,0112) within the Beam referenced by Referenced Beam Number (300C,0006).

C.31.3 RT Ion Machine Verification Module

Table C.31-3 specifies the Attributes used to convey the parameters used in external verification of a radiotherapy ion treatment delivery.

Table C.31-3. RT Ion Machine Verification Module Attributes

Attribute Name	Tag	Description
Ion Machine Verification Sequence	(0074,1046)	Sequence containing ion machine verification parameters. Zero or one Item shall be included in this Sequence.
>Ion Control Point Verification Sequence	(0074,104E)	Beam control points for current ion treatment beam. Only a single Item shall be included in this Sequence.
>>Meterset Rate Set	(3008,0045)	The specified speed of delivery of the specified dose in units specified by Primary Dosimeter Unit (300A,00B3) in referenced RT Plan per minute.
>>Nominal Beam Energy	(300A,0114)	Nominal Beam Energy at control point.
>>Beam Limiting Device Position Sequence	(300A,011A)	Beam limiting device (collimator) jaw or leaf (element) positions. One or more Items shall be included in this Sequence.
>>>RT Beam Limiting Device Type	(300A,00B8)	Type of beam limiting device (collimator). The value of this Attribute shall correspond to RT Beam Limiting Device Type (300A,00B8) defined in an Item of Beam Limiting Device Sequence (300A,00B6) Enumerated Values: **X** symmetric jaw pair in IEC X direction **Y** symmetric jaw pair in IEC Y direction **ASYMX** asymmetric jaw pair in IEC X direction **ASYMY** asymmetric pair in IEC Y direction **MLCX** multileaf (multi-element) jaw pair in IEC X direction **MLCY** multileaf (multi-element) jaw pair in IEC Y direction

Attribute Name	Tag	Description
>>>Leaf/Jaw Positions	(300A,011C)	Positions of beam limiting device (collimator) leaf (element) or jaw pairs in mm in the IEC BEAM LIMITING DEVICE coordinate axis appropriate to RT Beam Limiting Device Type (300A,00B8), e.g., X-axis for MLCX, Y-axis for MLCY. Contains 2N values, where N is the Number of Leaf/Jaw Pairs (300A,00BC) in Beam Limiting Device Sequence (300A,00B6). Values shall be listed in the IEC leaf (element) subscript order 101, 102, … 1N, 201, 202, … 2N.
>>Gantry Angle	(300A,011E)	Gantry angle of radiation source in degrees, i.e., orientation of the IEC GANTRY coordinate system with respect to the IEC FIXED REFERENCE coordinate system.
>>Gantry Rotation Direction	(300A,011F)	Direction of Gantry Rotation when viewing gantry from isocenter, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Beam Limiting Device Angle	(300A,0120)	Beam Limiting Device angle in degrees, i.e., orientation of the IEC BEAM LIMITING DEVICE coordinate system with respect to the IEC GANTRY coordinate system.
>>Beam Limiting Device Rotation Direction	(300A,0121)	Direction of Beam Limiting Device Rotation when viewing beam limiting device (collimator) from radiation source, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Patient Support Angle	(300A,0122)	Patient Support angle in degrees, i.e., orientation of the IEC PATIENT SUPPORT (turntable) coordinate system with respect to the IEC FIXED REFERENCE coordinate system.
>>Patient Support Rotation Direction	(300A,0123)	Direction of Patient Support Rotation when viewing table from above, for segment following Control Point. See Section C.8.8.14.8. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Vertical Position	(300A,0128)	Table Top Vertical position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Longitudinal Position	(300A,0129)	Table Top Longitudinal position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Lateral Position	(300A,012A)	Table Top Lateral position in mm in the IEC TABLE TOP coordinate system. See Section C.8.8.14.6.
>>Table Top Pitch Angle	(300A,0140)	Table Top Pitch Angle in degrees, i.e., the rotation of the IEC TABLE TOP coordinate system about the X-axis of the IEC TABLE TOP coordinate system. See Section C.8.8.25.6.2.

Attribute Name	Tag	Description
>>Table Top Pitch Rotation Direction	(300A,0142)	Direction of Table Top Pitch Rotation when viewing the table along the positive X-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Table Top Roll Angle	(300A,0144)	Table Top Roll Angle in degrees, i.e., the rotation of the IEC TABLE TOP coordinate system about the Y-axis of the IEC TABLE TOP coordinate system. See Section C.8.8.25.6.2.
>>Table Top Roll Rotation Direction	(300A,0146)	Direction of Table Top Roll Rotation when viewing the table along the positive Y-axis of the IEC TABLE TOP coordinate system, for segment following Control Point. See Section C.8.8.14.8 and Section C.8.8.25.6.2. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Head Fixation Angle	(300A,0148)	Angle in degrees of the head fixation for eye treatments with respect to the Table Top Pitch Angle (300A,0140) coordinate system. Positive head fixation angle is the same direction as positive Table Top Pitch. See Section C.8.8.25.6.4.
>>Gantry Pitch Angle	(300A,014A)	Gantry Pitch Angle in degrees of the radiation source, i.e., the rotation of the IEC GANTRY coordinate system about the X-axis of the IEC GANTRY coordinate system. See Section C.8.8.25.6.5.
>>Gantry Pitch Rotation Direction	(300A,014C)	Direction of Gantry Pitch Angle when viewing along the positive X-axis of the IEC GANTRY coordinate system, for segment following Control Point. See Section C.8.8.14.8 and Section C.8.8.25.6.5. Enumerated Values: **CW** clockwise **CC** counter-clockwise **NONE** no rotation
>>Snout Position	(300A,030D)	Axial position in mm of the snout, measured from isocenter to the downstream side of the snout (without consideration of variable length elements such as blocks, MLC and/or compensators).
>>Range Shifter Settings Sequence	(300A,0360)	Range Shifter settings for the current control point. One or more Items shall be included in this Sequence.
>>>Range Shifter Setting	(300A,0362)	Machine specific setting Attribute for the range shifter. See Section C.8.8.25.5.
>>>Referenced Range Shifter Number	(300C,0100)	Uniquely references Range Shifter described by Range Shifter Number (300A,0316) in Range Shifter Sequence (300A,0314).
>>Lateral Spreading Device Settings Sequence	(300A,0370)	Lateral Spreading Device settings for the current control point. One or more Items shall be included in this Sequence.
>>>Lateral Spreading Device Setting	(300A,0372)	Machine specific setting Attribute for the lateral spreading device. See Section C.8.8.25.5.

Attribute Name	Tag	Description
>>>Referenced Lateral Spreading Device Number	(300C,0102)	Uniquely references Lateral Spreading Device described by Lateral Spreading Device Number (300A,0334) in Lateral Spreading Device Sequence (300A,0332).
>>Range Modulator Settings Sequence	(300A,0380)	Range Modulator Settings for current control point. One or more Items shall be included in this Sequence.
>>>Range Modulator Gating Start Value	(300A,0382)	Start position, defining the range modulator position at which the beam is switched on.
>>>Range Modulator Gating Stop Value	(300A,0384)	Stop position, defining the range modulator position at which the beam is switched off.
>>>Referenced Range Modulator Number	(300C,0104)	Uniquely references Range Modulator described by Range Modulator Number (300A,0344) in Range Modulator Sequence (300A,0342).
>>Ion Wedge Position Sequence	(300A,03AC)	Wedge positions for current control point. One or more Items shall be included in this Sequence.
>>>Wedge Thin Edge Position	(300A,00DB)	Closest distance in mm from the central axis of the beam along a wedge axis to the thin edge as projected to the machine isocentric plane. Value is positive is the wedge does not cover the central axis, negative if it does. See Section C.8.8.25.6.4.
>>>Wedge Position	(300A,0118)	Position of Wedge at current Control Point. Enumerated Values: **IN** **OUT**
>>Referenced Control Point Index	(300C,00F0)	Uniquely identifies Control Point specified by Control Point Index (300A,0112 within the Beam referenced by Referenced Beam Number (300C,0006).
>Recorded Snout Sequence	(3008,00F0)	Snouts associated with Beam. Only a single Item shall be included in this Sequence.
>>Accessory Code	(300A,00F9)	An accessory identifier to be read by a device such as a bar code reader.
>>Snout ID	(300A,030F)	User or machine supplied identifier for Snout.
>Recorded Range Shifter Sequence	(3008,00F2)	Range shifters recorded with Beam. Zero or more Items shall be included in this Sequence.
>>Accessory Code	(300A,00F9)	An accessory identifier to be read by a device such as a bar code reader.
>>Range Shifter ID	(300A,0318)	User or machine supplied identifier for Range Modulator.
>>Referenced Range Shifter Number	(300C,0100)	Uniquely identifies range shifter specified by Range Shifter Number (300A,0316) within Beam referenced by Referenced Beam Number (300C,0006).
>Recorded Lateral Spreading Device Sequence	(3008,00F4)	Lateral spreading devices associated with Beam. Zero or more Items shall be included in this Sequence.
>>Accessory Code	(300A,00F9)	An accessory identifier to be read by a device such as a bar code reader.
>>Lateral Spreading Device ID	(300A,0336)	User or machine supplied identifier for Lateral Spreading Device.
>>Referenced Lateral Spreading Device Number	(300C,0102)	Uniquely identifies lateral spreading device specified by Lateral Spreading Device Number (300A,0334) within Beam referenced by Referenced Beam Number (300C,0006).

Attribute Name	Tag	Description
>Recorded Range Modulator Sequence	(3008,00F6)	Range modulators associated with Beam. Zero or more Items shall be included in this Sequence.
>>Accessory Code	(300A,00F9)	An accessory identifier to be read by a device such as a bar code reader.
>>Range Modulator ID	(300A,0346)	User or machine supplied identifier for Range Modulator.
>>Range Modulator Type	(300A,0348)	Type of Range Modulator. See Section C.31.3.1 for Defined Terms.
>>Beam Current Modulation ID	(300A,034C)	User-supplied identifier for the beam current modulation pattern.
>>Referenced Range Modulator Number	(300C,0104)	Uniquely references Range Modulator described by Range Modulator Number (300A,0344) in Range Modulator Sequence (300A,0342).
>Radiation Mass Number	(300A,0302)	Mass number of radiation.
>Radiation Atomic Number	(300A,0304)	Atomic number of radiation.
>Radiation Charge State	(300A,0306)	Charge state of radiation.
>Scan Mode	(300A,0308)	The method of beam scanning to be used during treatment. Enumerated Values: **NONE** No beam scanning is performed **UNIFORM** The beam is scanned between control points to create a uniform lateral fluence distribution across the field **MODULATED** The beam is scanned between control points to create a modulated lateral fluence distribution across the field
>Number of Range Shifters	(300A,0312)	Number of range shifters associated with current beam.
>Number of Lateral Spreading Devices	(300A,0330)	Number of lateral spreading devices associated with current beam.
>Number of Range Modulators	(300A,0340)	Number of range modulators associated with current beam.
>Patient Support Type	(300A,0350)	Defined Terms: **TABLE** Treatment delivery system table **CHAIR** Treatment delivery system chair See Section C.8.8.25.6.3.
>Patient Support ID	(300A,0352)	User-specified identifier for manufacturer specific patient support devices.
>Patient Support Accessory Code	(300A,0354)	A Patient Support accessory identifier to be read by a device such as a bar code reader.
>Fixation Light Azimuthal Angle	(300A,0356)	Azimuthal angle in degrees of the fixation light coordinate around the IEC BEAM LIMITING DEVICE Y-axis. Used for eye treatments. See Section C.8.8.25.6.4.
>Fixation Light Polar Angle	(300A,0358)	Polar angle in degrees of the fixation light coordinate. Used for eye treatments. See Section C.8.8.25.6.4.

C.31.3.1 Range Modulator Type

Defined Terms:

FIXED Fixed modulation width and weights using ridge filter or constant speed wheel with constant beam current.

WHL_FIXEDWEIGHTS Selected wheel/track (Range Modulator ID) is spinning at constant speed. Modulation width is adjusted by switching constant beam current on and off at wheel steps indicated by Range Modulator Interrupt Values.

WHL_MODWEIGHTS Selected wheel/track (Range Modulator ID) is spinning at constant speed. Weight per wheel step is adjusted by modulating beam current according to selected Beam Current Modulation ID (300A,034C).

C.32 Display System Modules

C.32.1 Display System Module

This Module describes the Display System.

Table C.32.1-1. Display System Module Attributes

Attribute Name	Tag	Description
Manufacturer	(0008,0070)	Manufacturer of the Display System.
Institution Name	(0008,0080)	Institution where the Display System is located.
Institution Address	(0008,0081)	Mailing address of institution where the Display System is located.
Device Serial Number	(0018,1000)	Manufacturer's serial number of the Display System. Note The components of the Display System may also have their own serial numbers.
Station Name	(0008,1010)	User defined name identifying the Display System.
Institutional Department Name	(0008,1040)	Department name in the institution where the Display System is located.
Institutional Department Type Code Sequence	(0008,1041)	A coded description of the type of Department or Service within the healthcare facility. Note This might be obtained from a corresponding HL7v2 message containing PV1:10 Hospital Service. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”		*BCID 7030 “Institutional Departments, Units and Services”.*
Manufacturer's Model Name	(0008,1090)	Manufacturer's model name of the Display System.
Equipment Administrator Sequence	(0028,7000)	Point of contact for problems with the equipment. Zero or more Items shall be included in this Sequence.
>Person Name	(0040,A123)	Name of the person or role that is administrating the equipment.
>Include Table 10-1 “Person Identification Macro Attributes Description”		
Number of Display Subsystems	(0028,7001)	Number of Display Subsystems in the Display System.
Display Subsystem Sequence	(0028,7023)	Description of each Display Subsystem. One or more Items shall be included in this Sequence.
>Display Subsystem ID	(0028,7003)	Number that identifies a specific display subsystem within a Display System. The value shall be unique within the Display Subsystem Sequence (0028,7023).
>Display Subsystem Name	(0028,7004)	User-defined name for the Display Subsystem.
>Display Subsystem Description	(0028,7005)	A free text description of the Display Subsystem.
>Display Device Type Code Sequence	(0028,7022)	Type of technology used in the Display Device
>>Include Table 8.8-1 “Code Sequence Macro Attributes”		*DCID 8303 “Display Device Type”.*

Attribute Name	Tag	Description
>Manufacturer	(0008,0070)	Manufacturer of the Display Device in the Display Subsystem. If the Display Subsystem is provided integrated into the Display System (e.g., for a tablet) and the Manufacturer is not otherwise known, the Manufacturer of the Display System may be recorded here. Note Each Display Subsystem is considered to have a single Display Device.
>Device Serial Number	(0018,1000)	Manufacturer's serial number of the Display Device (i.e., monitor device) in the Display Subsystem. If the Display Subsystem is provided integrated into the Display System (e.g., for a tablet) and the Device Serial Number is not otherwise known, the Device Serial Number of the Display System may be recorded here.
>Manufacturer's Model Name	(0008,1090)	Manufacturer's model name of the Display Device in the Display Subsystem. If the Display Subsystem is provided integrated into the Display System (e.g., for a tablet) and the Model Name is not otherwise known, the Model Name of the Display System may be recorded here.
>System Status	(0028,7006)	Current overall status of the Display Subsystem. See Section C.32.1.1 for Defined Terms.
>System Status Comment	(0028,7007)	A free text comment about the status of the Display Subsystem.
>Display Subsystem Configuration Sequence	(0028,700A)	Available Display Subsystem Configurations. One or more Items shall be included in this Sequence.
>>Configuration ID	(0028,700B)	Number that identifies a specific display subsystem configuration within the Display Subsystem Configuration Sequence (0028,700A). The value shall be unique within the Display Subsystem Configuration Sequence (0028,700A).
>>Configuration Name	(0028,700C)	User-defined name for the Display Subsystem Configuration.
>>Configuration Description	(0028,700D)	A free text description of the Display Subsystem Configuration.
>>Referenced Target Luminance Characteristics ID	(0028,700E)	References the intended luminance characteristics for this Configuration of this Display Subsystem. The value is the Luminance Characteristics ID (0028,7009) within the Target Luminance Characteristics Sequence (0028,7008) of the Target Luminance Characteristics Module.
>Current Configuration ID	(0028,7002)	References the current configuration of the Display Subsystem. The value is the Configuration ID (0028,700B) of the Item in the Display Subsystem Configuration Sequence (0028,700A).
>Measurement Equipment Sequence	(0028,7012)	Describes measurement equipment (if any) built into the Display Subsystem. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Description
>>Measurement Functions	(0028,7013)	Measurement functions of the measurement equipment. Enumerated Values: **PHOTOMETER** measurement of light intensity **COLORIMETER** measurement of energy along the visible spectrum **ILLUMINOMETER** measurement of illumination (ambient luminance) This multi-valued Attribute shall contain at most one of each enumerated value. When multiple values are present, the equipment is capable of performing multiple functions.
>>Measured Characteristics	(0028,7026)	Characteristic(s) which are measured by the measurement equipment. Enumerated Values: **UNIFORMITY** Luminance uniformity **LUMINANCE** Luminance **CHROMATICITY** Chromaticity **ILLUMINANCE** Illuminance This multi-valued Attribute shall contain at most one of each enumerated value. When multiple values are present, the equipment is capable of measuring multiple characteristics.
>>Measurement Equipment Type	(0028,7014)	Type of measurement equipment. See Section C.32.1.2 for Enumerated Values.
>>Manufacturer	(0008,0070)	Manufacturer of the measurement equipment.
>>Manufacturer's Model Name	(0008,1090)	Manufacturer's model name of the measurement equipment.
>>Device Serial Number	(0018,1000)	The measurement equipment serial number.
>>DateTime of Last Calibration	(0018,1202)	Date and time of the last calibration of the measurement equipment. Note This is likely different than the date of the calibration of the Display Subsystem itself.

C.32.1.1 System Status

Defined Terms for System Status (0028,7006):

NORMAL Device performance is within specified limits
WARNING Device performance improvement/re-calibration is appropriate
ADJUST Correction required; may be performed by trained staff
FAILURE Service required
UNKNOWN Unable to obtain status from the device

It is up to the implementation how to set the System Status (0028,7006) based on the contents of the status code sequences.

C.32.1.2 Measurement Equipment Type

Enumerated Values for Measurement Equipment Type (0028,7014):

BUILT_IN_FRONT The sensor is located on the front of the surface of a display device
BUILT_IN_BACK The sensor is located inside the display device
NEAR_RANGE The sensor is held at a close distance from the surface of the display device
TELESCOPIC The sensor is aimed toward the display device from a distance of about 1 meter

See [IEC 62563-1], Annex B, section B.2.1 to B.2.4 for examples of these types.

C.32.2 Target Luminance Characteristics Module

This Module is a library of target luminance characteristics to be achieved in the calibration of specific configurations of specific Display Subsystems.

Table C.32.2-1. Target Luminance Characteristics Module Attributes

Attribute Name	Tag	Description
Target Luminance Characteristics Sequence	(0028,7008)	Target luminance characteristics to which the Display Subsystem can be calibrated. One or more Items shall be included in this Sequence.
>Luminance Characteristics ID	(0028,7009)	Number that identifies this Luminance Characteristics Item. The value shall be unique within the Target Luminance Characteristics Sequence (0028,7008).
>Display Function Type	(0028,7019)	The type of Display Function used to define the target luminance curve. See Section C.32.2.1 for Enumerated Values.
>Target Minimum Luminance	(0028,701D)	The minimum luminance value of the target luminance curve, in candelas per square meter (cd/m^2).
>Target Maximum Luminance	(0028,701E)	The maximum luminance value of the target luminance curve, in candelas per square meter (cd/m^2).
>Gamma Value	(0028,701A)	The Gamma value for generating the target luminance curve. Required if the value of Display Function Type (0028,7019) is GAMMA.
>Number of Luminance Points	(0028,701B)	The number of luminance points in the user defined target luminance curve. Required if the value of Display Function Type (0028,7019) is USER_DEFINED.
>Luminance Response Sequence	(0028,701C)	Luminance Response Values for the user defined target luminance curve. The number of Items shall match the value of Number of Luminance Points (0028,701B). Required if the value of Display Function Type (0028,7019) is USER_DEFINED.
>>DDL Value	(0028,7017)	The integer Digital Driving Level (DDL) for this luminance value. The DDL Value for the first Item in the Sequence shall be 0. The DDL Value of the last Item in the Sequence shall be the maximum DDL value. Two Items in the Sequence shall not have the same DDL value. The DDL Value of the Items in the Sequence shall increase monotonically.
>>Luminance Value	(0028,701F)	Luminance in candelas per square meter (cd/m^2) corresponding to the DDL Value.
>Luminance Response Description	(0028,7020)	User defined text to describe the user defined target luminance curve.
>CIExy White Point	(0028,7018)	A single measured White Point recorded for the Display Subsystem. The white point is recorded as a CIE xy chromaticity with two dimensionless floating point values where the first is the x value and the second is the y value.
>Reflected Ambient Light	(2010,0160)	Reflected ambient light in candelas per square meter (cd/m^2) when the measurements were taken.

Attribute Name	Tag	Description
>Ambient Light Value Source	(0028,7025)	Source of the reflected ambient light value. Enumerated Values: **DEFAULT** a configured default value was used. **MEASURED** the value was measured at the time of the other measurements. **PROVIDED** the value was provided by an external source. Required if Reflected Ambient Light (2010,0160) is present.

C.32.2.1 Display Function Type

Enumerated Values for Display Function Type (0028,7019):

GSDF Grayscale Display Function; see PS3.14.
CIELAB See CIE 1976 (L*,a*,b*) and CIELab Color Space by Gernot Huffman 1948.
GAMMA Luminance has a power law response curve.
LINEAR Luminance has a linear response curve.
LOG10 Luminance has a logarithmic response curve
SRGB See "A Standard Default Color Space for the Internet - sRGB" - http://www.w3.org/Graphics/Color/sRGB.
USER_DEFINED Points of the luminance curve are defined by the user.

C.32.3 QA Results Module

This Module records the latest results of QA activities, such as calibration, performed on the Display Subsystems.

Table C.32.3-1. QA Results Module Attributes

Attribute Name	Tag	Description
QA Results Sequence	(0028,700F)	Results of QA activities. Exactly one Item shall be included for each Display Subsystem present in the Display System.
>Display Subsystem ID	(0028,7003)	The Display Subsystem ID of the Item in the Display Subsystem Sequence (0028,7023) to which these results apply.
>Display Subsystem QA Results Sequence	(0028,7010)	Results of QA activities for the identified Display Subsystem. Zero or more Items shall be included in this Sequence.
>>Configuration ID	(0028,700B)	The Configuration ID of the Item in the Display Subsystem Configuration Sequence (0028,700A) under which the QA was performed. A given Configuration ID value shall not appear more than once in this Sequence.
>>Configuration QA Results Sequence	(0028,7011)	Results of QA activities for the identified Display Subsystem in the identified configuration
>>>Display Calibration Result Sequence	(0028,7016)	The most recent calibration result. Zero or one Item shall be included in this Sequence.
>>>>Include Table C.32.3.1-1 “Display QA Result Context Macro Attributes”		
>>>>Luminance Characteristics ID	(0028,7009)	The Luminance Characteristics ID of the Item in the Target Luminance Characteristics Sequence (0028,7008) that represents the target values used during this calibration.

Attribute Name	Tag	Description
>>>Visual Evaluation Result Sequence	(0028,7015)	The most recent visual evaluation result. Zero or one Item shall be included in this Sequence.
>>>>*Include Table C.32.3.1-1 “Display QA Result Context Macro Attributes”*		
>>>>*Include Table C.32.3.2-1 “Visual Evaluation Result Macro Attributes”*		
>>>Luminance Uniformity Result Sequence	(0028,7027)	The most recent luminance uniformity result. Zero or one Item shall be included in this Sequence.
>>>>*Include Table C.32.3.1-1 “Display QA Result Context Macro Attributes”*		
>>>>*Include Table C.32.3.3-1 “Luminance Uniformity Result Macro Attributes”*		
>>>Luminance Result Sequence	(0028,7024)	The most recent luminance result. Zero or one Item shall be included in this Sequence.
>>>>*Include Table C.32.3.1-1 “Display QA Result Context Macro Attributes”*		
>>>>*Include Table C.32.3.4-1 “Luminance Result Macro Attributes”*		

Note

Several Result Sequences in the above table are permitted to contain zero Items. This means that no valid "most recent result" exists. This may be because such results have never been generated, or because the system considers that the most recent result is no longer valid (perhaps due to age or intervening equipment changes). Specifying such policy is outside the scope of DICOM.

C.32.3.1 Display QA Result Context Macro

This Macro records the context for a set of collected display QA results: when they were produced, the person/device that produced them.

Table C.32.3.1-1. Display QA Result Context Macro Attributes

Attribute Name	Tag	Description
Performed Procedure Step Start DateTime	(0040,4050)	Date and Time at which the QA job that generated the results started.
Performed Procedure Step End DateTime	(0040,4051)	Date and Time at which the QA job that generated the results ended.
Actual Human Performer Sequence	(0040,4035)	Human performer(s) responsible for the results. Zero or more Items shall be included in this Sequence.
>Human Performer Code Sequence	(0040,4009)	Coded identification of the human performer. Only a single Item shall be included in this Sequence.
>>*Include Table 8.8-1 “Code Sequence Macro Attributes”*		No Baseline Context ID is defined.
>Human Performer's Name	(0040,4037)	Name of the human performer.
>Human Performer's Organization	(0040,4036)	Organization to which the human performer is accountable for the results.
Measurement Equipment Sequence	(0028,7012)	Describes the measurement equipment (if any) used in deriving the results. This may describe standalone equipment or may re-iterate details of equipment built into the Display System. Zero or more Items shall be included in this Sequence.

Attribute Name	Tag	Description
>Measurement Functions	(0028,7013)	Measurement functions of the measurement equipment. Enumerated Values: **PHOTOMETER** measurement of light intensity **COLORIMETER** measurement of energy along the visible spectrum **ILLUMINOMETER** measurement of illumination (ambient luminance) This multi-valued Attribute shall contain at most one of each enumerated value. When multiple values are present, the equipment is capable of performing multiple functions.
>Measured Characteristics	(0028,7026)	Characteristic(s) which are measured by the measurement equipment. Enumerated Values: **UNIFORMITY** Luminance uniformity **LUMINANCE** Luminance **CHROMATICITY** Chromaticity **ILLUMINANCE** Illuminance This multi-valued Attribute shall contain at most one of each enumerated value. When multiple values are present, the equipment is capable of measuring multiple characteristics.
>Measurement Equipment Type	(0028,7014)	Type of measurement equipment. See Section C.32.1.2 for Enumerated Values.
>Manufacturer	(0008,0070)	Manufacturer of the measurement equipment.
>Manufacturer's Model Name	(0008,1090)	Manufacturer's model name of the measurement equipment.
>Device Serial Number	(0018,1000)	The measurement equipment serial number.
>DateTime of Last Calibration	(0018,1202)	Date and time of the last calibration of the measurement equipment. Note This is likely different than the date of the calibration of the Display System itself.

C.32.3.2 Visual Evaluation Result Macro

This Macro records the result of a Visual Evaluation QA task by a human for a Display System.

Table C.32.3.2-1. Visual Evaluation Result Macro Attributes

Attribute Name	Tag	Description
Visual Evaluation Test Sequence	(0028,7028)	Test Results of a visual evaluation of the display subsystem output. May include evaluation of multiple test pattern images, as long as all Items in this Sequence are generated in a single QA test session. One or more Items shall be included in this Sequence.
>Test Result	(0028,7029)	Result of a test. Enumerated Values: **PASS** Evaluated as acceptable **FAIL** Evaluated as not acceptable **SKIP** Not evaluated

Attribute Name	Tag	Description
>Test Result Comment	(0028,702A)	User comment on the result or performance of the test. Might include scoring values that are not intended to be machine readable.
>Test Pattern Code Sequence	(0028,702C)	Coded identification of the test pattern presented for visual evaluation. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 8301 "Test Pattern Codes".*
>Referenced Image Sequence	(0008,1140)	Reference to the Image Instance containing the test pattern presented for visual evaluation. Only a single Item shall be included in this Sequence. Required if Test Pattern Code Sequence (0028,702C) is absent in this Item. May be present otherwise.
>>Test Image Validation	(0028,702B)	Indication of whether the test image was validated as matching the characteristics of the display system (e.g., resolution and bit depth). Enumerated Values: **MATCHED** the test image was determined to match **UNMATCHED** the test image was not determined to match
Visual Evaluation Method Code Sequence	(0028,702E)	Coded description of the methodology used during this visual evaluation. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 8300 "Visual Evaluation Methods".*

C.32.3.3 Luminance Uniformity Result Macro

This Macro records the result of a Luminance Uniformity QA task for a Display Subsystem.

Table C.32.3.3-1. Luminance Uniformity Result Macro Attributes

Attribute Name	Tag	Description
Number of Luminance Points	(0028,701B)	The number of luminance measurements recorded. The number depends on the test pattern specified in the Measurement Pattern Code Sequence (0028,702D). Note Most commonly the value is 5, which is a total of the locations on the faceplate of the Display Device (center and four corners) as defined by the TG18-UNL80 or TG18-UNL10 test pattern.
Measurement Pattern Code Sequence	(0028,702D)	Definition of the locations on the display device at which luminance measurements were taken. One measurement is recorded for each location.
>Include Table 8.8-1 "Code Sequence Macro Attributes"		*BCID 8302 "Measurement Pattern Codes".*
DDL Value	(0028,7017)	The integer Digital Driving Level (DDL) at which the luminance values were measured. Note Luminance Uniformity measurement uses the same DDL value for all measurements.

Attribute Name	Tag	Description
White Point Flag	(0028,7021)	Whether white point values were also recorded at each location. Enumerated Values: **YES** **NO**
Luminance Response Sequence	(0028,701C)	Recorded Luminance Response Values The number of Items shall match the value of Number of Luminance Points (0028, 701B). The Items shall be stored in major row order (from left to right then from top to bottom).
>Luminance Value	(0028,701F)	Luminance in candelas per square meter (cd/m^2) at the measurement location. Note Each measured luminance includes both ambient light and light from the display device.
>CIExy White Point	(0028,7018)	White Point at the measurement location, The white point is recorded as a CIE xy chromaticity with two dimensionless floating point values where the first is the x value and the second is the y value.
Reflected Ambient Light	(2010,0160)	Reflected ambient light in candelas per square meter (cd/m^2) when the measurements were taken.
Ambient Light Value Source	(0028,7025)	Source of the ambient light value. Enumerated Values: **DEFAULT** a configured default value was used. **MEASURED** the value was measured at the time of the other measurements. **PROVIDED** the value was provided by an external source.

C.32.3.4 Luminance Result Macro

This Macro records the result of a Luminance QA task for a Display Subsystem.

Table C.32.3.4-1. Luminance Result Macro Attributes

Attribute Name	Tag	Description
Number of Luminance Points	(0028,701B)	The number of luminance measurements recorded.
Luminance Response Sequence	(0028,701C)	Measured Luminance Response Values The number of Items shall match the value of Number of Luminance Points (0028,701B).
>DDL Value	(0028,7017)	The integer Digital Driving Level (DDL) at which this luminance value was measured. The DDL Value for the first Item in the Sequence shall be 0. The DDL Value of the last Item in the Sequence shall be the maximum DDL value. Two Items in the Sequence shall not have the same DDL value. The DDL Value of the Items in the Sequence shall increase monotonically.

Attribute Name	Tag	Description
>Luminance Value	(0028,701F)	Luminance in candelas per square meter (cd/m^2) at the measurement location. Note Each measured luminance includes both ambient light and light from the display device.
>CIExy White Point	(0028,7018)	A single measured white point recorded for the display subsystem. The white point is recorded as a CIE xy chromaticity with two dimensionless floating point values where the first is the x value and the second is the y value.
Reflected Ambient Light	(2010,0160)	Reflected ambient light in candelas per square meter (cd/m^2) when the measurements were taken.
Ambient Light Value Source	(0028,7025)	Source of the ambient light value. Enumerated Values: **DEFAULT** a configured default value was used. **MEASURED** the value was measured at the time of the other measurements. **PROVIDED** the value was provided by an external source.

C.33 Content Assessment Modules

C.33.1 Content Assessment Results Module

This Module describes the results of the assessment of a SOP Instance.

The type of observations that are included in the results is up to the implementation. Although all observations with the Observation Significance (0082,0008) with value MAJOR are included, inclusion of other observation is on the discretion of the implementation.

Table C.33.1-1. Content Assessment Results Module Attributes

Attribute Name	Tag	Type	Attribute Description
Assessment Label	(0082,0023)	1	A label that is used to identify this Assessment.
Assessment Type Code Sequence	(0082,0021)	1	Type of Assessment that was performed. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 701 “Content Assessment Types”*
Assessment Set ID	(0082,0016)	3	Identifies the set of assessments to which this assessment result belongs.
Assessment Requester Sequence	(0082,0017)	2	The person or device that made the assessment request. Only a single Item shall be included in this Sequence.
>Include Table C.17-3b “Identified Person or Device Macro Attributes”			
Assessed SOP Instance Sequence	(0082,0004)	1	The SOP Instances that were assessed. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
>Referenced Comparison SOP Instance Sequence	(0082,0005)	1C	SOP Instance(s) used by the assessor to compare to the assessed SOP Instances. Required if the assessor used comparison SOP Instances. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Assessment Summary	(0082,0001)	1	Summary of the assessment result. The relationship between the values of Observation Type (0082,0008) found and the Assessment Summary value is implementation dependent. Enumerated Values: **PASSED** The assessment has passed. E.g., no observation of major or moderate concern was made. **INCONCLUSIVE** The object(s) have not definitively passed or failed. E.g., observations of moderate concern were made. **FAILED** The object(s) have failed the assessment. E.g., observations of major concern were made.
Assessment Summary Description	(0082,0003)	3	Human-readable summary description of the assessment result.
Pertinent Resources Sequence	(0038,0101)	3	List of Resources that contain information considered pertinent for the assessment. Note This may include specifications for the assessment process and criteria for determining the Observation Type (0082,0008). One or more Items may be present in this Sequence.
>Retrieve URI	(0040,E010)	1	Retrieval access path to resource. Includes fully specified scheme, authority, path, and query in accordance with [RFC3986].
>Resource Description	(0038,0102)	3	Description or title of the resource
Number of Assessment Observations	(0082,0006)	1	Number of Observations made during the assessment.
Assessment Observations Sequence	(0082,0007)	1C	Observations made during the assessment. Required if Number of Assessment Observations (0082,0006) is not zero. The number of Items included in the Sequence shall equal the value of Number of Assessment Observations (0082,0006).

Attribute Name	Tag	Type	Attribute Description
>Observation Significance	(0082,0008)	1	The significance of this observation regarding the quality or effectiveness of the assessed SOP Instance of this observation. Enumerated Values: **MAJOR** The observation represents a major concern. Further use of the assessed object(s) is not advised. **MODERATE** The observation represents a moderate concern. Intervention by an authorized person is advised prior to any use of the assessed object(s). **MINOR** The observation represents a minor concern, that does not inhibit further use of the assessed object(s). **CONSISTENT** The observation was consistent with the assessment criteria.
>Observation Basis Code Sequence	(0082,0022)	1	Basis on which the Observation was performed. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 703 “Basis of Assessment”*
>Observation Description	(0082,000A)	1	Human-readable description of the Observation.
>Structured Constraint Observation Sequence	(0082,000C)	2	Structured Constraint(s) that were used to make this observation and description of conformance or violation. Zero or more Items shall be included in this Sequence.
>>Include Table 10.25-1 “Attribute Value Constraint Macro Attributes”			
>>Assessed Attribute Value Sequence	(0082,0010)	1	The value of the Attribute in the assessed SOP Instance. One or more Items shall be included in this Sequence.
>>>Include Table 10.26-1 “Attribute Value Macro Attributes”			

C.34 Procedure Protocol Modules

This section describes Modules specific to the family of Defined and Performed Procedure Protocol IODs.

C.34.1 CT Protocol Series Module

The CT Protocol IODs use the General Series Module described in Section C.7.3.1, specialized by the CT Protocol Series Module, to describe the DICOM Series Entity described in Section A.1.2.3, and to define what constitutes a Series for the context of a Protocol.

Table C.34.1-1 specifies the Attributes that describe a CT Protocol Series.

Table C.34.1-1. CT Protocol Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of data in this Series. Enumerated Values: **CTPROTOCOL** See Section C.7.3.1.1.1 for further explanation.

C.34.2 Protocol Context Module

The context in which the described Protocol is defined or performed. This Module is applicable to defined and performed procedure protocols.

Details like the Potential Reasons for Procedure Code Sequence (0018,9909) or the Protocol Planning Information (0018,990F) may be copied from the defined protocol into the performed protocol to support quality assurance activities like checking whether the contents of the Reason for Requested Procedure Code Sequence (0040,100A) recorded in the performed protocol are consistent with the contents of the Potential Reasons for Procedure Code Sequence (0018,9909).

Table C.34.2-1. Protocol Context Module Attributes

Attribute Name	Tag	Type	Attribute Description
Custodial Organization Sequence	(0040,A07C)	3	Custodial organization for this Protocol Instance. Represents the organization that is currently in charge of maintaining this protocol Instance. Note This may or may not be identical to the Institution identified in the Equipment ~~Module. This~~Module. This may or may not be the Institution that originally created this Instance. Only a single Item is permitted in this Sequence.
>Institution Name	(0008,0080)	2	Name of Custodial Institution or Organization.
>Institution Code Sequence	(0008,0082)	2	Coded identifier of Custodial Institution or Organization. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID is defined.*
Responsible Group Code Sequence	(0008,0220)	2	The department, unit or service that is responsible for the management of this Protocol. See Section C.34.2.3. Zero or more Items shall be included in this Sequence
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7030 “Institutional Departments, Units and Services”.*
Protocol Name	(0018,1030)	1	Name for this Protocol.
Potential Scheduled Protocol Code Sequence	(0018,9906)	3	A list of Protocol Codes for which this Protocol may be considered a match. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
Potential Requested Procedure Code Sequence	(0018,9907)	3	A list of Procedure Codes for which this Protocol may be considered a match. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			
Potential Reasons for Procedure	(0018,9908)	3	List of reasons deemed appropriate by the Protocol author for a procedure using this Protocol Each reason shall be encoded in a separate value of this multi-value Attribute. Note One of the reasons listed here may be encoded in Reason for the Requested Procedure (0040,1002) within Instances generated from running the Protocol.
Potential Reasons for Procedure Code Sequence	(0018,9909)	3	List of reasons deemed appropriate by the Protocol author for a procedure using this Protocol. One or more Items are permitted in this Sequence. Note One of the reasons listed here may be encoded in Reason for Requested Procedure Code Sequence (0040,100A) within Instances generated from running the Protocol.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Potential Diagnostic Tasks	(0018,990A)	3	List of diagnostic tasks deemed appropriate by the Protocol author for a procedure using this Protocol. E.g., detect collections of blood, identify brain masses.
Contraindications Code Sequence	(0018,990B)	3	List of reasons for which the authors of the Protocol deemed it contraindicated. Note Constraints on values of patient demographic Attributes such as sex, age or weight are addressed separately in the Patient Specification Module. See Section C.34.5. One or more Items are permitted in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 1200 "Contraindications For CT Imaging".*
Predecessor Protocol Sequence	(0018,990E)	3	Defined or Performed Procedure Protocol Instances from which this Defined Procedure Protocol was derived. See Section C.34.2.1. This Attribute is not present in Performed Procedure Protocol Instances since the Referenced Defined Protocol Sequence (0018,990C) is used instead. One or more Items are permitted in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
Content Creator's Name	(0070,0084)	1	Name of the most recent person (such as a technologist or physician) to significantly modify the content of this SOP Instance. Note 1. For a Performed Protocol object, this is generally the operator who was the last one to interact with the protocol before it was performed. 2. A history of editors is not recorded here. Such information might conceivably be recovered by reviewing the Attribute value of other Instances such as those referenced in Predecessor Protocol Sequence (0018,990E).
Content Creator's Identification Code Sequence	(0070,0086)	3	Identification of the most recent person to significantly modify the content of this SOP Instance. Only a single Item is permitted in this Sequence.
>Include Table 10-1 “Person Identification Macro Attributes Description”			
Protocol Design Rationale	(0018,9910)	3	Explanation of the rationale behind the selected parameter values or changes to them.
Protocol Planning Information	(0018,990F)	3	Description of details and activities related to planning the execution of this Protocol. See Section C.34.2.2.
Instance Creation Date	(0008,0012)	1	Date the Protocol SOP Instance was created.
Instance Creation Time	(0008,0013)	1	Time the Protocol SOP Instance was created.

C.34.2.1 Predecessor Protocol Sequence

A Protocol may be a derivation of another Protocol (the "predecessor"). For example, a Protocol may be originally published as a non-model-specific Protocol for a certain purpose. Subsequently, a new Protocol may be derived from the original by making it specific to a certain model of scanner. Derivation may involve adjusting constraints or specifying additional constraints. If a Protocol no longer satisfies any of the indications of the Predecessor Protocol from which it was derived, the Predecessor shall not be referenced in this Sequence.

Note

Including predecessor information makes it possible to filter a set of Protocols, for example to list all Protocols that are derived versions of a certain known Protocol (e.g., ACRIN 6678), or list only the one that has been specialized for a specific model of equipment.

Sites that receive a generic Protocol might create a specialized variant to fit their local practice and avoid the tech having to make selections/changes each time it is used.

Only the immediate predecessor shall be referenced, but more than one predecessor may be referenced if multiple distinct predecessors were merged.

C.34.2.2 Protocol Planning Information

This information describes activities that are related to the effective performance of the Protocol but are not typically performed in the scanning room. This could include things like:

- Instruct patient to fast for 4 hours before imaging

- Obtain creatinine within 7 days before imaging
- Schedule scan 12-24hrs before surgery
- Premedicate patient with diphenhydramine 1 hr before imaging
- Schedule an additional liver Acquisition Protocol Element 10-15 minutes after contrast injection if the patient has a history of cholangiocarcinoma; note this example would affect both the length of the scheduled time slot and the actual performance with a delayed acquisition
- If available run the followup scan on the same device as the original scan.

C.34.2.3 Protocol Management

The Protocol Context Module contains Attributes for grouping and managing Protocol objects.

The Responsible Group Code Sequence (0008,0220) can be used by the department or clinical specialty to collect the Protocols for which they are responsible for review and management.

The Potential Scheduled Protocol Code Sequence (0018,9906) and Potential Reasons for Procedure Code Sequence (0018,9909) can gather Protocols associated with a given procedure code or indication respectively.

The contents of the Referenced Defined Protocol Sequence (0018,990C) in a collection of Performed Procedure Protocol objects can be used to determine the frequency of usage of the corresponding Defined Procedure Protocol objects.

C.34.3 Patient Protocol Context Module

The patient specific context in which the described Protocol is performed. This Module is applicable to performed procedures.

Table C.34.3-1. Patient Protocol Context Module Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Performed Protocol Sequence	(0018,990D)	1	References to Performed Protocol Instances describing related prior procedures for this patient. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.34.4 Clinical Trial Context Module

Table C.34.4-1 contains Attributes that identify a clinical trial context independent of any specific Clinical Trial Subjects.

Table C.34.4-1. Clinical Trial Context Module Attributes

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Sponsor Name	(0012,0010)	1	The name of the clinical trial sponsor. See Section C.7.1.3.1.1.
Clinical Trial Protocol ID	(0012,0020)	1	Identifier for the noted protocol . See Section C.7.1.3.1.2.
Clinical Trial Protocol Name	(0012,0021)	2	The name of the clinical trial protocol .See Section C.7.1.3.1.3.
Clinical Trial Site ID	(0012,0030)	2	The identifier of the site responsible for submitting clinical trial data. See Section C.7.1.3.1.4.

Attribute Name	Tag	Type	Attribute Description
Clinical Trial Site Name	(0012,0031)	2	Name of the site responsible for submitting clinical trial data. See Section C.7.1.3.1.5.
Clinical Trial Protocol Ethics Committee Name	(0012,0081)	1C	Name of the Ethics Committee or Institutional Review Board (IRB) responsible for approval of the Clinical Trial. Required if Clinical Trial Protocol Ethics Committee Approval Number (0012,0082) is present.
Clinical Trial Protocol Ethics Committee Approval Number	(0012,0082)	3	Approval number issued by committee described in Clinical Trial Protocol Ethics Committee Name (0012,0081).
Ethics Committee Approval Effectiveness Start Date	(0012,0086)	3	The date the approval identified in Clinical Trial Protocol Ethics Committee Approval Number (0012,0082) becomes effective.
Ethics Committee Approval Effectiveness End Date	(0012,0087)	3	The date the approval identified in Clinical Trial Protocol Ethics Committee Approval Number (0012,0082) ceases to be effective.
Clinical Trial Coordinating Center Name	(0012,0060)	2	The name of the institution that is responsible for coordinating the protocols for the clinical trial. See Section C.7.3.2.1.1.

C.34.5 Patient Specification Module

Table C.34.5-1 contains patient characteristics for which a Protocol may be considered applicable.

Table C.34.5-1. Patient Specification Module Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Specification Sequence	(0018,9911)	1	Constraints on the characteristics of patients to which the protocol is applicable. One or more Items shall be included in this Sequence.
>Include Table 10.25-1 “Attribute Value Constraint Macro Attributes”			Only Attributes defined in the Patient Module (See Table C.7-1) or the Patient Study Module (See Table C.7-4a) may be specified as Selector Attributes. See Section C.34.9.3. The same Attribute shall not be constrained in more than one Item in this Sequence. Note Since these constraints are being placed on the Attributes that will appear in the Patient Module or Patient Study Module of the resulting Instances, the Patient Specification Sequence will not appear in the Selector Sequence Pointer (0072,0052).

Attributes that might commonly be specified in this Sequence include:

- Patient's Age (0010,1010), to indicate Protocols for age ranges like adults, pediatrics, infants
- Patient's Sex (0010,0040), to indicate Protocols for males, females, both
- Patient's Weight (0010,1030), to indicate Protocols for different weight ranges

C.34.6 Equipment Specification Module

Table C.34.6-1 contains equipment characteristics for which a Protocol may be considered appropriate.

Table C.34.6-1. Equipment Specification Module Attributes

Attribute Name	Tag	Type	Attribute Description
Equipment Modality	(0008,0221)	1	Modality of the equipment to which the protocol is applicable. See Section C.7.3.1.1.1 for Defined Terms.
Model Specification Sequence	(0018,9912)	3	Equipment models/versions. See Section C.34.6.1. Zero or more Items shall be included in this Sequence.
>Manufacturer	(0008,0070)	1	Manufacturer of the equipment.
>Manufacturer's Related Model Group	(0008,0222)	3	Name of a group of related equipment models from the Manufacturer (0008,0070) to which the same protocol applies.
>Manufacturer's Model Name	(0008,1090)	1C	Manufacturer's model name of the equipment. Required if Manufacturer's Related Model Group (0008,0222) is not present. May be present otherwise.
>Software Versions	(0018,1020)	3	Manufacturer's designation of software version of the equipment. See Section C.7.5.1.1.3.
>General Accessory Sequence	(300A,0420)	3	Accessories or options that further specify the model. One or more Items are permitted in this Sequence.
>>Accessory Code	(300A,00F9)	1	Machine readable identifier for the accessory. E.g., this may indicate accessory equipment such as cardiac gating equipment.
>Device Serial Number	(0018,1000)	3	Serial number of a specific device for which the Protocol is intended.

The Protocol details in other Modules may implicitly further constrain the appropriate equipment. For example, the specified hardware may not have the ability to perform acquisitions that satisfy the acquisition parameter constraints, to perform reconstructions that satisfy the reconstruction parameter constraints, or to produce images with the desired characteristics.

C.34.6.1 Model Specification Sequence

Each Item in the Sequence, contains multiple Attributes to be satisfied at once. It is only necessary to match one Item in the Sequence. The decision about whether an Item is a suitable match is up to the executing device. The intention is to provide values that would allow a scanner device to identify whether a Protocol is appropriate for it.

Note

The values may not necessarily match exactly what the scanner would put into corresponding Attributes in Instances it creates.

C.34.7 Instructions Module

Table C.34.7-1 contains instructions relating to preparation and performance of the Protocol.

Table C.34.7-1. Instructions Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instruction Sequence	(0018,9914)	1	Instructions relating to preparation and performance of the Protocol. See Section C.34.7.1. One or more Items shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Instruction Index	(0018,9915)	1	Identifies the order in which instruction Sequence Items are performed. The value shall be an integer, increasing monotonically by 1, starting from 1.
>Instruction Text	(0018,9916)	1	A short displayable string indicating what should be done.
>Instruction Description	(0018,9917)	3	A detailed description explaining what should be done.
>Instruction Performed Flag	(0018,9918)	2C	Whether or not this instruction was followed in the performed Protocol. Required if the value of SOP Class UID (0008,0016) equals 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage). Enumerated Values: **YES** **NO**
>Instruction Performed DateTime	(0018,9919)	2C	Date and time the instruction was performed. Required if Instruction Performed Flag (0018,9918) is present with a value of YES.
>Instruction Performance Comment	(0018,991A)	3	Comment about how the instruction was actually performed, about the outcome of performing the instruction or about why the instruction was not performed.

C.34.7.1 Instruction Sequence

This Sequence describes instructions to be performed by the scanner staff in conjunction with the Protocol. The instructions are generally limited to ~~activites~~activities that happen inside the scan suite and might include

- preparation of the scanner (e.g., running a particular calibration, mounting a head holder or patient grab handles on the table) ,
- preparation of the patient (e.g., asking if they have fasted, placing padding or shielding, giving the patient water as oral contrast, turning the patient prone for the second acquisition in a virtual colonoscopy Protocol) ,
- instructions to the patient during the imaging procedure (e.g., asking the patient to hold their breath, asking the patient to hyper-ventilate prior to ~~breathold~~breath hold)
- instructions to the technologist during the imaging procedure (e.g., obtain the spiral acquisition during a single ~~breathhold~~breath hold, take additional images if some condition is true).

The instruction may also include timing or triggering details, for example:

- Start the Portal Venous phase Acquisition Protocol Element when an ROI placed over the liver detects a contrast bolus at 50 HU above baseline
- Start the Delay phase Acquisition Protocol Element three minutes after start of contrast injection
- Start the AP Localizer Acquisition Protocol Element eight minutes after start of contrast injection and repeat the AP Localizer Acquisition Protocol Element at one minute intervals until adequate ureter opacification is observed, then proceed to the abdomen Acquisition Protocol Element

Instructions related to the initial positioning of the patient are included in the Patient Positioning Module. This Module may describe subsequent changes in position between steps of the protocol.

Equipment preparation instructions would typically be limited to phantom imaging or other calibration procedures related to the individual patient scan. Phantom Imaging and/or Calibration to be performed as general QA/qualification (i.e., not associated with the individual patient scan) shall not be described in this Module.

Activities that are associated with the protocol but which are not typically performed in the scanning room, such as the need to obtain creatinine values within 7 days before performing the Protocol, or to premedicate the patient with Benadryl 1 hour before performing the Protocol, are described in the Protocol Planning Information (0018,990F) rather than in this Module.

C.34.8 Patient Positioning Module

Table C.34.8-1 contains details about the positioning of the patient before and during the imaging procedure.

Table C.34.8-1. Patient Positioning Module Attributes

Attribute Name	Tag	Type	Attribute Description
Protocol Defined Patient Position	(0018,9947)	1	Patient position relative to the equipment described by the procedure protocol. See Section C.7.3.1.1.2 for Defined Terms and further explanation.
Patient Positioning Instruction Sequence	(0018,991B)	3	Instructions for positioning and aligning the patient for the procedure. E.g., aligning an anatomical landmark with laser crosshairs. One or more Items are permitted in this Sequence. The precise correlation between positioning and scan elements is to be described in the Instruction Text if necessary.
>Instruction Index	(0018,9915)	1	Identifies the order in which instruction Sequence Items are presented/performed. The value shall be an integer, increasing monotonically by 1, starting from 1.
>Instruction Text	(0018,9916)	1	A displayable string explaining what should be done.
>Instruction Description	(0018,9917)	3	A detailed description explaining what should be done.
>Instruction Performed Flag	(0018,9918)	1C	Whether or not this instruction was performed. Required if the value of SOP Class UID (0008,0016) equals 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage). Enumerated Values: **YES** **NO**
>Instruction Performed Datetime	(0018,9919)	1C	Date and time the instruction was performed. Required if Instruction Performed Flag (0018,9918) is present with a value of YES.
Positioning Method Code Sequence	(0018,991C)	3	Identifies the method for positioning the patient. Only a single Item shall be included in this Sequence. See Section C.34.8.1.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 1015 “Patient Alignment Methods”.*

Attribute Name	Tag	Type	Attribute Description
Positioning Landmark Sequence	(0018,991D)	3	A coded location identifying the intended landmark used as the basis for positioning. Only a single Item is permitted in this Sequence. See Section C.34.8.1.
>Include Table 10.27-1 "Reference Location Macro Attributes"			*BCID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)* *BCID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)*
Target Frame of Reference UID	(0018,991E)	3	UID of the Frame of Reference of another ~~dataset~~data set to which the current procedure is intended to be roughly aligned. Note 1. For example, in a performed protocol it may be useful to record the Frame of Reference UID used in a prior Study that was used as a reference. 2. The Frame of Reference UID (0020,0052) in the Image Instances resulting from the performance of this protocol will likely be different than this Target Frame of Reference UID since perfect alignment is likely unachievable.
Target Position Reference Indicator	(0020,103F)	3	Position Reference Indicator for the Target Frame of Reference UID (0018,991E). See Section C.34.8.1.
Anatomic Region Sequence	(0008,2218)	2	Identifies the general anatomic region imaged by the Protocol. See Section C.34.8.2. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 4031 "Common Anatomic Regions".*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this Instance. See Section C.34.8.2. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 2 "Anatomic Modifier".*
Primary Anatomic Structure Sequence	(0008,2228)	2	Identifies the primary anatomic structure(s) of interest in this Protocol. Zero or more Items shall be included in this Sequence.
~~*>Include* Table 8.8-1 "Code Sequence Macro Attributes"~~			
>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID* 8134 "Anatomic Structures".
>Primary Anatomic Structure Modifier Sequence	(0008,2230)	3	Sequence of Items that modifies the primary anatomic structure of interest in this Instance. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 2 "Anatomic Modifier".*

C.34.8.1 Positioning Targets

The specific method by which the referenced localizer images, photos of patient skin marks, landmarks, or frames of reference are used to position the patient, is communicated by referencing the associated code in the Positioning Method Code Sequence (0018,991C).

C.34.8.2 Anatomic Region & Primary Anatomic Structure

Primary Anatomic Structure Sequence (0008,2228) shall identify the specific organ or structure that is the focus of the procedure described by the Protocol and will generally correlate with the Reason for Study and the Procedure Code. Anatomic Region Sequence (0008,2218) shall identify the region of the body spanned by the images produced by the Protocol. For example, a Protocol might identify the Primary Anatomic Structure as "liver" and the Anatomic Region as "abdomen".

The contents of the Anatomic Region Sequence (0008,2218) is not necessarily a precise description of the full extent of the scan or the reconstructed slices. "Chest" may refer to a scan that spans only part of the chest, the whole chest, or includes parts of regions beyond the chest. For a more precise description of the extent of the acquisition or reconstructed slices, refer to the Acquisition Start Location Sequence (0018,9931) and Acquisition End Location Sequence (0018,9932) or the Reconstruction Start Location Sequence (0018,993B) and Reconstruction End Location Sequence (0018,993C).

For Protocols that could be used in a variety of anatomic regions, such as one designed for a certain type of metastasis or biopsy, the Primary Anatomic Structure Sequence might contain a generic code like (49755003, SCT, "Morphologically abnormal structure") and the Anatomic Region Sequence may be empty in the (non-patient-specific) Defined Protocol, but could be populated in the Performed Protocol. In such cases, the Protocol Context Module may describe a list of anatomic regions for which the Protocol is intended/appropriate.

Note

It is expected that the modality will migrate these codes, as appropriate, into the resulting images to facilitate the selection of hanging protocols and report templates appropriate to the primary anatomic structure or future searches for anatomically relevant priors.

C.34.9 Defined CT Acquisition Module

Table C.34.9-1 contains a specification of acceptable values and ranges of acquisition parameters for an imaging procedure.

Table C.34.9-1. Defined CT Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Protocol Element Specification Sequence	(0018,991F)	1	Specification of the acquisition parameters for acquisition protocol elements in an imaging procedure. There shall be one Item in this Sequence for each Acquisition Protocol Element in the Protocol. See Section C.34.9.1. One or more Items shall be included in this Sequence.
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Acquisition Protocol Element being specified in this Item.
>Parameters Specification Sequence	(0018,9913)	3	Constraints on one or more acquisition parameters. One or more Items are permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Include Table 10.25-1 "Attribute Value Constraint Macro Attributes"			Only Attributes defined in Table C.34.10-1 (i.e., in the Acquisition Protocol Element Sequence (0018,9920) in the Performed CT Acquisition Module) and Private Data Elements associated with this acquisition protocol element may be specified as Selector Attributes. The semantics of values of Constraint Violation Significance (0082,0036) in the Macro are assigned in Section C.34.9.3. The same Attribute shall not appear in more than one Item in the Sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).
>>Modifiable Constraint Flag	(0082,0038)	1C	Specifies whether this constraint may be encoded in a derived Instance with a different value. See Section C.34.9.4. Enumerated Values: **YES** The constraint may be modified. **NO** The constraint may not be modified. Required if the constraint may not be modified, may be present otherwise.

Note

The Performed CT Acquisition Module in the CT Performed Procedure Protocol will generally be "fully populated". The Defined CT Acquisition Module in the CT Defined Procedure Protocol Object may be "sparsely populated" (i.e., contains only the Attributes the system that is specifying the protocol "cares about").

Attributes that might commonly be specified here include:

- KVP (0018,0060)
- X-Ray Tube Current in mA (0018,9330)
- Revolution Time (0018,9305)
- Single Collimation Width (0018,9306)
- Total Collimation Width (0018,9307)
- Spiral Pitch Factor (0018,9311)
- Exposure Modulation Type (0018,9323)
- CTDIvol Notification Trigger (0018,9942) (See Section C.34.9.2)
- DLP Notification Trigger (0018,9943)
- CTDIvol (0018,9345)

C.34.9.1 Acquisition Protocol Elements

A CT Protocol usually includes more than one Acquisition Protocol Element. For example, a chest Protocol might include three elements in total: two localizer CT radiographs (AP and Lateral), and a single helical scan.

Since all parameters will be nested inside an Acquisition Protocol Element Sequence (0018,9920) and some of the parameters will be further nested inside a CT X-Ray Details Sequence (0018,9325), close attention must be paid to the use of the Selector Sequence Pointer (0072,0052) in the Attribute Value Constraint Macro. Illustrative examples are provided in Table C.34.9-2.

Table C.34.9-2. Example Usage of Selector Macro Attributes for Acquisition Constraints

Example	Selector Attribute (0072,0026)	Selector Value Number (0072,0028)	Selector Sequence Pointer (0072,0052)	Selector Sequence Pointer Items (0074,1057)	Example Constraint
Constrain the value of Element Name (0018,9922) of the first Item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9922)	1	(0018,9920)	1	EQUAL"Localizer (AP) "
Constrain the value of Table Speed (0018,9309) of the second Item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9309)	1	(0018,9920)	2	EQUAL14 mm/sec
Constrain the value of KVP (0018,0060) of the first beam in the CT X-Ray Details Sequence (0018,9325) of the second Item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,0060)	1	(0018,9920), (0018,9325)	2\1	RANGE_INCL(120,140)
Constrain the first and second value of Exposure Modulation Type (0018,9323) of the second beam in the CT X-Ray Details Sequence (0018,9325) of the third Item in the Acquisition Protocol Element Sequence (0018,9920)	(0018,9323)	1	(0018,9920), (0018,9325)	3\2	EQUAL"ANGULAR"
	(0018,9323)	2	(0018,9920), (0018,9325)	3\2	EQUAL"ORGAN_BASED"

C.34.9.2 Dose Related Attributes in Parameter Specification Sequence

If CTDIvol Notification Trigger (0018,9942) or DLP Notification Trigger (0018,9943) are present in a parameter specification for an Acquisition Protocol Element, each is intended to communicate a Dose Check (NEMA XR-25-2010) threshold value associated with that Acquisition Protocol Element. As such, a Constraint Type (0082,0032) of EQUAL would be the most appropriate.

If CTDIvol (0018,9345) is present in a parameter specification for an Acquisition Protocol Element, the value is intended to communicate an estimate of the CTDIvol for that Acquisition Protocol Element. It is expected that the value would either be a single CTDIvol that represents a typical value given the parameter constraints and defaults provided, or a range that represents the expected value range if the parameters are varied within the defined constraints. The value of CTDIvol is not itself a constraint on the execution of the Protocol, but rather an estimate to help the radiologist, technologist and/or physicist when reviewing and managing sets of Protocols. Constraints and associated behaviors are provided by the CTDIvol Notification Trigger, the DLP Notification Trigger and the NEMA XR-25 Dose Check standard.

Note

It should be recognized that the formulae and methods used by any given scanner model to estimate CTDIvol may evolve over time. When such changes occur, devices that generate CT Defined Procedure Protocol Instances, are advised to generate new Instances using the revised estimation methods.

C.34.9.3 Attribute Value Constraint Macro

The CT Defined Procedure Protocol SOP Class assigns the following significance to the values of Constraint Violation Significance (0082,0036) :

- FAILURE - Violating the constraint is a violation of the Protocol and requires supervisory permission and auditing.
- WARNING - Violating the constraint is a violation of the Protocol and requires operator confirmation and auditing.
- INFORMATIVE - Violating the constraint is not a violation of the Protocol. The constraint represents a guideline. Violation of the guideline may be recorded or shown to the operator.

If the Attribute is absent, a value of INFORMATIVE may be assumed.

C.34.9.4 Modifiable Constraint Flag

New protocol Instances derived from original protocol Instances with different constraints on a given Attribute "modify" the constraint. This flag may be used by devices that create original Instances to specify which constraints can be modified by other devices in derived Instances.

For example, a CT device that creates a Defined Procedure Protocol, may indicate that the Element Name (0018,9922) of the Acquisition Protocol Element, or the CTDIvol Notification Trigger (0018,9942) constraints may be modified, but the Spiral Pitch Factor (0018,9311) constraint may not since the latter depends on correlated changes by the device to other Attributes. Such information would be useful to a protocol management workstation that is letting its operator make changes to the CTDIvol Notification Trigger.

Note

There is a difference between these "derivation" modifications and what an operator does at the time of protocol execution. At execution time, the operator is using the CT device to change Selector Attribute values and those values are compared to the Constraint Values in the Constraint Macro of the Defined Protocol. The result may (or may not be) stored in a Performed Procedure Protocol Instance. At derivation time, an operator is using a workstation to change Constraint Values in the Constraint Macro and store a new Defined Procedure Protocol Instance.

C.34.10 Performed CT Acquisition Module

This Module contains acquisition parameter values for a performed CT imaging procedure. The purpose of this Module is to record all relevant parameters, not just to record the values that were constrained in the executed Defined Protocol (if any).

This Module contains Attributes that are "set" on the machine, e.g., to affect its behavior, but not those that describe the results. The latter may be found in the reconstructed images.

Table C.34.10-1. Performed CT Acquisition Module Attributes

Attribute Name	Tag	Type	Attribute Description
Acquisition Protocol Element Sequence	(0018,9920)	2	Parameter values for each Protocol Element in the acquisition protocol. Each Item in the Sequence describes one Element. Elements are performed in the order of their Protocol Element Number (0018,9921). See Section C.34.9.1. Zero or more Items shall be included in this Sequence.
>Include Table 10.28-1 “Protocol Element Identification Macro Attributes”			
>Acquisition Type	(0018,9302)	1	Description of the method used during acquisition. See Section C.8.15.3.2.1 for Defined Terms.
>Tube Angle	(0018,9303)	1C	The constant angle at which the X-Ray source is located during acquisition. 0 degrees means that the source is located at the highest point of the gantry orbit. Degrees increase from 0 to positive 360 in a clockwise direction as viewed when facing the gantry where the table enters the gantry. Required if Acquisition Type (0018,9302) is CONSTANT_ANGLE.

Attribute Name	Tag	Type	Attribute Description
>Constant Volume Flag	(0018,9333)	1	Identifies that the acquisition was performed by repetitively acquiring the same volume set over a period of time. Note The Acquisition Type (0018,9302) value may be SEQUENCED, SPIRAL or STATIONARY depending on whether table movement is necessary to cover the volume. Enumerated Values: **YES** **NO**
>Fluoroscopy Flag	(0018,9334)	1	Identifies that near real-time display of a block of continuously acquired data was performed. Enumerated Values: **YES** **NO**
>Revolution Time	(0018,9305)	1C	The time in seconds of a complete revolution of the source around the gantry orbit. This value is independent of the Reconstruction Angle (0018,9319) of the frame. Required if Acquisition Type (0018,9302) is other than CONSTANT_ANGLE.
>Single Collimation Width	(0018,9306)	1	The width of a single row of acquired data (in mm). Note Adjacent physical detector rows may have been combined to form a single effective acquisition row.
>Total Collimation Width	(0018,9307)	1	The width of the total collimation (in mm) over the area of active X-Ray detection. Note This will be equal to the number of effective detector rows multiplied by single collimation width.
>Table Height	(0018,1130)	1	The distance in mm from the top of the patient table to the center of rotation of the source (i.e., the data collection center or isocenter). The distance is positive when the table is below the data collection center.
>Gantry/Detector Tilt	(0018,1120)	1	Nominal angle of tilt in degrees of the scanning gantry. Not intended for mathematical computations. Zero degrees means the gantry is not tilted, negative degrees are when the top of the gantry is tilted away from where the table enters the gantry.
>Table Speed	(0018,9309)	1	The distance in mm that the table moves in one second during the gathering of data.
>Table Feed per Rotation	(0018,9310)	1	Motion of the table (in mm) during a complete revolution of the source around the gantry orbit.
>Spiral Pitch Factor	(0018,9311)	1	Ratio of the Table Feed per Rotation (0018,9310) to the Total Collimation Width (0018,9307).

Attribute Name	Tag	Type	Attribute Description
>CTDIvol	(0018,9345)	1C	Computed Tomography Dose Index ($CTDI_{vol}$~~)~~), in mGy according to [IEC 60601-2-44]~~ (Clause 29.1.103.4), The Volume~~. The $CTDI_{vol}$ ~~CTDI~~describes ~~vol~~the average CTDIvol for this Acquisition Protocol Element for the selected CT conditions of operation. ~~It describes the average CTDIvol for this AcquisitionProtocol Element for the selected CT conditions of operation.~~ Required if Acquisition Type (0018,9302) is not CONSTANT_ANGLE. May be present otherwise.
>CTDI Phantom Type Code Sequence	(0018,9346)	1C	The type of phantom used for CTDI measurement according to [IEC 60601-2-44]. Required if CTDIvol (0018,9345) is present. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Defined CID 4052 "Phantom Devices".*
>CTDIvol Notification Trigger	(0018,9942)	3	The threshold for the CTDIvol value, in mGy, at which a dose notification is triggered for this Acquisition Protocol Element. See Section C.34.10.2.
>DLP Notification Trigger	(0018,9943)	3	The threshold for the DLP value, in mGy.cm, at which a dose notification is triggered for this Acquisition Protocol Element. See Section C.34.10.2.
>Acquisition Motion	(0018,9930)	1	Motion of scan progression. See Section C.34.10.1. Defined Terms: **SINGLE** Scan progresses in a single pass from Acquisition Start Location to Acquisition End Location. **SHUTTLE** Scan progresses from Acquisition Start Location to Acquisition End Location, then reverses direction and scans back to Acquisition Start Location. **NO_MOTION** All slices are acquired simultaneously. **NOT_IMPORTANT** ~~Acan~~Scan either direction is acceptable. The value of NOT_IMPORTANT is not permitted in the Performed Procedure Protocol IOD.
>Acquisition Start Location Sequence	(0018,9931)	3	Anatomically oriented transverse location where this acquisition starts. Note 1. This represents the nominal start location. Due to overscan, tissue may be irradiated beyond this location. 2. In a Defined Procedure Protocol, this represents the intended start location. The operator may or may not select a location that exactly matches this anatomical location. 3. In a Performed Procedure Protocol, this value may have been copied from the Defined Procedure Protocol and may not represent the exact anatomical location selected by the operator. Only a single Item is permitted in the Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Include Table 10.27-1 "Reference Location Macro Attributes"			*BCID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)* *BCID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)*
>Acquisition End Location Sequence	(0018,9932)	3	Anatomically oriented transverse location where this acquisition ends. Note 1. This represents the nominal end location. Due to overscan, tissue may be irradiated beyond this location. 2. In a Defined Procedure Protocol, this represents the intended end location. The operator may or may not select a location that exactly matches this anatomical location. 3. In a Performed Procedure Protocol, this value may have been copied from the Defined Procedure Protocol and may not represent the exact anatomical location selected by the operator. Only a single Item is permitted in the Sequence.
>>Include Table 10.27-1 "Reference Location Macro Attributes"			*BCID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)* *BCID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)*
>CT X-Ray Details Sequence	(0018,9325)	1	Parameter values for each of the X-Ray beams in the Acquisition Protocol Element. Each Item in the Sequence describes one X-Ray beam. See Section C.34.10.3. One or more Items shall be included in this Sequence.
>>Beam Number	(300A,00C0)	1	Identification number of the beam.
>>KVP	(0018,0060)	1	Peak kilo voltage output of the X-Ray generator.
>>Exposure Time in ms	(0018,9328)	1	Duration of exposure for this Acquisition Protocol Element in milliseconds. If Acquisition Type (0018,9302) equals SPIRAL the duration of exposure shall be weighted by the Spiral Pitch Factor (0018,9311).
>>X-Ray Tube Current in mA	(0018,9330)	1	Nominal X-Ray tube current in milliamperes.
>>Exposure in mAs	(0018,9332)	1	The exposure expressed in milliampere seconds, for example calculated from exposure time and X-Ray tube current.
>>Auto KVP Selection Type	(0018,9944)	1	The type of automated selection of the kVp value. Defined Terms: **NONE** Value is not selected automatically. **CNR_BASED** Value is selected based on Contrast to Noise Ratio. **DIAMETER_BASED** Value is selected based on patient diameter.

Attribute Name	Tag	Type	Attribute Description
>>Auto KVP Upper Bound	(0018,9945)	3	Upper limit on the value of the auto-selected kVp. Note Constraints on KVP (0018,0060) represent constraints on the nominal KVP for the scan. Auto KVP Upper Bound (0018,9945) represents a direct constraint on the range of values that may be produced by the automated selection of the kVp value.
>>Auto KVP Lower Bound	(0018,9946)	3	Lower limit on the value of the auto-selected kVp. Note Constraints on KVP (0018,0060) represent constraints on the nominal KVP for the scan. Auto KVP Lower Bound (0018,9946) represents a direct constraint on the range of values that may be produced by the automated selection of the kVp value.
>>Exposure Modulation Type	(0018,9323)	1	A multi-valued label describing the type of current modulation used for the purpose of limiting the dose. Defined Terms: **NONE** **ANGULAR** Current is modulated over different tube angles. **LONGITUDINAL** Current is modulated along the axis of the table. **ECG_BASED** Current is modulated based on the cardiac phase. **ORGAN_BASED** Current is modulated based on the organs in the field of view.
>>Focal Spot(s)	(0018,1190)	1	Used nominal size of the focal spot in mm. The Attribute may only have one or two values, for devices with variable focal spot, small dimension followed by large dimension.
>>Data Collection Diameter	(0018,0090)	1	The diameter in mm of the region over which data were collected. See Section C.8.15.3.6.1. Note In the case of an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the diameter is that in a plane normal to the central ray of the diverging X-Ray beam as it passes through the data collection center.
>>Filter Type	(0018,1160)	1	Type of filter(s) inserted into the X-Ray beam. Defined Terms: **NONE** **WEDGE** **BUTTERFLY** **STRIP** **MULTIPLE** **BOWTIE** Note Multiple filters can be expressed by a combination of terms, e.g., BUTTERFLY+WEDGE.…

Attribute Name	Tag	Type	Attribute Description
>>Cardiac Synchronization Technique	(0018,9037)	1	Cardiac synchronization technique applied during acquisition or processing. Enumerated Values: **NONE** **REALTIME** **PROSPECTIVE** **RETROSPECTIVE** **PACED** See Section C.7.6.18.1.
>>Cardiac Signal Source	(0018,9085)	1C	Source of cardiac synchronization signal. Defined Terms: **ECG** Electrocardiogram. **VCG** Vector cardiogram. **PP** Peripheral pulse. Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE.
>>Cardiac RR Interval Specified	(0018,9070)	1C	R-R interval in ms measured prior to or during the scan. Required if Cardiac Synchronization Technique (0018,9037) equals other than NONE.
>>Cardiac Beat Rejection Technique	(0018,9169)	1C	Cardiac arrhythmia rejection technique. Defined Terms: **NONE** **RR_INTERVAL** Rejection based on deviation from average RR interval. **QRS_LOOP** Rejection based on deviation from regular QRS loop. **PVC** Rejection based on PVC criteria. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
>>Low R-R Value	(0018,1081)	2C	R-R interval low limit for beat rejection, in ms. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
>>High R-R Value	(0018,1082)	2C	R-R interval high limit for beat rejection, in ms. Required if Cardiac Synchronization Technique (0018,9037) equals PROSPECTIVE or RETROSPECTIVE.
>>Skip Beats	(0018,1086)	3	Number of beats prescribed to be skipped after each detected arrhythmia.
>>Cardiac Framing Type	(0018,1064)	1C	Type of framing performed. See Section C.7.6.18.1.1.1 for description and Defined Terms. Required if type of framing is not time forward from trigger, may be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>>Respiratory Motion Compensation Technique	(0018,9170)	1	Technique to reduce respiratory motion artifacts. Defined Terms: **NONE** **BREATH_HOLD** **REALTIME** **GATING** **TRACKING** **RETROSPECTIVE** **CORRECTION** See Section C.7.6.18.2.
>>Respiratory Signal Source	(0018,9171)	1C	Signal source from which respiratory motion is derived. Defined Terms: **NONE** **BELT** **NASAL_PROBE** **CO2_SENSOR** **ECG** Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE or BREATH_HOLD. May be present otherwise.
>>Respiratory Trigger Delay Threshold	(0020,9256)	1C	Respiratory trigger threshold in percent of the chest expansion for the frame relative to the last Respiratory-Peak. See Section C.7.6.16.2.17.1 for further explanation. Required if Respiratory Motion Compensation Technique (0018,9170) equals other than NONE, REALTIME or BREATH_HOLD. May be present otherwise.
>>Respiratory Trigger Type	(0020,9250)	1C	Characteristic of the respiratory signal used to the define the respiratory triggering. Defined Terms: **TIME** **AMPLITUDE** **BOTH** Required if the value is not TIME. May be present otherwise.
>Requested Series Description	(0018,9937)	3	Requested text to copy into the Series Description(0008,103E) of raw Instances resulting from this Acquisition Protocol Element.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of Instances resulting from this Acquisition Protocol Element. Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.34.12.1.

C.34.10.1 Acquisition Motion

The motion, in patient terms, during acquisition progression. For example, due to the direction of contrast ~~propogation~~propagation or the need to manage equipment connected to the patient, it may be helpful to specify the acquisition progress in the expected direction of contrast ~~propogation~~propagation.

A scan that shuttles back and forth can be encoded as multiple elements and each specifies the Start Location and the End Location. Alternatively, a scanner may provide the ability to shuttle in a single scan element, in which case this value indicates the initial direction of motion and further details about the shuttling are likely contained in Private Attributes.

C.34.10.2 Dose Notification Triggers

The ~~Computed Tomography~~NEMA Dose Check Standard ~~(~~[NEMA XR-25]~~NEMA XR-25 athttp://www.nema.org/stds/xr25.cfm)~~ specifies that a Notification Value may be set for the Computed Tomography Dose Index (CTDIvol) and/or the Dose Length Product (DLP) of each Protocol Element. A Dose Check Protocol Element corresponds to an Acquisition Protocol Element in this IOD.

C.34.10.3 CT X-Ray Details Sequence

Some systems perform Acquisition Protocol Elements with multiple tubes operating simultaneously, or with a tube switching back and forth between two energy settings. Such acquisitions are encoded with multiple Items in this Sequence.

C.34.11 Defined CT Reconstruction Module

Table C.34.11-1 contains specification of acceptable values and ranges of reconstruction parameters for an imaging procedure.

Table C.34.11-1. Defined CT Reconstruction Module Attributes

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element Specification Sequence	(0018,9933)	1	Specification of the parameters for reconstruction of the acquired data of an imaging procedure. There shall be one Item in this Sequence for each reconstruction protocol element in the Protocol. See Section C.34.11.1. One or more Items shall be included in this Sequence.
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Reconstruction Protocol Element being specified in this Item.
>Parameters Specification Sequence	(0018,9913)	3	Constraints on reconstruction parameters. One or more Items are permitted in this Sequence.
>>Include Table 10.25-1 "Attribute Value Constraint Macro Attributes"			Only Attributes defined in Table C.34.12-1 (i.e., in the Reconstruction Protocol Element Sequence (0018,9934) in the Performed CT Reconstruction Module) and Private Data Elements associated with this reconstruction protocol element may be specified as Selector Attributes. The semantics of values of Constraint Violation Significance (0082,0036) in the Macro are assigned in Section C.34.9.3. The same Attribute shall not appear in more than one Item in the Sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).

Attribute Name	Tag	Type	Attribute Description
>>Modifiable Constraint Flag	(0082,0038)	1C	Whether this constraint may be encoded in a derived Instance with a different value. See Section C.34.9.4. Required if the constraint may not be modified, may be present otherwise. Enumerated Values: **YES** The constraint may be modified. **NO** The constraint may not be modified.

Attributes that might commonly be specified here include:

- Reconstruction Algorithm (0018,9315)
- Convolution Kernel (0018,1210)
- Reconstruction Diameter (0018,1100)
- Slice Thickness (0018,0050)
- Pixel Spacing (0028,0030)

C.34.11.1 Reconstruction Protocol Elements

A CT Protocol frequently specifies multiple reconstructions. For example, a single helical Acquisition Protocol Element may be reconstructed once as thin slices and a second time as thick slices.

C.34.12 Performed CT Reconstruction Module

This Module contains reconstruction parameter values for a performed CT imaging procedure.

This Module contains Attributes that affect machine behavior but not those that are merely descriptive. The latter may be found in the reconstructed images.

Table C.34.12-1. Performed CT Reconstruction Module Attributes

Attribute Name	Tag	Type	Attribute Description
Reconstruction Protocol Element Sequence	(0018,9934)	1	Parameter values for each reconstruction protocol element in the Protocol. See Section C.34.11.1. Elements are performed in the order of their Protocol Element Number (0018,9921). One or more Items shall be included in this Sequence.
>Include Table 10.28-1 "Protocol Element Identification Macro Attributes"			
>Source Acquisition Protocol Element Number	(0018,9938)	1	A value corresponding to the Protocol Element Number (0018,9921) of the Acquisition Protocol Element from this Protocol being reconstructed in this reconstruction protocol element. This may be multi-valued if multiple acquisitions are combined in a single reconstruction protocol element.
>Source Acquisition Beam Number	(0018,9939)	1	One or more values corresponding to the Beam Number (300A,00C0) in the Acquisition Protocol Element (specified in Source Acquisition Protocol Element Number (0018,9938)) from which data was used in this reconstruction protocol element.

Attribute Name	Tag	Type	Attribute Description
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if the referenced acquisition protocol element is not in this Instance. Shall have a value of 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage).
>Referenced SOP Instance UID	(0008,1155)	1C	The UID of the Instance containing the acquisition protocol element referenced in Source Acquisition Protocol Element Number (0018,9938). Required if the referenced acquisition protocol element is not in this Instance.
>Reconstruction Start Location Sequence	(0018,993B)	1	Anatomically oriented transverse location where this reconstruction starts. Note 1. This represents the start of the data used in the reconstruction, not necessarily the slice location of the first reconstructed slice. 2. This represents the intended start location. The operator may or may not have selected a location that exactly matches this anatomical location. 3. In the case where an anatomical reference basis cannot be determined or derived from the Defined Protocol Instance, for example when an ad hoc reconstruction is being performed, the implementation may use the acquired volume (128160, DCM, "Acquired Volume") as the reference basis with an appropriate offset. Only a single Item is permitted in the Sequence.
>>Include Table 10.27-1 “Reference Location Macro Attributes”			*BCID 1000 “CT Transverse Plane Reference Basis” for Reference Basis Code Sequence (0018,9902)* *BCID 1010 “Reference Geometry - Planes” for Reference Geometry Code Sequence (0018,9903)*

Attribute Name	Tag	Type	Attribute Description
>Reconstruction End Location Sequence	(0018,993C)	1	Anatomically oriented transverse location where this reconstruction ends. Note 1. This represents the end of the data used in the reconstruction, not necessarily the slice location of the last reconstructed slice. 2. This represents the intended end location. The operator may or may not have selected a location that exactly matches this anatomical location. 3. In the case where an anatomical reference basis cannot be determined or borrowed from the Defined Protocol Instance, for example when an ad hoc reconstruction is being performed, the implementation may use the acquired volume (128160, DCM, "Acquired Volume") as the reference basis with an appropriate offset. Only a single Item is permitted in the Sequence.
>>Include Table 10.27-1 “Reference Location Macro Attributes”			*BCID 1000 “CT Transverse Plane Reference Basis” for Reference Basis Code Sequence (0018,9902)* *BCID 1010 “Reference Geometry - Planes” for Reference Geometry Code Sequence (0018,9903)*
>Reconstruction Algorithm Sequence	(0018,993D)	3	Algorithm used in this reconstruction protocol element. Only a single Item is permitted in the Sequence.
>>Include Table 10-19 “Algorithm Identification Macro Attributes”			*BCID 10033 “CT Reconstruction Algorithm” for Algorithm Family Code Sequence (0066,002F)*
>Convolution Kernel	(0018,1210)	1	A label describing the convolution kernel or algorithm used to reconstruct the data. A single value shall be present.
>Convolution Kernel Group	(0018,9316)	1	A label describing the group that the Convolution Kernel (0018,1210) belongs. Defined Terms: **BRAIN** **SOFT_TISSUE** **LUNG** **BONE** **CONSTANT_ANGLE**
>Reconstruction Diameter	(0018,1100)	1C	The diameter in mm of the region from which data were used in creating the reconstruction of the image. Data may exist outside this region and portions of the patient may exist outside this region. See Section C.8.15.3.6.1. Required if Reconstruction Field of View (0018,9317) is not present.
>Reconstruction Field of View	(0018,9317)	1C	The field of view width (x-dimension) followed by height (y-dimension) as used for reconstruction in mm. Required if Reconstruction Diameter (0018,1100) is not present.

Attribute Name	Tag	Type	Attribute Description
>Reconstruction Target Center (Patient)	(0018,9318)	3	The x, y, and z coordinates (in the Patient-Based Coordinate System) of the reconstruction center target point as used for reconstruction in mm. See Section C.8.15.3.6.1. Note If the reconstructed image is not magnified or panned the value corresponds with the Data Collection Center (0018,9313) Attribute.
>Reconstruction Target Center Location Sequence	(0018,993E)	3	An anatomically based description of a point in the patient used as the reconstruction center target point. Note This represents the intended reconstruction center location. They operator may or may not select a location that exactly matches this anatomical location.
>>Include Table 10.27-1 "Reference Location Macro Attributes"			*BCID 1000 "CT Transverse Plane Reference Basis" for Reference Basis Code Sequence (0018,9902)* *BCID 1010 "Reference Geometry - Planes" for Reference Geometry Code Sequence (0018,9903)*
>Reconstruction Pixel Spacing	(0018,9322)	1	Physical distance in the patient between the center of each reconstructed pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order.
>Rows	(0028,0010)	1	Number of rows in the reconstructed image.
>Columns	(0028,0011)	1	Number of columns in the reconstructed image.
>Reconstruction Angle	(0018,9319)	1	Angle (in degrees) over which the data from which the frame was reconstructed was collected.
>Image Filter	(0018,9320)	3	A label describing the filter applied to the reconstructed image after the original reconstruction has been completed.
>Image Filter Description	(0018,9941)	3	A description of the nature or effect of the Image Filter (0018,9320). E.g., sharpening, noise removing, edge enhancing.
>Derivation Code Sequence	(0008,9215)	3	Additional processing applied to the reconstructed image after image filter (if any)
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			
>Slice Thickness	(0018,0050)	1	Nominal reconstructed slice thickness, in mm.
>Spacing Between Slices	(0018,0088)	1	Spacing between slices, in mm. The spacing is measured from the center-to-center of each slice. Note Slice overlap may be constrained implicitly by constraining the Slice Thickness (0018,0050) and Spacing Between Slices (0018,0088). However, since each constraint is considered independently, the overlap may be any value resulting from the combination of allowable values for thickness and spacing.
>Window Center	(0028,1050)	3	Preferred value for Window Center (0028,1050) in the Image Instances produced by this reconstruction protocol element.
>Window Width	(0028,1051)	3	Preferred value for Window Width (0028,1051) in the Image Instances produced by this reconstruction protocol element.

Attribute Name	Tag	Type	Attribute Description
>Requested Series Description	(0018,9937)	3	Requested text to copy into the Series Description (0008,103E) of the images resulting from this reconstruction protocol element.
>Content Qualification	(0018,9004)	3	Content Qualification Indicator of Instances resulting from this Reconstruction Protocol Element. Enumerated Values: **PRODUCT** **RESEARCH** **SERVICE** See Section C.34.12.1.

C.34.12.1 Content Qualification

Content Qualification (0018,9004), if present, specifies the value to be copied into reconstructed Instances. For details on the meaning of this Attribute in those Instances, see section C.8.13.2.1.1.

This Attribute does not describe the content qualification of the protocol itself.

C.34.13 Defined Storage Module

Table C.34.13-1 contains specification of acceptable values and ranges of storage parameters for an imaging procedure. Storage protocol elements may be used to automatically send the output of particular protocol elements to particular destinations. For example, a lung protocol might send thick images to PACS for reading and thin images to a CAD workstation for detection of nodules; a cardiac protocol might send an image set to a clinical analysis workstation; and a protocol used for pre-operative hip replacement planning might send images to the orthopedics department.

Table C.34.13-1. Defined Storage Module Attributes

Attribute Name	Tag	Type	Attribute Description
Storage Protocol Element Specification Sequence	(0018,9935)	1	Specification of the parameters for storage of imaging data. There shall be one Item in this Sequence for each Storage Protocol Element. See Section C.34.13.1. One or more Items shall be included in this Sequence.
>Protocol Element Number	(0018,9921)	1	The Protocol Element Number of the Storage Protocol Element being specified in this Item.
>Parameters Specification Sequence	(0018,9913)	3	Constraints on storage parameters. One or more Items are permitted in this Sequence.
>>Include Table 10.25-1 “Attribute Value Constraint Macro Attributes”			Only Attributes defined in Table C.34.14-1 (i.e., in the Storage Protocol Element Sequence (0018,9936) in the Performed Storage Module) and Private Data Elements associated with this storage protocol element may be specified as Selector Attributes. The semantics of values of Constraint Violation Significance (0082,0036) in the Macro are assigned in Section C.34.9.3. The same Attribute shall not appear in more than one Item in the Sequence with the same values for Selector Sequence Pointer (0072,0052) and Selector Sequence Pointer Items (0074,1057).

Attribute Name	Tag	Type	Attribute Description
>>Modifiable Constraint Flag	(0082,0038)	1C	Whether this constraint may be encoded in a derived Instance with a different value. See Section C.34.9.4. Required if the constraint may not be modified, may be present otherwise. Enumerated Values: **YES** The constraint may be modified. **NO** The constraint may not be modified.

Attributes that might be specified here include:

- Source Reconstruction Protocol Element Number (0018,993A) of reconstructed slices that will be saved
- Source Acquisition Protocol Element Number (0018,9938) if raw data is to be stored
- Destination AE (2100,0140) where the images will be stored

C.34.13.1 Storage Protocol Elements

A CT Protocol frequently specifies multiple storage protocol elements. For example, thin slices may be transmitted to a 3D workstation, while raw data is stored on a local cache and thick slices are stored to PACS for reading.

C.34.14 Performed Storage Module

This Module contains storage parameter values for a performed imaging procedure.

Table C.34.14-1. Performed Storage Module Attributes

Attribute Name	Tag	Type	Attribute Description
Storage Protocol Element Sequence	(0018,9936)	1	Parameter values for each storage protocol element in the Protocol. The output Instances of the referenced Acquisition or Reconstruction Protocol Elements are stored to the location specified in the Output Information Sequence. See Section C.34.13.1. One or more Items shall be included in this Sequence. The performing system might not support the requested storage protocol or not be configured for the desired destination. Note Whether to report failure of one or more of the storage protocol elements as a failure of the protocol is at the discretion of the performing system. The performing system may, additionally or as a fallback, be configured to store output objects to a default destination or retain them locally.
>Include Table 10.28-1 “Protocol Element Identification Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Source Acquisition Protocol Element Number	(0018,9938)	1C	A value corresponding to the Element Number (0018,9921) of the Acquisition Protocol Element for which data is stored. Note Source Acquisition Protocol Element references are for storage of raw acquisition data. Reconstructed slice storage involves reference to the corresponding Reconstruction Protocol Element in the Source Reconstruction Protocol Element Number (0018,993A). This may be multi-valued if multiple acquisition protocol element data are being stored together. Required if Source Reconstruction Protocol Element Number (0018,993A) is not present.
>Source Reconstruction Protocol Element Number	(0018,993A)	1C	The Element Number (0018,9921) corresponding to the Reconstruction Protocol Element for which data is stored. This may be multi-valued if multiple reconstruction protocol element data are being stored together. Required if Source Acquisition Protocol Element Number (0018,9938) is not present.
>Source Acquisition Beam Number	(0018,9939)	1C	The Beam Number (300A,00C0) in the Acquisition Protocol Element (specified in Source Acquisition Protocol Element Number (0018,9938)) for which data is stored. Multiple values may be specified if data for multiple beams is being stored. Required if SOP Class UID (0008,0016) has a value of 1.2.840.10008.5.1.4.1.1.200.2 (CT Performed Procedure Protocol Storage) and Source Acquisition Protocol Element Number (0018,9938) is present and only some of the beams in the Acquisition Protocol Element are to be stored.
>Referenced SOP Class UID	(0008,1150)	1C	Uniquely identifies the referenced SOP Class. Required if the referenced acquisition or reconstruction protocol element is not in this Instance. Enumerated Value: **1.2.840.10008.5.1.4.1.1.200.2** CT Performed Procedure Protocol Storage
>Referenced SOP Instance UID	(0008,1155)	1C	The UID of the Protocol Instance containing the element referenced in Source Reconstruction Protocol Element Number (0018,993A) or Source Acquisition Protocol Element Number (0018,9938). Required if the referenced acquisition or reconstruction protocol element is not in this Instance.
>Output Information Sequence	(0040,4033)	1	References to acquired and reconstructed data objects stored as part of this storage protocol element. One or more Items shall be included in this Sequence. Note It is expected that the storage destinations for Radiation Dose SR Instances and Performed Protocol objects will be managed by direct configuration of the acquisition device rather than using this Sequence on a protocol by protocol basis.
>>Include Table 10-3c “Storage Macro Attributes”			

C.34.15 Protocol Approval Module

The Protocol Approval Module records approvals of the content of one or more SOP Instances containing protocols by a person or device.

An approval is modeled as a form of Assertion. The nature of the approval is defined by the Assertion Code in the embedded Assertion Macro.

Neither the Protocol Approval Module nor the underlying Assertion Macro address securing the approved Instance against tampering (e.g., via a digital hash) or authenticating the identity of the source of the Assertion.

Table C.34.15-1. Protocol Approval Module Attributes

Attribute Name	Tag	Type	Attribute Description
Approval Subject Sequence	(0044,0109)	1	Instances that are the subject of the Approval Sequence. All Assertions in the Approval Sequence (0044,0100) apply to all Instances in this Sequence. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Approval Sequence	(0044,0100)	1	Recorded approvals of the subject Instances. One or more Items shall be included in this Sequence.
>Include Table 10.30-1 “Assertion Macro Attributes”			*Assertion Code Sequence (0044,0101) BCID 800 “Protocol Assertion Codes”.* *The Approver is recorded in the Asserter Identification Sequence inside the Assertion Macro.*
>Institution Code Sequence	(0008,0082)	1C	Institution or organization for which use of the protocol is approved/disapproved or eligible/ineligible for reimbursement. Note The institution identified by the code can represent a hospital network, a hospital, a clinic or a department. An ~~institition~~institution can assign codes for it's subsidiary organizations. Required if Assertion Code Sequence (0044,0101) is (128603, DCM, "Approved for use at the institution") or (128623, DCM, "Disapproved for use at the institution") or (128613, DCM, "Eligible for reimbursement") or (128614, DCM, "Eligible for reimbursement on per patient basis") or (128615, DCM, "Ineligible for reimbursement").
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*No Baseline CID defined*
>Clinical Trial Protocol ID	(0012,0020)	1C	Identifier of the clinical trial protocol for which use of the protocol is approved or disapproved. Note For experimental use this Attribute is used to identify the experiment. Required if Assertion Code Sequence (0044,0101) is (128604, DCM, "Approved for use in the clinical trial") or (128624, DCM, "Disapproved for use in the clinical trial") or (128611, DCM, "Approved for experimental use") or (128612, DCM, "Disapproved for experimental use").

Note

The institution for which use of the protocol is approved (recorded in the Approval Sequence (0044,0100) Item) may or may not differ from the institution that is currently responsible for managing the protocol Instance (recorded in the Custodial Organization Sequence (0040,A07C) of the Defined Protocol Instance). Similarly, the clinical trial for which use of the protocol is approved (recorded in the Approval Sequence (0044,0100) Item) may or may not differ from the clinical trial, if any, for which the protocol Instance was originally designed (recorded in the Clinical Trial Context of the Defined Protocol Instance).

A number of the Assertion codes in CID 800 “Protocol Assertion Codes” affirm details related to Attributes in a Protocol object. The Protocol Attributes associated with each Assertion code are shown in Table C.34.15-2. A receiving system might display the associated Attribute contents together with the Assertion code to convey the full meaning of the Assertion.

Table C.34.15-2. Associated Attributes for Protocol Assertion Codes

Coding Scheme Designator	Code Value	Code Meaning	Associated Attribute
DCM	128601	Appropriate for the indications	Potential Reasons for Procedure Code Sequence (0018,9909)
DCM	128621	Inappropriate for the indications	Potential Reasons for Procedure Code Sequence (0018,9909)
DCM	128602	Consistent with labeling of the device	Model Specification Sequence (0018,9912)
DCM	128622	Inconsistent with labeling of the device	Model Specification Sequence (0018,9912)
DCM	128606	Appropriate for the device	Model Specification Sequence (0018,9912)
DCM	128618	Inappropriate for the device	Model Specification Sequence (0018,9912)
DCM	128607	Inside operational limits of the device	Model Specification Sequence (0018,9912)
DCM	128619	Outside operational limits of the device	Model Specification Sequence (0018,9912)
DCM	128608	Optimized for the device instance	Model Specification Sequence (0018,9912) Device Serial Number (0018,1000)
DCM	128620	Not optimized for the device instance	Model Specification Sequence (0018,9912) Device Serial Number (0018,1000)

Note

An Instance may contain multiple approvals. Receiving systems will determine which approvals apply and what may be useful to display to the system operator.

C.35 Manufacturing 3D Model Modules

C.35.1 Manufacturing 3D Model Module

Table C.35.1-1 defines Attributes specific to models used in medical 3D manufacturing.

Table C.35.1-1. Manufacturing 3D Model Module Attributes

Attribute Name	Tag	Type	Attribute Description
Measurement Units Code Sequence	(0040,08EA)	1	Units of distance for the coordinate system for the encapsulated 3D Manufacturing Model file. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 7063 “Model Scale Units”.*

Attribute Name	Tag	Type	Attribute Description
Model Modification	(0068,7001)	3	Specifies whether a modification of the observed anatomy (other than mirroring) was used to create the model (e.g. simulating an expected surgical result). In the negative, the model follows the observed patient anatomy in the source data. Enumerated Values: **YES** **NO**
Model Mirroring	(0068,7002)	3	Specifies whether mirroring of anatomy from the other side of the patient was used to create the model. Enumerated Values: **YES** **NO**
Model Usage Code Sequence	(0068,7003)	3	Specifies the use for which the manufactured object is intended. Only a single Item is permitted in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7064 “Model Usage”.*
Content Description	(0070,0081)	3	A description of the model.
Icon Image Sequence	(0088,0200)	3	A preview image representing the rendered model. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b “Image Pixel Macro Attributes”			*See Section C.7.6.1.1.6 for further explanation.*
Derivation Algorithm Sequence	(0022,1612)	3	Software algorithm that created the 3D model. Only a single Item shall be included in this Sequence.
>Include Table 10-19 “Algorithm Identification Macro Attributes”			
Model Group UID	(0068,7004)	3	Uniquely identifies a group to which the model belongs. Manufacturing models that share the same Model Group UID are considered distinct parts within the same assembly.
Recommended Display CIELab Value	(0062,000D)	3	Specifies the color recommended to be used for the model. This color applies both when digitally displaying the model and when selecting material for manufacturing. This would typically be used to visually distinguish between models that are part of the same assembly and/or provide best analog to real world appearance. The units are specified in PCS-Values, and the value is encoded as CIELab. This value may be superseded by individual colors that have been specified inside the encapsulated model (when the encapsulated format allows this). See Section C.10.7.1.1.

Attribute Name	Tag	Type	Attribute Description
Recommended Presentation Opacity	(0066,000C)	3	Specifies the opacity recommended to be used for the model. This opacity applies both when digitally displaying the model and when selecting material for manufacturing. A non-opaque value would typically be specified when either (a) another model grouped in the same assembly needs to be visible behind or inside this model, or (b) the model represents anatomy that is not fully opaque. If not present, then it is assumed the model should be presented and manufactured as opaque. See Section C.27.1.1.3.

C.36 RT Second Generation Modules

The following Attribute Macros and Modules are used by the RT Second Generation IODs.

C.36.1 RT Second Generation Concepts

This section ~~dicusses~~discusses general concepts used in RT Second Generation Modules.

Note

See also explanations in Section 7.14 “Extension of The DICOM Model of The Real-world for Radiotherapy Second Generation Information Objects” and in the IOD definitions in Section A.86.1.

C.36.1.1 RT Second Generation Radiation Concepts

C.36.1.1.1 Control Points

A Control Point represents the state of a delivery device in a sequence of states defined at a given Cumulative Meterset (300A,063C) value.

A Control Point contains geometric and radiological parameters. Control Points are used by the delivery device to implement a planned delivery and to record the actual delivery.

C.36.1.1.2 Nominal Energy

Nominal energy characterizes the penetration of the beam into a material. The values are defined by the manufacturer to label a specific beam spectrum. For photon beam delivery, the maximum energy of the delivered photon spectrum is typically used. For electron beam delivery, the most probable energy of the spectrum is typically used.

C.36.1.1.3 Meterset

A Meterset is a single parameter from which the absorbed dose delivered can be calculated through a calibration procedure with additional information. The Meterset is used to measure the progress of radiation delivery during treatment, or report on progress after treatment.

See [IEC 60601-2-64] for more information on using monitor units as the unit for the Meterset.

C.36.1.1.4 Radiation Dose Point

A point chosen in space, or in the patient treatment volume, to measure or plan for a specific amount of radiation. The point usually is placed at a significant location, such as within a tumor (where radiation will be delivered), or within healthy tissue (where radiation will be minimized) or where a measurement device can be positioned.

C.36.1.1.5 Continuous Rotation Angle

A Continuous Rotation Angle is an angle in the range (-∞,+∞).

Continuous Rotation Angle represent a rotation direction and magnitude. The magnitude is not limited to be between 0 and 360 degrees.

All rotations are defined in a right-handed coordinate system, thus the direction of a positive rotation is seen as clockwise when viewed in the positive direction of the axis of rotation.

C.36.1.1.6 External Contour

The External Contour is the spatial extent that is taken into account for dose calculation. The External Contour includes the Patient Anatomy Model, Bolus, Patient Positioning Devices, Patient Immobilization Devices or other devices in the path of the radiation.

C.36.1.1.7 C-Arm LINAC

A C-Arm LINAC is a linear accelerator that follows the coordinate definitions of [IEC 61217]. Any hardware belonging to this category may or may not represent an actual C-Arm gantry.

C.36.1.1.8 Virtual Simulation

Virtual Simulation is a form of Radiotherapy treatment simulation that uses volumetric imaging studies in a computer to model the geometry of a radiation beam with respect to a patients anatomy. The spatial relationship between beam and anatomy is verified in Digitally Reconstructed Radiograph (DRR) images that conceptually represent actual beam portal images.

C.36.1.1.9 Beam Modifier Coordinate System

Beam modifiers, e.g., beam limiting devices, compensators and blocks, are specified by geometric coordinates.

A Base Beam Modifier Coordinate System is defined with respect to the Equipment Coordinate System (see Section 10.39.1.1). The x/y plane of the Base Beam Modifier Coordinate System is referred to as the Base Beam Modifier Definition Plane. The orientation of the Base Beam Modifier Coordinate System is such that the Base Beam Modifier Definition Plane is parallel to the x/y plane of the Equipment Coordinate System. The origin of the Base Beam Modifier Coordinate System is offset from the RT Device Distance Reference Location by the RT Beam Modifier Definition Distance (300A,0688) as shown in Figure C.36.1-1.

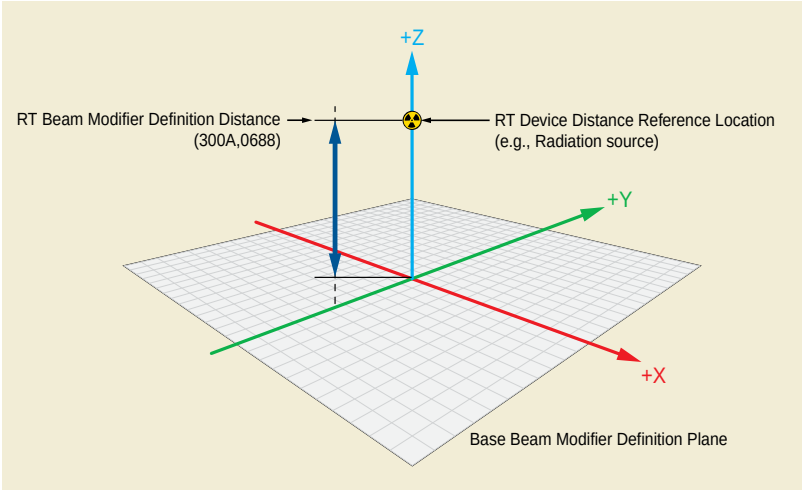


Figure C.36.1-1. Base Beam Modifier Coordinate System

Each beam modifier is defined in its own Beam Modifier Coordinate System with the following characteristics:

- Defined with respect to the Base Beam Modifier Coordinate System.
- Right-handed Cartesian coordinate system, with the positive z-axis pointing towards the nominal Radiation Source location.

- The Beam Modifier Coordinate System rotates about the z-axis of the Base Beam Modifier Coordinate System. The orientation at a zero angle about the z-axis is the same as the Base Beam Modifier Coordinate System, i.e., the x- and y-axes are aligned.
- The x/y plane of the Beam Modifier Coordinate System is referred to as the Beam Modifier Definition Plane.

C.36.1.1.10 Radiation Source

A Radiation Source is a generalized source of radiation that encompasses linear accelerators, brachytherapy sources, etc. Each source is associated with a nominal Radiation Source location which is a point in space from which the radiation is considered to be emanating.

C.36.2 RT Second Generation Macros

C.36.2.1 RT Second Generation General Purpose Macros

C.36.2.1.1 Radiation Fraction Pattern Macro

The Radiation Fraction Pattern Macro specifies the intended fraction pattern to be used to deliver the radiation treatment.

Table C.36.2.1.1-1. Radiation Fraction Pattern Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Fraction Pattern Sequence	(3010,0079)	1C	The pattern of delivery of fractions within and across days of the week in a machine-readable form. Required if a fraction pattern has been defined. Only a single Item shall be included in this Sequence.
>Number of Fraction Pattern Digits Per Day	(300A,0079)	1C	The maximum number of fractions encodable within a day in a Fraction Pattern (3010,0087). Required if Weekday Fraction Pattern Sequence (3010,0087) is present. See Section C.36.2.1.1.1.1.
>Repeat Fraction Cycle Length	(300A,007A)	1C	Number of weeks needed to describe fraction pattern. Required if Weekday Fraction Pattern Sequence (3010,0087) is present. See Section C.36.2.1.1.1.1.
>Weekday Fraction Pattern Sequence	(3010,0087)	3	Sequence of week-day based fraction patterns. Each Item represents an alternative pattern. One or more Items are permitted in this Sequence. See Section C.36.2.1.1.1.1.
>>Fraction Pattern	(300A,007B)	3	String of 0's (no treatment) and 1's (treatment) describing the fraction pattern for the fractions defined by this set. Length of string is 7 x Number of Fraction Pattern Digits Per Day x Repeat Fraction Cycle Length. The first character of the string represents Monday. See Section C.36.2.1.1.1.1.
>>Intended Start Day of Week	(3010,0086)	3	String of 0's (no treatment) and 1's (treatment) describing the intended start fraction for this set. Length of string is 7 x Number of Fraction Pattern Digits Per Day x Repeat Fraction Cycle Length. The first character of the string represents Monday. See Section C.36.2.1.1.1.2.

Attribute Name	Tag	Type	Attribute Description
>Minimum Hours between Fractions	(3010,0084)	3	Minimum number of hours between consecutive fractions. Consecutive fractions are given in Number of Fraction Pattern Digits Per Day (300A,0079).
>Intended Fraction Start Time	(3010,0085)	3	The intended time(s) of day when the first RT Treatment Fraction of the day should be started.

C.36.2.1.1.1 Radiation Fraction Pattern Macro Attribute Descriptions

C.36.2.1.1.1.1 Fraction Pattern

The Radiation Fraction Pattern describes the intended scheme, i.e., how fractions are to be distributed along calendar days for the actual radiation set.

Examples of Fraction Patterns:

1. 1 fraction per day (Monday to Friday) , no fractions on Saturday and Sunday, 1 week-pattern:

   Number of Fraction Pattern Digits Per Day (300A,0079) = 1

   Repeat Fraction Cycle Length (300A,007A) = 1

   Fraction Pattern (300A,007B) = 1111100

2. 2 fractions per day (Monday to Friday) , no fractions on Saturday and Sunday 1 week-pattern:

   Number of Fraction Pattern Digits Per Day (300A,0079) = 2

   Repeat Fraction Cycle Length (300A,007A) = 1

   Fraction Pattern (300A,007B) = 11111111110000

3. 1 fraction per day (Monday, Wednesday, Friday) , no fractions on Saturday and Sunday 1 week-pattern:

   Number of Fraction Pattern Digits Per Day (300A,0079) = 1

   Repeat Fraction Cycle Length (300A,007A) = 1

   Fraction Pattern (300A,007B) = 1010100

4. 2 fractions per day (Monday, Wednesday, Friday) , one fraction on Saturday morning and Sunday afternoon 1 week-pattern:

   Number of Fraction Pattern Digits Per Day (300A,0079) = 2

   Repeat Fraction Cycle Length (300A,007A) = 1

   Fraction Pattern (300A,007B) = 11001100111001

5. 1 fraction per day every other day 2 week-pattern:

   Number of Fraction Pattern Digits Per Day (300A,0079) = 1

   Repeat Fraction Cycle Length (300A,007A) = 2

   Fraction Pattern (300A,007B) = 10101010101010

C.36.2.1.1.1.2 Intended Start Day of Week

The Intended Start Day of Week (3010,0086) specifies the day(s) of the week, when the first fraction of the treatment should be delivered. If more than one day is specified, one of the days may be selected to start the treatment.

The treatment then continues as specified in Fraction Pattern (300A,007B), irrespective of when the actual delivery starts.

Examples of Intended Start Day of Week and the relation to Fraction Pattern:

1. 1 Start Day, one fraction per day

   The treatment should start on Wednesday and be continued at Friday of the first week, followed by treatments at Monday, Wednesday, Friday the next week etc., until all fractions are delivered.

   Number of Fraction Pattern Digits Per Day (300A,0079) = 1

   Repeat Fraction Cycle Length (300A,007A) = 1

   Fraction Pattern (300A,007B) = 1010100

   Intended Start Day of Week (3010,0086) = 0010000

2. Start of any of 3 days, two fractions per day

   Treatment should start

   - on Monday morning and continued by 1 fraction on Monday afternoon, 2 fractions on Wednesday and Friday
   - or on Monday afternoon and continued by 2 fractions on Wednesday and Friday
   - or on Wednesday morning, followed by a fraction on Wednesday afternoon, ~~folloed~~followed by 2 fractions on Friday.

   The treatment will continue the next week with 2 fractions on Monday, Wednesday, Friday etc. until all fractions are delivered.

   Number of Fraction Pattern Digits Per Day (300A,0079) = 1

   Repeat Fraction Cycle Length (300A,007A) = 2

   Fraction Pattern (300A,007B) = 11001100110000

   Intended Start Day of Week (3010,0086) = 11001000000000

C.36.2.1.2 RT Treatment Phase Macro

The treatment phase Macro contains the identification and additional information about an RT Treatment Phase.

Table C.36.2.1.2-1. RT Treatment Phase Macro Attributes

Attribute Name	Tag	Type	Attribute Description
RT Treatment Phase Index	(3010,003A)	1	Index of the RT Treatment Phase in the Sequence.
RT Treatment Phase UID	(3010,003B)	2	A UID by which this RT Treatment Phase can be referenced.
Include Table 10.31-1 "Entity Labeling Macro Attributes"			
Intended Phase Start Date	(3010,004C)	2	The date when this treatment phase is intended to start. See Section C.36.2.1.2.1.1.
Intended Phase End Date	(3010,004D)	2	The date when this treatment phase is intended to be completed. See Section C.36.2.1.2.1.1.

C.36.2.1.2.1 RT Treatment Phase Macro Attribute Descriptions

C.36.2.1.2.1.1 Intended Phase Start Date, Intended Phase End Date

The Intended Phase Start Date (3010,004C) and Intended Phase End Date (3010,004D) contains the date when this treatment phase is intended to be started or completed. Do not confuse the content of this Attribute with the date when the treatment delivery is

scheduled or when it actually starts or ends. The scheduled date is managed by workflow systems where definitive treatment session scheduling is maintained. The actual date of performed delivery will be available in the RT Radiation Record Instances. The actual dates may differ from the Intended Phase Start Date (3010,004C) and/or Intended Phase End Date (3010,004D).

C.36.2.1.3 RT Treatment Phase Interval Macro

The RT Treatment Phase Interval Macro contains the information about time-relationship between RT Treatment Phases. This consists of sets of pair-wise relationships, declaring the relation of a earlier phase to a later, potentially overlapping, phase.

Table C.36.2.1.3-1. RT Treatment Phase Interval Macro Attributes

Attribute Name	Tag	Type	Attribute Description
RT Treatment Phase Interval Sequence	(3010,004E)	2	Intervals between treatment phases. Zero or more Items shall be included in this Sequence. See Section C.36.2.1.3.2.
>Basis RT Treatment Phase Index	(3010,003E)	1	The RT Treatment Phase which provides the basis for this interval. This index corresponds to an Item in the Intended RT Treatment Phase Sequence (3010,004B). See Section C.36.2.1.3.1.
>Related RT Treatment Phase Index	(3010,003F)	1	The RT Treatment Phase which is related to the phase identified by Basis RT Treatment Phase Index (3010,003E). Each RT Treatment Phase Index value shall appear in this Attribute in only one Item within this Sequence. This index corresponds to an Item in the Intended RT Treatment Phase Sequence (3010,004B). See Section C.36.2.1.3.1.
>Temporal Relationship Interval Anchor	(3010,004F)	1C	The anchor point of the interval specified in this Item with respect to the phase referenced by the Basis RT Treatment Phase Index (3010,003E). Enumerated Values: **START** The interval is specified with respect to the start of the basis phase. **END** The interval is specified with respect to the end of the basis phase. Required if a value is present in Minimum Number of Interval Days (3010,0050) or Maximum Number of Interval Days (3010,0051).
>Minimum Number of Interval Days	(3010,0050)	2	The minimum number of days that the start of the related phase should follow the basis phase referenced in Basis RT Treatment Phase Index (3010,003E). Fractional values are allowed. Negative values are allowed if Temporal Relationship Interval Anchor (3010,004F) has a value of END.
>Maximum Number of Interval Days	(3010,0051)	2	The maximum number of days that the start of the related phase should follow the basis phase referenced Basis RT Treatment Phase Index (3010,003E). Fractional values are allowed. Negative values are allowed if Temporal Relationship Interval Anchor (3010,004F) has a value of END.

C.36.2.1.3.1 Referenced RT Treatment Phases

The RT Treatment Phase Interval Sequence (3010,004E) allows the definition of an interval between two treatment phases. RT Treatment Phases referenced by the Basis RT Treatment Phase Index (3010,003E) and the Related RT Treatment Phase Index (3010,003F) are related in terms of the number of days between them. Note that the number of days can also be negative and therefore the related treatment phase could start before the prior treatment phase starts respectively ends.

Each RT Treatment Phase identified by the Related RT Treatment Phase Index (3010,003F) may be related to only one RT Treatment Phase identified by the Basis RT Treatment Phase Index (3010,003E). Therefore, any Basis RT Treatment Phase Index (3010,003E) must only appear once in Related RT Treatment Phase Index (3010,003F) within the Sequence.

See also Section C.36.6.1.4.

As a result of the combinations possible, the maximum number of Items in the RT Treatment Phase Interval Sequence (3010,004E) shall be one less than the number of treatment phases present.

C.36.2.1.3.2 RT Treatment Phase Interval Conflicts

The Standard does not preclude encoding conflicting information.

C.36.2.1.4 Dosimetric Objective Macro

The Dosimetric Objective Macro specifies an intended goal to be used in the definition of the dosimetric plan, for plan optimization etc. Dosimetric Objectives may define limits which affect the dose, such as dose volume constraints, minimum or maximum dose, treatment time or MU limits, and radiobiologic effects.

Dosimetric Objectives, such as dose volume constraints, minimum or maximum dose, etc., can be used to specify dose goals for anatomical or other treatment volumes that are referenced by Conceptual Volumes. Other Dosimetric Objectives can also be used to specify general plan optimization objectives not related to anatomical or other treatment volumes, such as Meterset Minimization, etc.

Table C.36.2.1.4-1. Dosimetric Objective Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Dosimetric Objective UID	(3010,006E)	1	A UID by which this Dosimetric Objective can be referenced. See Section C.36.2.1.4.1.1.
Originating SOP Instance Reference Sequence	(3010,0007)	1C	Reference to the SOP Instance that contains the original definition of this Dosimetric Objective identified by Dosimetric Objective UID (3010,006E). Required when the Dosimetric Objective UID (3010,0948) was not issued in the current SOP Instance, but read from another SOP Instance.. Only a single Item shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Dosimetric Objective Type Code Sequence	(3010,006D)	1	The type of dose objective which this Item represents. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 9500 “Dosimetric Objective Types”.*
Dosimetric Objective Parameter Sequence	(3010,0070)	2	Parameters for the objective identified in Dosimetric Objective Type Code Sequence (3010,006D). Zero or more Items shall be included in this Sequence. See Section C.36.2.1.4.1.2.
>Include Table 10-2 “Content Item Macro Attributes Description”			

Attribute Name	Tag	Type	Attribute Description
>Radiobiological Dose Effect Sequence	(3010,0001)	1C	Describes the radiobiological effects if any that are taken into account to compute dose. Required if Dosimetric Objective Parameter Sequence (3010,0070) contains a parameter which represents a dose. Only a single Item shall be included in this Sequence. See Section C.36.2.1.4.1.2.
>>Include Table C.36.2.1.5-1 "Radiobiological Dose Effect Description Macro Attributes"			
Absolute Dosimetric Objective Flag	(3010,0073)	1	Whether the objective must be met by the resulting Radiotherapy treatment plan. Enumerated Values: **YES** Objective must be met. **NO** Objective should be met but may be compromised. Detecting whether or not a Radiotherapy treatment plan has met this Dosimetric Objective and how this situation is handled is out of scope of the Standard.
Dosimetric Objective Purpose	(3010,0075)	2	The purpose for which the objective is to be used. Enumerated Values: **OPTIMIZATION** Used as an input to the optimization process. **EVALUATION** Used as a tool for evaluation. **BOTH** Used as both an input to the optimization process and for evaluation.

C.36.2.1.4.1 Dosimetric Objective Macro Attribute Descriptions

C.36.2.1.4.1.1 Dosimetric Objective UID

Dosimetric Objectives (see Section C.36.6.1.6) are identified by UIDs. These UIDs serve as a key to allow references of Dosimetric Objectives within or across various SOP Instances.

C.36.2.1.4.1.2 Dosimetric Objective Parameter Sequence

A Dosimetric Objective is described by a type expressed in the Dosimetric Objective Type Code Sequence (3010,006D), and a Sequence of zero or more parameters to quantify the objective within the Dosimetric Objective Parameter Sequence (3010,0070).

Table C.36.2.1.4-2 specifies the parameters that shall be sent.

Table C.36.2.1.4-2. Dosimetric Objective Parameters

Dosimetric Objective Type Code Sequence (3010,006D)	Parameter	Parameter	Parameter
	Concept Name Code(s)	Value Type(s)	Measurement Units Code(s)
Code included in: CID 9532 "No-Parameter Dosimetric Objectives"	none	none	none
Code included in: CID 9529 "Single Dose Dosimetric Objectives"	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")

Dosimetric Objective Type Code Sequence (3010,006D)	Parameter	Parameter	Parameter
	Concept Name Code(s)	Value Type(s)	Measurement Units Code(s)
Code included in: CID 9530 “Percentage and Dose Dosimetric Objectives”	EV (130021, DCM, "Specified Volume Percentage")	NUMERIC	Units = EV (%,UCUM,"Percent")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")
Code included in: CID 9531 “Volume and Dose Dosimetric Objectives”	EV (130020, DCM, "Specified Volume Size")	NUMERIC	Units = EV (cm3,UCUM,"Cubic Centimeter")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")
(130010, DCM, "Minimum Conformity Index")	EV (130074, DCM, "Specified Conformity Index")	NUMERIC	Units = EV (1,UCUM,"no units")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")
(130011, DCM, "Minimum Healthy Tissue Conformity Index")	EV (130075, DCM, "Specified Healthy Tissue Conformity Index")	NUMERIC	Units = EV (1,UCUM,"no units")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")
(130012, DCM, "Minimum Conformation Number")	EV (130076, DCM, "Specified Conformation Number")	NUMERIC	Units = EV (1,UCUM,"no units")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")
(130013, DCM, "Maximum Homogeneity Index")	EV (130077, DCM, "Specified Homogeneity Index")	NUMERIC	Units = EV (1,UCUM,"no units")
	EV (130019, DCM, "Specified Radiation Dose")	NUMERIC	Units = EV (Gy,UCUM,"Gray")

C.36.2.1.4.1.2.1 Dosimetric Objective Parameter Sequence Examples

To describe the objective that a maximum of 30% of the volume can receive 50 Gy or more (V_{50}<=30%), one would use the Dosimetric Objective Type Code Sequence (3010,006D) with code value (130015, DCM, "Maximum Percent Volume at Dose"), with the parameters specified in the Dosimetric Objective Parameter Sequence (3010,0070) as follows:

Dosimetric Objective Sequence (3010,006C):

- Dosimetric Objective Type Code Sequence (3010,006D):
  - (130015, DCM, "Maximum Percent Volume at Dose")
- Dosimetric Objective Parameter Sequence (3010,0070)
  - Item 1:
    - Value Type (0040,A040) = NUMERIC
    - Concept Name Code Sequence (0040,A043)
      - (130021, DCM, "Specified Volume Percentage")
    - Numeric Value (0040,A30A) = 30
    - Measurement Units Code Sequence (0040,08EA)
      - (%, UCUM, "Percent")
  - Item 2:

- Value Type (0040,A040) = NUMERIC
- Concept Name Code Sequence (0040,A043)
  - (130019, DCM, "Specified Radiation Dose")
- Numeric Value (0040,A30A) = 50
- Measurement Units Code Sequence (0040,08EA)
  - (Gy, UCUM, "Gray")

C.36.2.1.4.1.3 Radiobiological Dose Effect Sequence

The Radiobiological Dose Effect Sequence (3010,0001) specifies whether a code value of (Gy,UCUM,"Gray") in the Measurement Units Code Sequence (0040,08EA) in the Dosimetric Objective Parameter Sequence (3010,0070) denotes physical or effective dose.

C.36.2.1.5 Radiobiological Dose Effect Description Macro

The Radiobiological Dose Effect Description Macro describes whether dose values are provided as physical dose or effective dose. An effective dose value incorporates adjustments to dose by taking into account the radiobiological effects.

Table C.36.2.1.5-1. Radiobiological Dose Effect Description Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Radiobiological Dose Effect Flag	(3010,0002)	1	Whether radiobiological effects are taken into account for a given dose value. Enumerated Values: **YES** Effective dose after correction for biological effect. **NO** Physical dose.
Effective Dose Calculation Method Category Code Sequence	(3010,0003)	2C	The category of the method used to calculate the effective dose. Required if Radiobiological Dose Effect Flag (3010,0002) equals YES. Zero or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 9537 “Effective Dose Calculation Method Categories”.*
>Effective Dose Calculation Method Code Sequence	(3010,0004)	3	Defines the effective dose calculation method. One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*See Section C.36.2.1.5.1.1.*
Effective Dose Calculation Method Description	(3010,0005)	2C	The description of the method used to calculate the effective dose. Required if Radiobiological Dose Effect Flag (3010,0002) is YES.

C.36.2.1.5.1 Radiobiological Dose Effect Description Macro Attribute Descriptions

C.36.2.1.5.1.1 Effective Dose Method Modifier Code Sequence

The calculation of the radiobiological effect may be further described by a specific method.

In Table C.36.2.1.5-2, if the Effective Dose Calculation Method Category Code Sequence (3010,0003) has the code value specified in the left column, the Context Group for Effective Dose Calculation Method Code Sequence (3010,0004) shall be the one specified in the right column.

Table C.36.2.1.5-2. Effective Dose Calculation Method Context Groups

Effective Dose Calculation Method Category Code Sequence (3010,0003)	Context Group for Effective Dose Calculation Method Code Sequence (3010,0004)
(130126, DCM, "Radiation transport-based methods")	*DCID 9538 “Radiation Transport-based Effective Dose Method Modifiers”*
(130127, DCM, "Fractionation-based or temporally-based methods")	*DCID 9539 “Fractionation-based Effective Dose Method Modifiers”*

C.36.2.1.6 RT Radiation Common Base Macro

The Radiation Fraction Pattern Macro specifies the intended fraction pattern to be used to deliver the radiation treatment.

Table C.36.2.1.6-1. RT Radiation Common Base Macro Attributes

Attribute Name	Tag	Type	Attribute Description
RT Radiation Physical and Geometric Content Detail Flag	(300A,0638)	1	The level of detail of content within this SOP Instance. Enumerated Values: **FULL** The physical and geometric parameters of all devices are fully defined and dosimetric information is present. This level of detail is typically present after volumetric planning. **IDENT_ONLY** The physical and geometric parameters of all devices may not be fully specified, but the devices can be identified. This level of detail is typically present after non-volumetric planning (e.g., 2D planning) or in records of delivered treatments. **GEOMETRY_ONLY** The geometric parameters of all devices are fully specified, but no dosimetric information is present. This level of detail is typically present after Virtual Simulation.
RT Record Flag	(300A,0639)	1	Whether or not device parameters about actual delivery of treatment to a patient have been recorded. Enumerated Values: **YES** Values in this Instance are a record of a delivered treatment, based on e.g., read-outs or measurements. **NO** Values in this Instance are a specification of a treatment to be delivered, e.g., by a treatment planning system.
RT Treatment Technique Code Sequence	(3010,0080)	1C	Type of treatment technique. Only a single Item shall be included in this Sequence. Required if the SOP Class of the SOP Instance including this Module is not RT Radiation Salvage Record Storage (“1.2.840.10008.5.1.4.1.1.481.17”). May be present otherwise. See Section C.36.2.1.6.1.1.
>Include Table 8.8-1 “Code Sequence Macro Attributes”.			CID is specified at invocation.
~~*Include* Table C.36.2.2.4-1 “RT Treatment Position Macro Attributes”.~~			~~*See* Section C.36.2.1.6.1.2.~~

Attribute Name	Tag	Type	Attribute Description
Include Table C.36.2.2.4-1 “RT Treatment Position Macro Attributes”.			*See* Section C.36.2.1.6.1.2.
RT Tolerance Set Sequence	(300A,0629)	3	A set of tolerance values to be applied to parameters used for delivery of the RT Radiation. Only a single Item is permitted in this Sequence.
>Include Table C.36.2.2.17-1 “RT Tolerance Set Macro Attributes”.			
Treatment Machine Special Mode Code Sequence	(300A,0635)	1C	A mode of operation on the treatment machine. Required if a special delivery mode is used for treatment and the SOP Class of the SOP Instance including this Module is not RT Radiation Salvage Record Storage (“1.2.840.10008.5.1.4.1.1.481.17”). May be present otherwise. Only a single Item shall be included in this Sequence. See Section C.36.2.1.6.1.3.
>Include Table 8.8-1 “Code Sequence Macro Attributes”.			CID is specified at invocation.

C.36.2.1.6.1 RT Radiation Common Attribute Descriptions

C.36.2.1.6.1.1 Radiotherapy Procedure Technique Sequence

The RT Treatment Technique Code Sequence (3010,0080) describes the treatment technique, i.e., how the radiation beam is shaped and targeted.

C.36.2.1.6.1.2 RT Treatment Position Macro

The RT Treatment Position Macro describes how the patient is to be positioned with respect to the delivery device for treatment.

The behavior of the machine regarding the patient position between specified Control Points is outside the scope of this Standard. Communicating devices shall agree on this behavior.

C.36.2.1.6.1.3 Treatment Machine Special Mode Sequence

The Treatment Machine Special Mode Code Sequence (300A,0635) contains a code, for example, (130341, DCM, "Total Body Irradiation") or (130342, DCM, "Total Skin Irradiation"), which selects a set of vendor- and machine-specific parameters that alter the treatment parameters and/or safety constraints.

C.36.2.2 RT Second Generation Device Macros

C.36.2.2.1 Treatment Device Identification Macro

The Treatment Device Identification Macro identifies a device used to deliver radiation to the patient during a radiotherapy treatment session.

Table C.36.2.2.1-1. Treatment Device Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Treatment Device Identification Sequence	(300A,063A)	1	Identifies treatment device. Only a single Item shall be included in this Sequence.
>Include Table 10.35-1 “Device Model Macro Attributes”.			*Identifies the device model for the Treatment Device.*

Attribute Name	Tag	Type	Attribute Description
>Manufacturer's Device Class UID	(0018,100B)	2	Manufacturer's Unique Identifier (UID) for the class of the device. A class is a manufacturer-specific grouping concept with no DICOM-defined scope or criteria. A class is independent from a marketing-defined make, model or version. A class allows definition of a group of devices with a similar set of capabilities.
>Include Table 10.36-1 "Device Identification Macro Attributes".			*DCID 9551 "Treatment Delivery Device Types".*
>Institution Name	(0008,0080)	3	Institution where the equipment is located.
>Institution Address	(0008,0081)	3	Mailing address of the institution where the equipment is located.
>Institutional Department Name	(0008,1040)	3	Department in the institution where the equipment is located.

C.36.2.2.2 RT Patient Support Devices Macro

The RT Patient Support Devices Macro identifies a patient support device (table, table top, chair or similar) which shall be used for treatment.

Table C.36.2.2.2-1. RT Patient Support Devices Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Patient Support Devices	(300A,0687)	1	Number of Patient Support Devices defined in the Patient Support Devices Sequence (300A,0686).
Patient Support Devices Sequence	(300A,0686)	1C	Patient support device definitions. Required if the Number of Patient Support Devices (300A,0687) is non-zero. The number of Items included in this Sequence shall equal the value ~~ofNumber~~of Number of Patient Support Devices (300A,0687).
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Include Table 10.35-1 "Device Model Macro Attributes".			
>Include Table 10.36-1 "Device Identification Macro Attributes".			*DCID 9505 "Fixation or Positioning Devices".*
>Conceptual Volume Sequence	(3010,0025)	2	References a conceptual volume that describes the geometry and properties of the patient support device. Zero or one Item shall be included in this Sequence.
>>Include Table 10.34-1 "Conceptual Volume Segmentation Reference And Combination Macro Attributes".			

C.36.2.2.3 RT Accessory Device Identification Macro

The RT Accessory Device Identification Macro identifies an RT accessory device and its location.

Table C.36.2.2.3-1. RT Accessory Device Identification Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.35-1 "Device Model Macro Attributes".			

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table 10.36-1 "Device Identification Macro Attributes".~~			~~*CID is specified at invocation.*~~
Include Table 10.36-1 "Device Identification Macro Attributes".			*CID is specified at invocation.*
RT Accessory Device Slot ID	(300A,0615)	2C	Identifier for location (slot) of radiation modifier accessory where the current accessory is inserted. Required if accessory is located in a slot and Referenced RT Accessory Holder Device Index (300A,060E) is not present.
RT Accessory Slot Distance	(300A,0613)	2C	Distance in mm from the reference location as specified by RT Device Distance Reference Location Code Sequence (300A,0659) to the Accessory Slot. Required if RT Accessory Device Slot ID (300A,0615) is present and has a value.
Referenced RT Accessory Holder Device Index	(300A,060E)	2C	The value of Device Index (3010,0039) of the Accessory Holder device in the RT Accessory Holder Definition Sequence (300A,0614). Required if accessory is mounted on a holder device and RT Accessory Device Slot ID (300A,0615) is not present.
RT Accessory Holder Slot ID	(300A,0611)	2C	Identifier for location (slot) of radiation modifier in the Accessory Holding device where the current accessory is inserted. Required if Referenced RT Accessory Holder Device Index (300A,060E) is present and has a value and the referenced Accessory Holder Device contains an RT Accessory Holder Slot Sequence (300A,0610).

C.36.2.2.4 RT Treatment Position Macro

The RT Treatment Position Macro establishes a connection between the patients geometry and the treatment delivery equipment to define the treatment position. When used in an RT Radiation object, this treatment position is the prescribed position. When used in an RT Radiation Record object, this treatment position is the record of the actual position.

Table C.36.2.2.4-1. RT Treatment Position Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Patient Orientation Code Sequence	(0054,0410)	1	Sequence that describes the orientation of the patient with respect to gravity. See Section C.8.4.6.1.1 for further explanation. Only a single item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 19 "Patient Orientation".*
>Patient Orientation Modifier Code Sequence	(0054,0412)	1C	Patient Orientation Modifier. Required if needed to fully specify the orientation of the patient with respect to gravity. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 20 "Patient Orientation Modifier".*
Patient Equipment Relationship Code Sequence	(3010,0030)	1	Sequence describing the orientation of the patient with respect to equipment. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 21 "Patient Equipment Relationship".*

Attribute Name	Tag	Type	Attribute Description
Patient Setup UID	(300A,0650)	1C	Identifies a conceptual patient setup that may or may not be realized by one or more RT Patient Setup Instances. Required if Referenced RT Patient Setup Sequence (300A,0632) is present. May be present otherwise.
Referenced RT Patient Setup Sequence	(300A,0632)	1C	References the RT Patient Setup SOP Instance that was used as the setup instruction for the patient prior to delivery of the radiation. Required if there was a Patient Setup SOP Instance defined providing the instructions to the delivery system. Only a single Item shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes".			
Treatment Position Sequence	(300A,063F)	1C	Patient positions during treatment, being prescribed or recorded. Required if the SOP Class of the SOP Instance including this Module is not RT Radiation Salvage Record Storage ("1.2.840.10008.5.1.4.1.1.481.17"). May be present otherwise. One or more Items shall be included in this Sequence.
>Treatment Position Index	(300A,0606)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Include Table 10.39-1 "Patient to Equipment Relationship Macro Attributes".			*DCID 9553 "Treatment Points".*

C.36.2.2.5 RT Control Point General Macro

This Macro specifies the base Attributes for the definition of an RT Radiation Control Point.

Table C.36.2.2.5-1. RT Control Point General Macro Attributes

Attribute Name	Tag	Type	Attribute Description
RT Control Point Index	(300A,0600)	1	The index of the RT Control Point within the Sequence where this Macro is included. RT Control Points shall be executed in the order of the RT Control Point Index. The value shall start at 1 and increase monotonically by 1 within the Sequence where this Macro is included.
Cumulative Meterset	(300A,063C)	1C	Meterset at the RT Control Point. The units are specified by Radiation Dosimeter Unit Sequence (300A,0658). For the Item with RT Control Point Index equal 1, the Cumulative Meterset shall be equal to 0.0. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL or IDENT_ONLY or RT Record Flag (300A,0639) equals YES and if the conditions in Section C.36.2.2.5.1.1 are satisfied. May be present otherwise only if the conditions in Section C.36.2.2.5.1.1 are satisfied. See Section C.36.2.2.5.1.3.

Attribute Name	Tag	Type	Attribute Description
Referenced Treatment Position Index	(300A,060B)	1C	The value of Treatment Position Index (300A,0606) from the Treatment Position Sequence (300A,063F) within this IOD that this RT Control Point refers to. Required if Treatment Position Sequence (300A,063F) is present and the conditions in Section C.36.2.2.5.1.1 are satisfied.
Recorded RT Control Point DateTime	(300A,073A)	1C	Date and time of the Recorded RT Control Point. For all but the final Control Point this shall be the date and time when the delivery of radiation at this Control Point began. For the final Control Point this shall be the date and time when the previous control point ended. Required if RT Record Flag (300A,0639) equals YES and if the SOP Class of the SOP Instance including this Module is not RT Radiation Salvage Record Storage ("1.2.840.10008.5.1.4.1.1.481.17"). May be present otherwise only if RT Record Flag (300A,0639) equals YES.
Referenced Radiation RT Control Point Index	(300A,073B)	2C	The value of RT Control Point Index (300A,0600) of the RT Control Point in the RT Radiation SOP Instance referenced by Referenced RT Instance Sequence (300A,0631) in this Instance. Required if RT Record Flag (300A,0639) equals YES and if the recorded RT Control Point Index corresponds to a planned RT Radiation Control Point Index.

C.36.2.2.5.1 RT Control Point Attribute Concept

The treatment-modality Modules use a common formalism to represent parameters that define the ~~behaviour~~behavior of a delivery device during delivery of radiation. These parameters are communicated as a sequence of values, organized as Control Points (see Section C.36.1.1.1) and represented as RT Control Points. The resolution of RT Control Points depends on the level of detail required to define the ~~behaviour~~behavior of the delivery device.

A Control Point is a point on a ~~timeline~~time line of a delivery process. RT Control Points are sequenced using an index number starting with 1, e.g., 1, 2, 3, 4. The RT Control Point parameters reflect the state of the delivery device at that point in time. The Control Point Cumulative Meterset reflects the dose that has been delivered from the beginning of the delivery process up to that point in time.

For all beam deliveries there are at least two RT Control Points, corresponding to the start and end of delivery. E.g., for a simple Static Beam delivery with a constant field aperture, only two RT Control Points are needed to define the start and end, as there are no changes in-between. For a dynamic delivery, in which the MLC leaves are changing while radiation is delivered, the number of Control Points will be higher to provide enough detail to define the leaf movement with sufficient resolution to achieve the radiation fluence distribution expected for the prescribed dose.

DICOM does not specify the behavior of the machine parameters between Control Points. The planning system needs to know the hardware-specific characteristics of the delivery system for which the plan is being created.

C.36.2.2.5.1.1 Requirements for Changing Values within RT Control Point Sequence Attributes

This Section specifies when individual attributes shall be present in a Sequence.

The RT Control Point Sequence specifies a certain order of execution.

At each RT Control Point the value of various Attributes may be specified as an explicit value (which in the case of a type 2C attribute may be a null value) and if absent remain at the same value as specified previously. There are physical and mechanical implications of specifying a new value as opposed to staying at the same value, for example gear lash, floating point jitter, etc.

At the first Sequence Item in RT Control Point Sequences (i.e., with an RT Control Point Index (300A,0600) equal to 1) all Attributes affected by this Section shall be present if applicable conditions are met.

For Sequence Items other than the first Sequence Item, Attributes shall be present if applicable conditions are met and the value is different from the previously populated value for the same Attribute (in the case of a type 2C attribute, a null value is considered as

a value). The previously populated value is the value from the Item where the Attribute was present with the greatest value of RT Control Point Index (300A,0600) less than the value of the RT Control Point Index (300A,0600) in the current Item.

This means that for an Item in which an Attribute is absent, the application stays at the value of the previously populated Item.

For Sequences inside a RT Control Point Sequence Item, the Sequence shall be present if any of the nested Attributes affected by this Section differ from the corresponding previously populated Item.

For multi-valued Attributes, such as Parallel RT Beam Delimiter Positions (300A,064A), all values shall be present if any value changes.

C.36.2.2.5.1.2 Control Point Attribute Example

The following examples illustrate RT Control Points:

1. Static Beam delivery:

RT Control Point Index (300A,0600)	Cumulative Meterset (300A,063C)	All other parameters
1	0	<defined>
2	76	<not present>

At completion this beam delivers 76 Monitor Units using a fixed static set of treatment parameters defined in RT Control Point 1.

2. Arc delivery:

RT Control Point Index (300A,0600)	Cumulative Meterset (300A,063C)	Source Roll Angle (300A,067A)	All other parameters
1	0	<initial angle>	<defined>
2	56	<final angle>	<not present>

At completion this delivers 56 Monitor Units while rotating the gantry from initial angle to final angle.

3. Dynamic delivery of two equally weighted segments:

RT Control Point Index (300A,0600)	Cumulative Meterset (300A,063C)	Parallel RT Beam Delimiter Positions (300A,064A) X Referenced Device Index 1	Parallel RT Beam Delimiter Positions(300A,064A) Y Referenced Device Index 2	RT Beam Limiting Device Angle (300A,0679)	All other parameters
1	0	2\2	2\2	30	<defined>
2	40	<not present>	4\4	<not present>	<not present>
3	80	4\4	<not present>	<not present>	<not present>

At completion this delivers 80 Monitor Units while first increasing the Y opening and then increasing the X opening, while the beam limiting device angle stays fixed. For the RT Beam Limiting Device Opening Sequence (300A,0656) this results in having three Items for the first Control Point and only one for Control Points 2 (Referenced Device Index 2 only) and 3 (Referenced Device Index 1 only). See also Figure C.36.2.2.5.1-1.

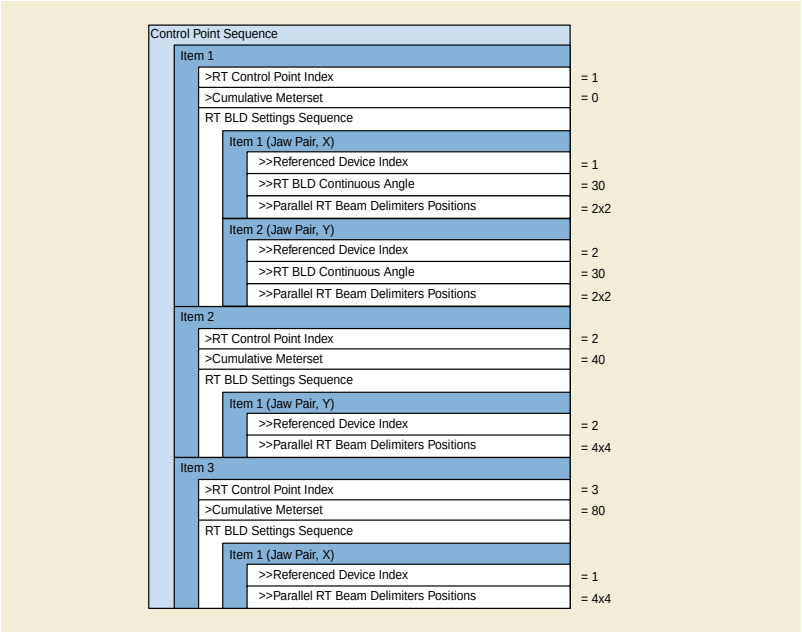


Figure C.36.2.2.5.1-1. Control Points Sub-Sequence Attribute Presence

4. Dynamic Delivery of two unequally weighted segments with a step change of 5 degrees in the positive direction of the Patient Support Angle:

   Note

   Patient Support Angle is represented by the Image to Equipment Mapping Matrix (0028,9520). The table contains the effective angle and not the complete matrix.

RT Control Point Index (300A,0600)	Cumulative Meterset (300A,063C)	Image to Equipment Mapping Matrix (0028,9520)	Source Roll Angle (300A,067A)	All other parameters
1	0	0	-90	<defined>
2	30	<not present>	<not present>	<not present>
3	<not present>	5	0	<not present>
4	90	<not present>	<not present>	<not present>

At completion this delivers 90 Monitor Units. Between RT Control Point 2 and 3 the Patient Support Angle and Source Roll Continuous Angle are changed and no radiation is delivered.

C.36.2.2.5.1.3 Cumulative Meterset

The Meterset at a given Control Point is specified by Cumulative Meterset (300A,063C). This value is specified in units defined by Radiation Dosimeter Unit Sequence (300A,0658) in the RT Delivery Device Common Module in Section C.36.12. The Meterset values are intended to correspond to the values produced by the primary or the single Meterset-measuring device of a RT Radiation Delivery Device.

C.36.2.2.6 External Beam Control Point General Macro

This Macro specifies the RT Control Point Attributes used to model external beam radiation.

Table C.36.2.2.6-1. External Beam Control Point General Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.36.2.2.5-1 "RT Control Point General Macro Attributes".			
Delivery Rate	(300A,063D)	2C	The intended nominal rate of delivery of the specified Cumulative Meterset (300A,063C). Required if the conditions in Section C.36.2.2.5.1.1 are satisfied. See Section C.36.2.2.5.1.
Delivery Rate Unit Sequence	(300A,063E)	1C	The unit of the Delivery Rate (300A,063D). Required if Delivery Rate (300A,063D) is present and has a value. See Section C.36.2.2.5.1. Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes".			CID is specified at invocation.
Beam Area Limit Sequence	(300A,0689)	1C	Area within which the treatment beam must be contained, for example when using MLC tracking for a moving target. Only a single Item shall be included in this Sequence. Required if beam shall be limited. See Section C.36.2.2.5.1.
>Include Table 10.38-1 "Outline Definition Macro Attributes".			The Outline is defined on the Beam Modifier Definition Plane.

C.36.2.2.7 Radiation Generation Mode Macro

The Radiation Generation Mode Macro contains Attributes required to generate radiation by a delivery device.

Treatment devices can produce a multitude of different beams with properties such as energy spectrum, depth dose, surface dose and beam profile. A particular combination of such properties is referred to as a Radiation Generation Mode. Such Radiation Generation Modes are created by the machine by using different primary electron/particle beams, flattening and scattering filters, etc., creating a specific physical and geometric distribution of radiation. In many cases the Radiation Generation Mode characterizes the fluence just below the Monitor Chamber. Subsequently these primary beams may be modulated by beam modifiers such as Beam Limiting Devices, Wedges, Spreaders etc. While these beam modifiers are described in the Control Point Sequence, the primary beam is assumed to have fixed characteristics. In many cases, the Radiation Generation Mode will be constant throughout the radiation.

Radiation Generation Modes specify the beam fluence. To convey content other than the beam fluence, such as annotating the role of the beam in the clinical process or the usage of that beam during a treatment session, annotate treatment constraints, use other Attributes like RT Radiation Set Intent (300A,0637) in the RT Radiation Set Module and information provided by the workflow protocols.

Table C.36.2.2.7-1. Radiation Generation Mode Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Radiation Generation Modes	(300A,0685)	1C	Number of Radiation Generation Modes defined in the Radiation Generation Mode Sequence (300A,067B). The Number shall be greater than zero. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
Radiation Generation Mode Sequence	(300A,067B)	1C	Radiation Generation Modes defining the type of radiation and characteristics of the beam generated. Radiation Generation Modes shall characterize different primary beam fluence. The number of Items included in this Sequence shall equal the value of Number of Radiation Generation Modes(300A,0685). Required if Number of Radiation Generation Modes (300A,0685) is present.
>Radiation Generation Mode Index	(300A,0601)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Radiation Generation Mode Label	(300A,067C)	1	User-defined label that identifies this Radiation Generation Mode. See Section C.36.2.2.7.1.3.
>Radiation Generation Mode Description	(300A,067D)	2	User-defined description of the Radiation Generation Mode.
>Radiation Generation Mode Machine Code Sequence	(300A,067E)	1C	A vendor-specified machine-readable code that unambiguously identifies this Radiation Generation Mode. Only a single Item shall be included in this Sequence. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise. See Section C.36.2.2.7.1.2.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			No Baseline CID is defined.
>Radiation Type Code Sequence	(300A,067F)	1	Type of radiation for this Radiation Generation Mode. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			CID is specified at invocation.
>Energy Unit Code Sequence	(300A,0684)	1	The unit of energy values specified in Nominal Energy (300A,0680), Minimum Nominal Energy (300A,0681), Maximum Nominal Energy (300A,0682). Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”.			CID is specified at invocation.
>Nominal Energy	(300A,0680)	1C	The nominal beam energy in units as defined in the Energy Unit Code Sequence (300A,0684). Required if Minimum Nominal Energy (300A,0681) and Maximum Nominal Energy (300A,0682) are not present. See Section C.36.2.2.7.1.1.
>Minimum Nominal Energy	(300A,0681)	1C	The minimum nominal beam ~~energyin~~energy in units as defined in the Energy Unit Code Sequence (300A,0684). Required if Nominal Energy (300A,0680) is not present. See Section C.36.2.2.7.1.1.

Attribute Name	Tag	Type	Attribute Description
>Maximum Nominal Energy	(300A,0682)	1C	The maximum nominal beam energy in units as defined in the Energy Unit Code Sequence (300A,0684). Required if Nominal Energy (300A,0680) is not present. See Section C.36.2.2.7.1.1.
>Radiation Fluence Modifier Code Sequence	(300A,0683)	1	Identifies the type of fluence modifier of this Radiation Generation Mode. One or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			CID is specified at invocation.
>Radiation Device Configuration and Commissioning Key Sequence	(300A,065A)	2	Keys identifying the configuration and commissioning data used as input for treatment planning of this Instance. Value Type (0040,A040) is constrained to value UIDREF. Zero or more Items shall be included in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes Description".			*No Baseline CID defined.*

C.36.2.2.7.1 Radiation Generation Mode Macro Attribute Description

C.36.2.2.7.1.1 Energy Attributes

The Nominal Energy (300A,0680) parameter is provided for beams where a single discrete energy is annotated by that value. Energy modulation can be used at the Control Point level (both discrete and continuous), in which case the Minimal Nominal Energy (300A,0681) and Maximal Nominal Energy (300A,0682) are used.

C.36.2.2.7.1.2 Radiation Generation Mode Machine Code

When two Radiation Generation Modes differ in any value ~~ofNominal~~of Nominal Energy (300A,0680), Minimum Nominal Energy (300A,0681), Maximum Nominal Energy (300A,0682) or any code value(s) of ~~theRadiation~~the Radiation Type Code Sequence (300A,067F) or the Radiation Fluence Modifier Code Sequence(300A,0683), the Radiation Generation Modes must have different values for Radiation Generation Mode Machine Code. Even if all those attributes have the same values, the two modes may still have a different value for Radiation Generation Mode Machine Code, e.g., when other device-specific beam generation steering parameters differ.

C.36.2.2.7.1.3 Radiation Generation Mode Label

Radiation Generation Mode Label (300A,067C) should uniquely identify a specific mode within a treatment device. The label is intended only for display to human readers, while the authoritative definition of the Radiation Generation Mode is contained in the other attributes of the Sequence.

C.36.2.2.8 RT Beam Limiting Devices Definition Macro

This Macro describes the configuration of Beam Limiting Devices which cannot vary during delivery.

Table C.36.2.2.8-1. RT Beam Limiting Devices Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of RT Beam Limiting Devices	(300A,0641)	1C	Number of RT Beam Limiting Devices in the RT Beam Limiting Device Definition Sequence (300A,064D). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
RT Beam Limiting Device Definition Sequence	(300A,064D)	1C	Beam limiting device (collimator), such as jaw or leaf (element) sets. The number of Items included in this Sequence shall equal the value of Number of RT Beam Limiting Devices (300A,0641). Required if Number of RT Beam Limiting Devices (300A,0641) is present and has a non-zero value.
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the RT Beam Limiting Device Definition Sequence (300A,064D) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Include Table C.36.2.2.3-1 “RT Accessory Device Identification Macro Attributes”.			CID is specified at invocation.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. If Device Type Code Sequence (3010,002E) contains either (130331, DCM, "Leaf Pairs"), or (130333, DCM, "Single Leaves") the motion of the RT Beam Delimiters is along the x-axis of the Beam Modifier Definition Plane. See Section C.36.1.1.9.
>RT Beam Limiting Device Proximal Distance	(300A,0642)	2	Distance in mm from the reference location as specified by RT Device Distance Reference Location Code Sequence (300A,0659) to the proximal end of beam limiting device (collimator) along the beam axis. See Section C.36.2.2.8.1.4.
>RT Beam Limiting Device Distal Distance	(300A,0643)	2	Distance in mm from the reference location as specified by RT Device Distance Reference Location Code Sequence (300A,0659) to the distal end of beam limiting device (collimator) along the beam axis. See Section C.36.2.2.8.1.4.
>Parallel RT Beam Delimiter Device Sequence	(300A,0647)	1C	Device that uses parallel beam delimiters to limit the beam. Required if Device Type Code Sequence (3010,002E) contains either (130331, DCM, "Leaf Pairs") or (130333, DCM, "Single Leaves"). Only a single Item shall be present in the Sequence.
>>Number of Parallel RT Beam Delimiters	(300A,0648)	1	Number of beam delimiters parallel to the axis of motion. E.g., a beam limiting device jaw pair is represented as 1 parallel delimiter, an MLC with 100 leaf pairs or with 100 single leaves is represented as 100 parallel delimiters. See Section C.36.2.2.8.1.3.

Attribute Name	Tag	Type	Attribute Description
>>Parallel RT Beam Delimiter Device Orientation Label Code Sequence	(300A,0644)	1	A code used to identify the orientation of the beam limiting device. Only a single Item shall be present in the Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 9547 "RT Beam Limiting Device Orientation Labels".* *See Section C.36.2.2.8.1.1.*
>>Parallel RT Beam Delimiter Opening Mode	(300A,064E)	1	The operation mode of Parallel RT Beam Delimiters used to define a treatment aperture. Enumerated Values: **BINARY** leaf positions constrained to two states: open and closed **VARIABLE** any leaf position may be specified
>>Parallel RT Beam Delimiter Boundaries	(300A,0649)	1	Boundaries in mm of parallel beam delimiters. These are defined along the axis perpendicular to the motion of the delimiters of the RT Beam Limiting Device Type (300A,00B8) with respect to the Beam Modifier Coordinate System. The order of values shall increase monotonically. See Section C.36.2.2.8.1.2. N+1 values shall be provided, where N is the Number of Parallel RT Beam Delimiters (300A,0648).
>>Parallel RT Beam Delimiter Leaf Mounting Side	(300A,064F)	1C	Specifies the mounting side identified by the direction from the tip to the tail of the delimiter parallel to the axis specified by Device Type Code Sequence (3010,002E). Enumerated Values: **P** Positive mounting side. The axis intercept of the leaf tip is less than the axis intercept of the leaf tail. **N** Negative mounting side. The axis intercept of the leaf tip is greater than the axis intercept of the leaf tail. **M** values shall be provided, where M is the Number of Parallel RT Beam Delimiters (300A,0648), in the order of the Parallel RT Beam Delimiter Boundaries (300A,0649). Required if Device Type Code Sequence (3010,002E) contains (130333, DCM, "Single Leaves"). See Section C.36.2.2.8.1.3.
>Fixed RT Beam Delimiter Device Sequence	(300A,0646)	1C	Device that uses a fixed aperture to limit the beam. Required if Device Type Code Sequence (3010,002E) is part of CID 9545 Fixed Beam Limiting Device Types. Only a single Item shall be included in this Sequence.
>>Include Table 10.38-1 "Outline Definition Macro Attributes".			*The Outline is defined on the Beam Modifier Definition Plane.*

C.36.2.2.8.1 RT Beam Limiting Device Definition Macro Attribute Description

C.36.2.2.8.1.1 Parallel RT Beam Delimiter Device Orientation Label Code

The value of Parallel RT Beam Delimiter Device Orientation Label Code Sequence (300A,0644) shall be ~~choosen~~chosen as follows:

When the value of Beam Modifier Orientation Angle (300A,0645) equals zero the code shall be (130334, DCM, "X Orientation").

When the value of Beam Modifier Orientation Angle (300A,0645) equals 90 the code shall be (130335, DCM, "Y Orientation").

When the value of Beam Modifier Orientation Angle (300A,0645) is not zero or 90, the label should be chosen to best reflect the user perception or another code may be used.

C.36.2.2.8.1.2 Parallel RT Beam Delimiter Boundaries

The Parallel RT Beam Delimiter Boundaries (300A,0649) shall be the positions of the mechanical boundaries (projected on the Beam ~~ModifierDefinition~~Modifier Definition Plane defined by the RT Beam Modifier Definition Distance (300A,0688)) between beam delimiter elements. These are fixed for a given beam limiting device. Parallel RT Beam Delimiter Positions (300A,064A) are values specific to a given Control Point, specifying the beam limiting device element openings.

C.36.2.2.8.1.3 Number of Parallel RT Beam Delimiters

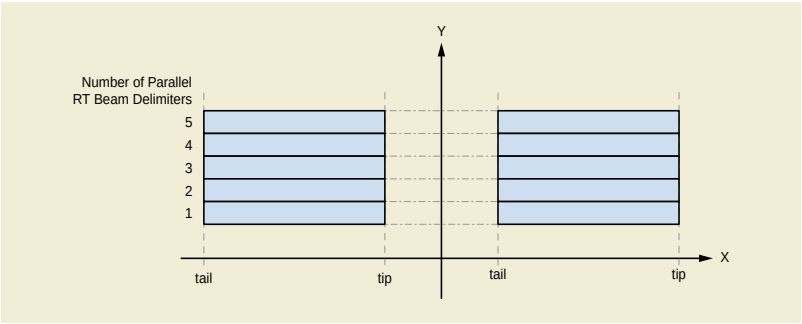


Figure C.36.2.2.8.1-1. Number of Parallel RT Beam Delimiters for X Leaf Pairs

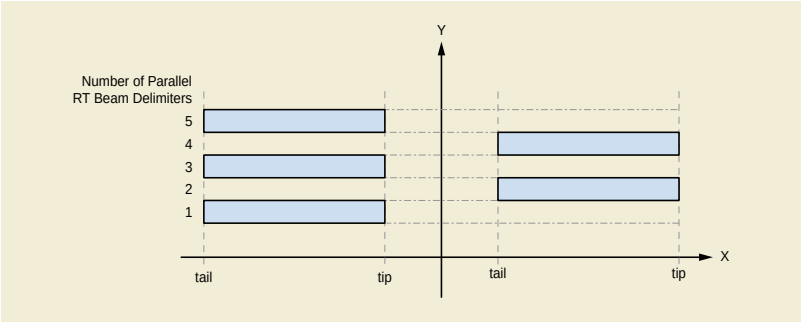


Figure C.36.2.2.8.1-2. Number of Parallel RT Beam Delimiters for X Single Leaves

In example in Figure C.36.2.2.8.1-2 the delimiters labeled 1, 3 and 5 have a Parallel RT Beam Delimiter Leaf Mounting Side (300A,064F) value of N (negative direction) and the delimiters labeled 2 and 4 have a Parallel RT Beam Delimiter Leaf Mounting Side value of P (positive direction).

C.36.2.2.8.1.4 RT Beam Limiting Device Proximal Distance and RT Beam Limiting Device Distal Distance

The following figure shows the RT Beam Limiting Device Proximal Distance (300A,0642) and RT Beam Limiting Device Distal Distance (300A,0643).

In this example the reference location ~~specifed~~specified by the RT Device Distance Reference Location Code Sequence (300A,0659) has the value (130358, DCM, "Nominal Radiation Source Location").

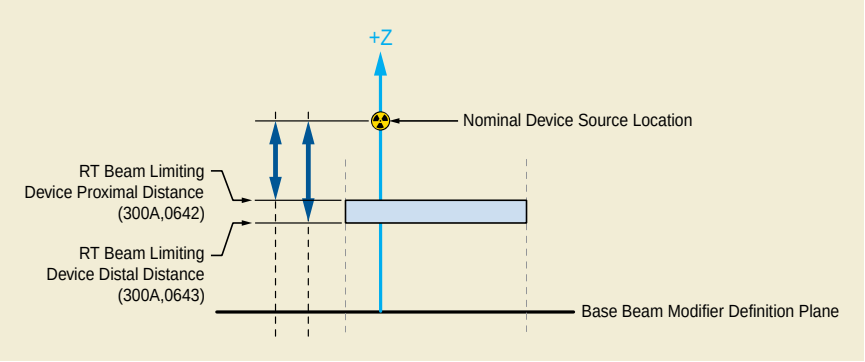


Figure C.36.2.2.8.1-3. RT Beam Limiting Device Proximal and Distal Distance

C.36.2.2.8.1.5 Referenced Defined Device Index

The Referenced Defined Device Index (300A,0602) provides the facility to relate devices from one Instance to the other. Device Macros such as the RT Beam Limiting Device Definition Macro are used in Sequences which list the devices used in the context of a SOP Instance. Each device is identified by the Device Index (3010,0039). These devices may be described in other related SOP Instances. The values of Device Index (3010,0039) are not required to be the same in different SOP Instances.

For example, an RT Radiation Instance may contain the RT Beam Limiting Device Definition Sequence (300A,064D), listing the Beam Limiting Devices to be used for treatment. A related RT Radiation Record Instance for the same type of delivery device will contain the same Sequences. However, the collection of devices used may not be the same:

E.g., the RT Radiation Instance may describe a treatment that contains three Items with the following indices:

- Device Index = 1: Type (130331, DCM, "Leaf Pairs") with one leaf pair and the orientation (130334, DCM, "X Orientation"), representing X-Jaws
- Device Index = 2: Type (130331, DCM, "Leaf Pairs") with one leaf pair and the orientation (130335, DCM, "Y Orientation"), representing Y-Jaws
- Device Index = 3: Type (130331, DCM, "Leaf Pairs") with 80 leaf pairs and the orientation (130334, DCM, "X Orientation"), representing an X-MLC

However, the treatment may have been executed on a different machine which has the X-Jaws and the X-MLC, but a fixed collimator in the Y direction instead of the Y-Jaws. Therefore, the Y-Jaws will not be recorded as they have not been used. Also, the fixed collimator in Y direction is not recorded, as this is not a device which is part of the RT Beam Limiting Device Definition Sequence (300A,064D). The Referenced Defined Device Index (300A,0602) will then point to the indices in the referenced RT Radiation Instance to annotate which device in the RT Radiation Record corresponds to the device in the RT Radiation. In this case, the RT Radiation Record would contain the devices as listed in the following:

- Device Index = 1: Type (130331, DCM, "Leaf Pairs") with one leaf pair and the orientation (130334, DCM, "X Orientation"), representing X-Jaws-> Referenced Defined Device Index = 1
- Device Index = 2: Type (130331, DCM, "Leaf Pairs") with 80 leaf pairs and the orientation (130334, DCM, "X Orientation"), representing an X-MLC-> Referenced Defined Device Index = 3

C.36.2.2.9 RT Beam Limiting Device Opening Macro

This Macro defines the opening created by RT Beam Limiting Devices at a specific Control Point or set of Control Points.

Table C.36.2.2.9-1. RT Beam Limiting Device Opening Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of RT Beam Limiting Device Openings	(300A,0657)	1C	Number of RT Beam Limiting Device Openings in the RT Beam Limiting Device Opening Sequence (300A,0656). Required if Number of RT Beam Limiting Devices (300A,0641) is present and has a non-zero value.
RT Beam Limiting Device Opening Sequence	(300A,0656)	1C	Beam limiting device (collimator) settings defining the opening for the current Control Point. Required if Number of RT Beam Limiting Device Openings (300A,0657) is present and has a non-zero value and the conditions in Section C.36.2.2.5.1.1 are satisfied. The number of Items included in this Sequence shall equal the value of Number of RT Beam Limiting Device Openings (300A,0657).
>Referenced Device Index	(300A,0607)	1	The value of Device Index (3010,0039) from the RT Beam Limiting Device Definition Sequence (300A,064D) corresponding to the Beam Limiting Device used in this Item.
>RT Beam Limiting Device Offset	(300A,064B)	1C	The offsets (x,y) in mm of the Parallel RT Beam Delimiter Positions (300A,064A) from the central beam axis. See Section C.36.2.2.9.1.1 and Section C.36.2.2.8.1.2. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Parallel RT Beam Delimiter Positions	(300A,064A)	1C	One-dimensional positions of the tip in mm of beam delimiters. If Device Type Code Sequence (3010,002E) contains (130333, DCM, "Single Leaves"), N values shall be provided where N is the Number of Parallel RT Beam Delimiters (300A,0648). If Device Type Code Sequence contains (130330, DCM, "Jaw Pair") or (130331, DCM, "Leaf Pairs"), 2N values shall be provided where N is the Number of Parallel RT Beam Delimiters (300A,0648). The values shall be grouped by the mounting side identified by the Parallel RT Beam Delimiter Leaf Mounting Side (300A,064F) with the values of RT Beam Delimiter Elements on the negative mounting side first. The order of values shall correspond to the order of ~~theParallel~~the Parallel RT Beam Delimiter Boundaries (300A,0649). See Section C.36.2.2.9.1.1, Section C.36.2.2.9.1.2 and Section C.36.2.2.9.1.3. Required if the conditions in Section C.36.2.2.5.1.1 are ~~satisfiedand~~satisfied and if Device Type Code Sequence contains (130330, DCM, "Jaw Pair"), (130331, DCM, "Leaf Pairs") or (130333, DCM, "Single Leaves").
>RT Beam Delimiter Geometry Sequence	(300A,064C)	1C	The outline of the Beam Limiting Device opening. Required if the conditions in Section C.36.2.2.5.1.1 are ~~satisfiedand~~satisfied and if DeviceType Code Sequence (3010,002E) contains (130332, DCM, "Variable Circular Collimator"). See Section C.36.2.2.9.1.1 and Section C.36.2.2.9.1.3. Only a single Item shall be included in this Sequence.
>>Include Table 10.38-1 “Outline Definition Macro Attributes”.			*The Outline Shape Type (0018,1630) shall be CIRCULAR.* *The plane is defined in Section C.36.2.2.9.1.1.*

C.36.2.2.9.1 RT Beam Limiting Device Opening Attribute Descriptions

C.36.2.2.9.1.1 Geometric Value Attributes

All geometric values in Table C.36.2.2.9-1 are defined in the Beam Modifier Definition Plane.

C.36.2.2.9.1.2 RT Beam Delimiter Element Positions

For Device Type Code Sequence (3010,002E) values of (130330, DCM, "Jaw Pair") or (130331, DCM, "Leaf Pairs"), the order of values are

N1, N2, Nn

P1, P2, Pn

where N denotes the negative mounting side, P the positive mounting side and the indices increasing corresponding to the order of the values of Parallel RT Beam Delimiter Boundaries (300A,0649).

C.36.2.2.9.1.3 RT Beam Delimiter Geometry

The definition of the tip positions in Parallel RT Beam Delimiter Positions (300A,064A) or delimiter outline in the RT Beam Delimiter Geometry Sequence (300A,064C) is as defined by the manufacturer and shall be documented in the Conformance Statement. Typically, this will be the radiological or physical edge.

C.36.2.2.10 Wedges Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery.

Table C.36.2.2.10-1. Wedges Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Wedges	(300A,00D0)	1C	Number of Wedges defined in the Wedge Definition Sequence (300A,0651). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
Wedge Definition Sequence	(300A,0651)	1C	Treatment wedge definitions. Required if Number of Wedges (300A,00D0) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value of Number of Wedges(300A,00D0).
>Include Table C.36.2.2.3-1 “RT Accessory Device Identification Macro Attributes”.			*DCID 9546 “Radiotherapy Wedge Types”.*
>Device Index	(3010,0039)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.

Attribute Name	Tag	Type	Attribute Description
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the Wedges Definition Sequence (300A,0651) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Radiation Beam Wedge Angle	(300A,0652)	1	Nominal wedge angle in degrees. See Section C.36.2.2.10.1.1.
>Radiation Beam Effective Wedge Angle	(300A,0654)	2	Effective wedge angle in degrees. See Section C.8.8.14.14.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. The direction from thick edge to thin edge is along the positive y-axis of the Beam Modifier Definition Plane. See Section C.36.1.1.9 and Section C.36.2.2.10.1.1.

C.36.2.2.10.1 Wedges Definition Macro Attribute Description

C.36.2.2.10.1.1 Radiation Beam Wedge Orientation and Radiation Beam Wedge Angle

For an Equipment Frame of Reference UID 1.2.840.10008.1.4.3.1 the wedge orientation has the value of 0 degree when the thin edge of the wedge is directed towards the positive direction of the y-axis of the Beam Modifier Coordinate system.

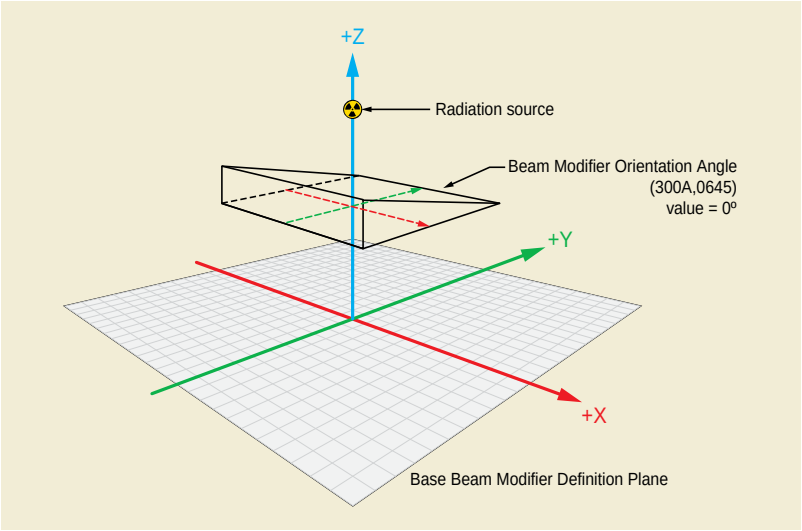


Figure C.36.2.2.10.1-1. Beam Modifier Orientation Angle

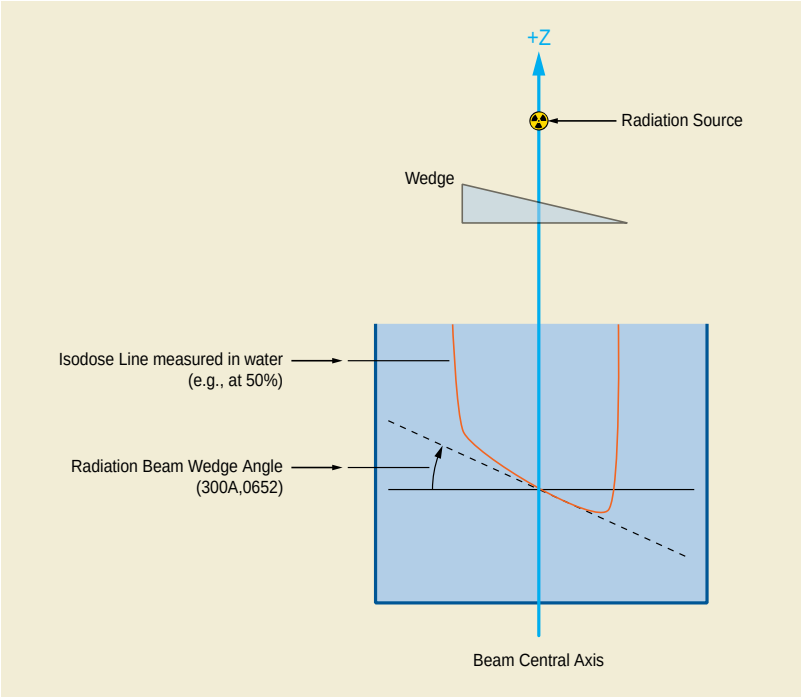


Figure C.36.2.2.10.1-2. Radiation Beam Wedge Angle

C.36.2.2.11 Wedge Positions Macro

This Macro defines the positions of Wedges used in a specific Control Point or set of Control Points.

Table C.36.2.2.11-1. Wedge Positions Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Wedge Positions	(300A,0655)	1C	Number of Wedge Positions defined in the Wedge Position Sequence (300A,0116). Required if Number of Wedges (300A,00D0) is present and has a non-zero value.
Wedge Position Sequence	(300A,0116)	1C	Position for each Wedge for the current Control Point. Required if Number of Wedge Positions (300A,0655) is present and has a non-zero value and the conditions in Section C.36.2.2.5.1.1 are satisfied. The number of Items included in this Sequence shall equal the value of Number of Wedge Positions (300A,0655).
>Referenced Device Index	(300A,0607)	1	The value of Device Index (3010,0039) in Wedge Definition Sequence (300A,0651) for the Wedge being used.
>Wedge Position	(300A,0118)	1	Position of Wedge at current Control Point. Enumerated Values: **IN** The compensator surface shape is directed towards the patient. **OUT** The wedge is in fully retracted position. **PARTIAL** The wedge is inserted only part of the way.

Attribute Name	Tag	Type	Attribute Description
>Radiation Beam Wedge Thin Edge Distance	(300A,0653)	1C	Closest distance in mm from the central axis of the beam along the wedge angle direction to the thin edge as projected on the Beam ~~ModifierDefinition~~Modifier Definition Plane defined by the RT Beam Modifier Definition Distance (300A,0688). The value is negative if the thin edge is located on the positive y-axis, and is positive otherwise. Required if Wedge Position (300A,0118) is PARTIAL. See Section C.36.2.2.11.1.1.

C.36.2.2.11.1 Wedge Positions Macro Attribute Descriptions

C.36.2.2.11.1.1 Radiation Beam Wedge Thin Edge Distance

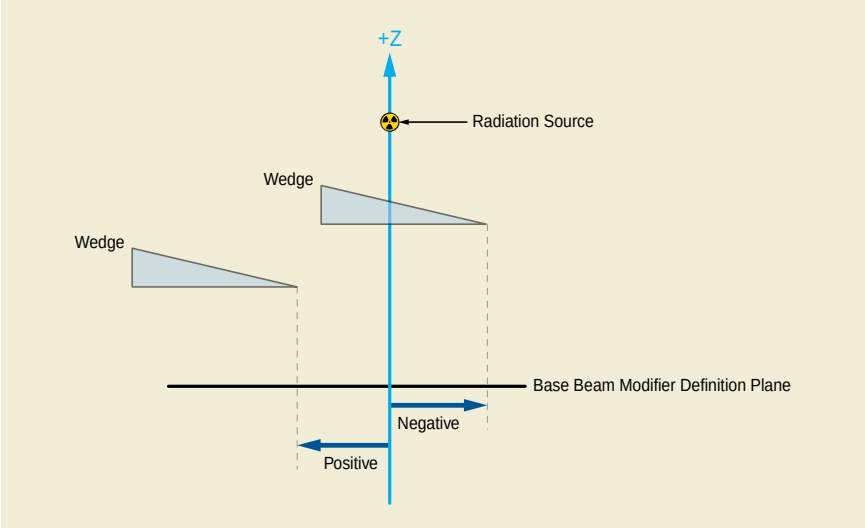


Figure C.36.2.2.11.1-1. Radiation Beam Wedge Thin Edge Position

C.36.2.2.12 Compensators Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery.

Table C.36.2.2.12-1. Compensators Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Compensators	(300A,00E0)	1C	Number of Compensators defined in the Compensator Definition Sequence (300A,0662). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
Compensator Definition Sequence	(300A,0662)	1C	Treatment compensator definitions. Required if Number of Compensators (300A,00E0) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value ~~ofNumber~~of Number of Compensators (300A,00E0).

Attribute Name	Tag	Type	Attribute Description
>Include Table C.36.2.2.3-1 "RT Accessory Device Identification Macro Attributes".			*DCID 9542 "Compensator Device Types".*
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the Compensator Definition Sequence (300A,0662) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.1.1.9.
>Compensator Base Plane Offset	(300A,0666)	1C	The distance in mm between the mounting plane and the base plane of the compensator. The value shall be positive when the base plane is farther away from the reference location (as specified by RT Device Distance Reference Location Code Sequence (300A,0659)) than the mounting plane. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise. See Section C.36.2.2.12.1.2.
>Compensator Map Orientation	(300A,0663)	1C	Side of the compensator base that the compensator surface shape faces. Enumerated Values: **PATIENT_SIDE** The compensator surface shape is directed towards the patient. **SOURCE_SIDE** The compensator surface shape is directed towards the Radiation Source. **DOUBLE_SIDED** The compensator has two compensator surface shapes which are directed towards the patient and source respectively. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
>Compensator Shape Sequence	(300A,0668)	1C	Description of the shape of the Compensator and the fabrication parameters. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise. Only one Item shall be present.

Attribute Name	Tag	Type	Attribute Description
>>Compensator Divergence	(300A,02E0)	1	Whether or not the compensator is shaped according to the beam geometrical divergence. Enumerated Values: **PRESENT** The compensator is shaped according to the beam geometrical divergence. **ABSENT** The compensator is not shaped according to the beam geometrical divergence.
>>Material ID	(300A,00E1)	2	User-defined identifier for the material used to manufacture the Compensator.
>>Compensator Proximal Thickness Map	(300A,0664)	1C	A data stream of triplets of x, y and thickness in mm representing a map of the coordinates in the Beam Modifier Definition Plane and thicknesses from the compensator base plane. The order of triplets is not significant. Required if Compensator Map Orientation (300A,0663) is SOURCE_SIDE or DOUBLE_SIDED. See Section C.36.2.2.12.1.1 and Section C.36.2.2.12.1.3.
>>Compensator Distal Thickness Map	(300A,0665)	1C	A data stream of triplets of x, y and thickness in mm representing a map of the coordinates in the Beam Modifier Definition Plane and thicknesses from the compensator base plane. The order of triplets is not significant. Required if Compensator Map Orientation (300A,0663) is PATIENT_SIDE or DOUBLE_SIDED. See Section C.36.2.2.12.1.1 and Section C.36.2.2.12.1.3.
>>Compensator Shape Fabrication Code Sequence	(300A,0667)	2	The method of fabrication, such as shape of tools to be used, surface ~~modelling~~modeling technique. Zero or more Items shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes".			No Baseline CID is defined.
>>Radiation Beam Compensator Milling Tool Diameter	(300A,0669)	2	The diameter in mm of the milling tool to be used to create the compensator. The diameter is expressed as the actual physical size and not a size projected on the Beam ~~ModifierDefinition~~Modifier Definition Plane.

C.36.2.2.12.1 Compensators Definition Macro Attribute Descriptions

C.36.2.2.12.1.1 Compensators Thickness Map and Tray Distance

The thickness values stored in Compensator Proximal Thickness Map (300A,0664) and Compensator Distal Thickness Map (300A,0665) shall be specified parallel to the radiation beam axis if Compensator Divergence (300A,02E0) equals ABSENT, or specified according to the beam geometrical divergence if Compensator Divergence (300A,02E0) equals PRESENT.

C.36.2.2.12.1.2 Compensator Base Plane Offset

The compensator base plane is the side of the compensator which is flat. In case of a double-sided compensator, the base plane is the plane from which the compensator thickness is specified.

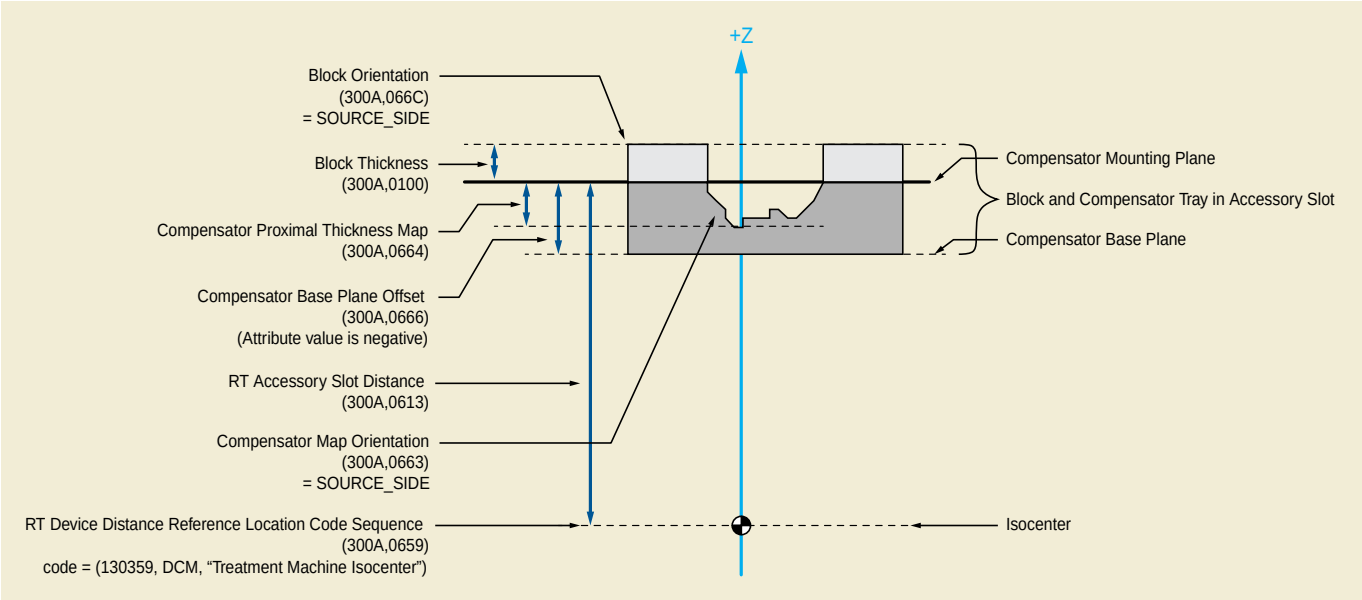


Figure C.36.2.2.12.1-1. Example of Block and Compensator Geometry

C.36.2.2.12.1.3 Compensator Thickness Data Direction

The direction of the rows and columns in Compensator Proximal Thickness Map (300A,0664) and Compensator Distal Thickness Map (300A,0665) is defined as follows: The direction of rows goes along the positive X direction and the direction of the columns goes along the negative Y direction of the Beam Modifier Coordinate System.

C.36.2.2.13 Blocks Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery.

Table C.36.2.2.13-1. Blocks Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Blocks	(300A,00F0)	1C	Number of Blocks defined in the Block Definition Sequence (300A,066A). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) is FULL. May be present otherwise.
Block Definition Sequence	(300A,066A)	1C	Block definitions. Required if Number of Blocks (300A,00F0) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value of Number of Blocks (300A,00F0). Only one Item in this Sequence shall have (130123, DCM, "Aperture Block") as the code value of Device Type Code Sequence (3010,002E).
>Include Table C.36.2.2.3-1 “RT Accessory Device Identification Macro Attributes”.			*DCID 9517 “Radiotherapy Block Device Types”.* *The Device Alternate Identifier (3010,001B) Attribute of the RT Accessory Device Identification Macro shall not contain a value when the Number of Block Slab Items (300A,0440) is non-zero.*
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.

Attribute Name	Tag	Type	Attribute Description
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the Block Definition Sequence (300A,066A) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.1.1.9.
>Material ID	(300A,00E1)	2	User-defined identifier for material used to manufacture the Block.
>Block Divergence	(300A,00FA)	1C	Whether or not the block is shaped according to the beam geometrical divergence. Enumerated Values: **PRESENT** Block edges are shaped for beam divergence. **ABSENT** Block edges are not shaped for beam divergence. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
>Block Orientation	(300A,066C)	1C	Specifies on which side of the block base the block extends. Enumerated Values: **PATIENT_SIDE** The block extends from its base towards the patient. **SOURCE_SIDE** The block extends from its base towards the Radiation Source. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
>Radiation Beam Block Thickness	(300A,066D)	2C	Physical thickness of block in mm parallel to the central radiation beam axis. Required if Material ID (300A,00E1) has a value. May be present otherwise.
>Block Edge Data Sequence	(300A,066F)	2	Block Edge Data streams. The polygons represented by the Block Edge Data (300A,066B) data streams in all Items in this Sequence shall be non-overlapping. Zero or more Items shall be included in this Sequence.
>>Block Edge Data	(300A,066B)	1	A data stream of coordinate pairs in mm representing a polygon which comprise the block edge. The polygon is implicitly closed from the last pair to the origin pair and all edges shall be non-intersecting except at the vertices. Any given coordinate pair shall only occur once in the data stream. Coordinates are projected on the Beam ~~ModifierDefinition~~Modifier Definition Plane.

Attribute Name	Tag	Type	Attribute Description
>Number of Block Slab Items	(300A,0440)	1C	Number of slabs composing the block if the block has been sliced parallel to the Beam ~~ModifierDefinition~~Modifier Definition Plane. If the block has not been sliced the value shall be zero. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
>Block Slab Sequence	(300A,0441)	1C	Sequence of slab(s) that comprise the block. Required if Number of Block Slab Items (300A,0440) is present and has a value greater than 1. The number of Items included in this Sequence shall equal the value of Number of Block Slab Items (300A,0440).
>>Block Slab Number	(300A,0043)	1	Identification number of the Block Slab. The value shall start at 1, and increase monotonically by 1. The number indicates the order of the slabs with respect to the source, where Number 1 corresponds to the slab nearest to the source.
>>Radiation Beam Block Slab Thickness	(300A,066E)	3	Physical thickness of block slab in mm in a direction parallel to the radiation beam axis. The sum of Radiation Beam Block Slab Thickness (300A,066E) values in all Items of this Sequence must equal the Radiation Beam Block Thickness (300A,066D) of the block.
>>Device Alternate Identifier	(3010,001B)	2	An identifier intended to be read by a device such as a bar code reader.
>>Device Alternate Identifier Type	(3010,001C)	1C	Defines the type of Device Alternate Identifier. Required if Device Alternate Identifier (3010,001B) is present. Defined Terms: **BARCODE** **RFID**
>>Device Alternate Identifier Format	(3010,001D)	1C	Description of the format in which the Device Alternate Identifier (3010,001B) is issued. Required if Device Alternate Identifier (3010,001B) is present. See Section 10.36.1.1.

C.36.2.2.14 RT Accessory Holders Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery and which are used to hold accessories such as blocks or compensators.

Table C.36.2.2.14-1. RT Accessory Holders Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of RT Accessory Holders	(300A,0670)	1C	Number of RT Accessory Holders defined in the RT Accessory Holder Definition Sequence (300A,0614). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
RT Accessory Holder Definition Sequence	(300A,0614)	1C	Accessory Holder device definitions. Required if Number of RT Accessory Holders (300A,0670) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value ~~ofNumber~~of Number of RT Accessory Holders (300A,0670).
>Include Table C.36.2.2.3-1 "RT Accessory Device Identification Macro Attributes".			*DCID 9518 "Radiotherapy Accessory No-slot Holder Device Types".* *DCID 9519 "Radiotherapy Accessory Slot Holder Device Types".*
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the RT Accessory Holder Definition Sequence (300A,0614) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.1.1.9.
>RT Accessory Holder Water-Equivalent Thickness	(300A,060D)	2	Water-Equivalent thickness in mm of the Accessory Holder parallel to the radiation beam axis.
>RT Accessory Holder Slot Existence Flag	(300A,060F)	1	Indicates whether the RT Accessory Holder has slots in which other RT Accessory Holders or beam modifying devices can be inserted. Enumerated Values: **YES** The RT Accessory Holder has one or more slots. **NO** The RT Accessory Holder has no slots.
>RT Accessory Holder Slot Sequence	(300A,0610)	1C	Slots being available in this Accessory Holder. Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL and RT Accessory Holder Slot Existence Flag (300A,060F) has the value YES.. May be present if RT Accessory Holder Slot Existence Flag (300A,060F) has the value YES. One or more Items shall be included in this Sequence.
>>RT Accessory Holder Slot ID	(300A,0611)	1	The ID of the slot where accessories are inserted.
>>RT Accessory Holder Slot Distance	(300A,0612)	2	Distance in mm from the reference location as specified by RT Device Distance Reference Location Code Sequence (300A,0659) to the slot along the radiation beam axis.

C.36.2.2.14.1 RT Accessory Holders Description

A treatment delivery unit may allow the attachment of one or more accessory holders within which the user may install various devices for applying the beam to the patient. These installed devices may include, but not be limited to, one or more of the following items:

- custom blocks for patient-specific lateral collimation (beam limiting),
- pre-collimators for general lateral collimation (beam limiting),
- uniform thickness range shifter for modifying the range uniformly across the beam,
- two-dimensional range shifters (custom boluses) for modifying the range differentially across the defined field,
- ridge filters for creating multiple ranges within the beam,
- cross-wires for aligning the patient with the beam,
- a mirror or camera for aligning or viewing the irradiated area,
- beam monitoring detectors,
- applicator sealer for preventing fluids from entering the applicator.

The following example illustrates the use of the RT Accessory Holders Macro and the RT Accessory Device Identification Macro:

- The gantry head has a slot called Acc Mount.
- In this example, an electron applicator is mounted in that slot. The electron applicator itself has a slot called E Aperture, where other accessories can be mounted. Therefore the electron applicator is an RT Accessory Holder, which includes a slot sequence to model that slot.
- In this example, a block tray is mounted in the E Aperture slot. The block tray can support blocks, therefore it is an RT Accessory Holder, but the slot sequence is absent in the block tray definition, since the tray has no slots.
- The block is an RT Accessory, which is mounted in the block tray.

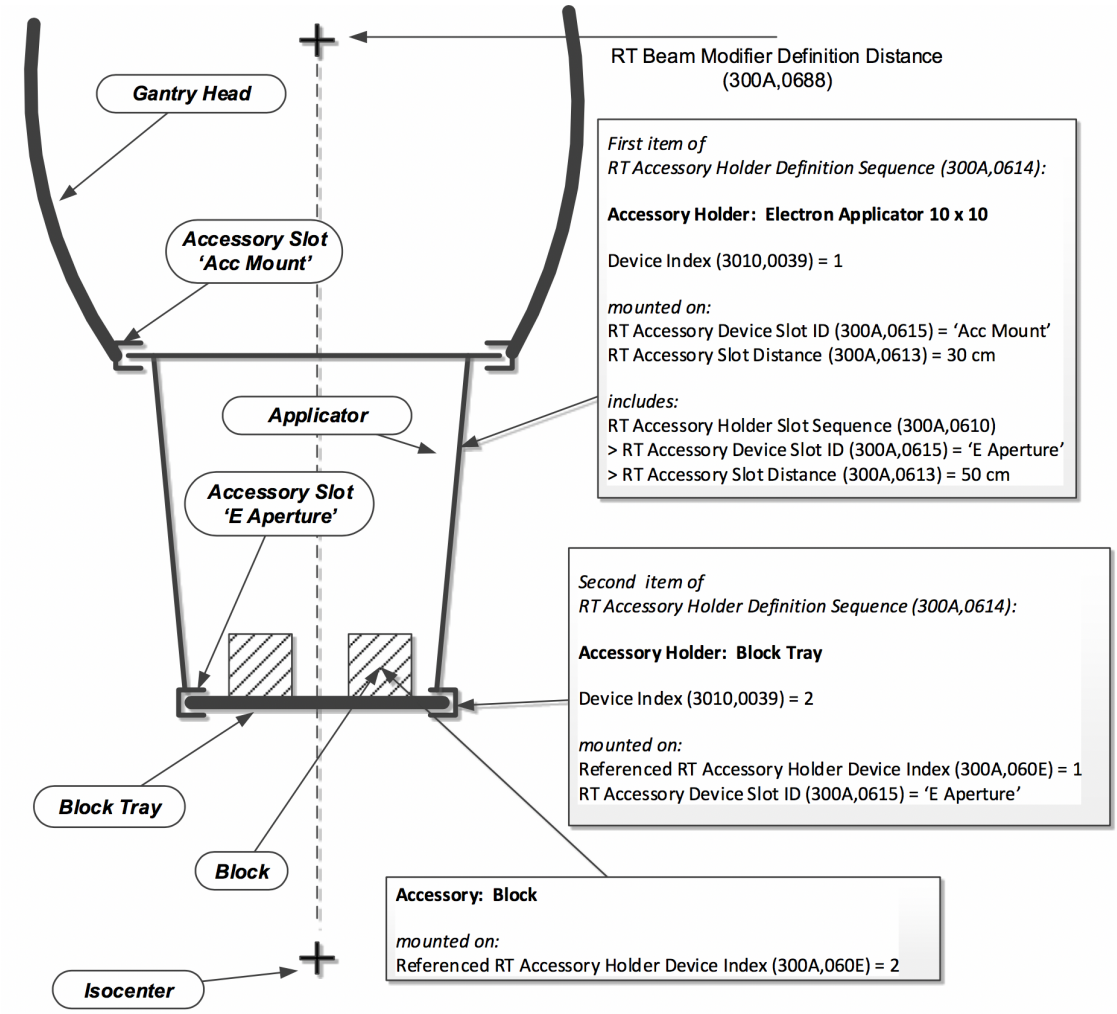


Figure C.36.2.2.14.1-1. RT Accessory Holders

C.36.2.2.15 General Accessories Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery.

Table C.36.2.2.15-1. General Accessories Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of General Accessories	(300A,0672)	1C	Number of General Accessories defined in the General Accessory Definition Sequence (300A,0671). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
General Accessory Definition Sequence	(300A,0671)	1C	General accessory devices. Required if the Number of General Accessories (300A,0672) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value of Number of General Accessories (300A,0672).

Attribute Name	Tag	Type	Attribute Description
>Include Table C.36.2.2.3-1 "RT Accessory Device Identification Macro Attributes".			*BCID 9548 "General Accessory Device Types".*
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the General Accessory Definition Sequence (300A,0671) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Beam Modifier Orientation Angle	(300A,0645)	1	Angle in degrees of the Beam Modifier Coordinate System with respect to the Base Beam Modifier Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.1.1.9.

C.36.2.2.16 Boluses Definition Macro

This Macro defines the geometric configuration elements which cannot vary during delivery.

Table C.36.2.2.16-1. Boluses Definition Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Number of Boluses	(300A,0674)	1C	Number of boluses defined in the Bolus Definition Sequence (300A,0673). Required if RT Radiation Physical and Geometric Content Detail Flag (300A,0638) equals FULL. May be present otherwise.
Bolus Definition Sequence	(300A,0673)	1C	Bolus device definitions. Required if Number of Boluses (300A,0674) is present and has a non-zero value. The number of Items included in this Sequence shall equal the value ~~ofNumber~~of Number of Boluses (300A,0674).
>Include Table C.36.2.2.3-1 "RT Accessory Device Identification Macro Attributes".			*DCID 9516 "Radiotherapy Bolus Device Types".*
>Device Index	(3010,0039)	1	Index of the Device in this Sequence. The value shall start at 1 and increase monotonically by 1.

Attribute Name	Tag	Type	Attribute Description
>Referenced Defined Device Index	(300A,0602)	1C	Device Index value that links the device defined by this Sequence Item to the corresponding device in an RT Radiation Instance. The device identification of the two devices may or may not be the same. The value is the index of a device in the Bolus Definition Sequence (300A,0673) within the single SOP Instance referenced by Referenced RT Instance Sequence (300A,0631). Required if the Instance referenced in Referenced RT Instance Sequence (300A,0631) contains the device that corresponds to the device defined by this Sequence Item. See Section C.36.2.2.8.1.5.
>Conceptual Volume Sequence	(3010,0025)	2	References a Conceptual Volume that describes the geometry and properties of the bolus. See Section C.36.2.2.16.1.1. Zero or one Item shall be included in this Sequence.
>>Include Table 10.34-1 “Conceptual Volume Segmentation Reference And Combination Macro Attributes”.			

C.36.2.2.16.1 Boluses Definition Macro Attribute Description

C.36.2.2.16.1.1 Conceptual Volume Sequence

The Conceptual Volume Sequence (3010,0025), if present, identifies the segmented Conceptual Volume used to define the bolus. The segment is defined by the Referenced Segment Reference Index (3010,0020) in the Conceptual Volume Segmentation Reference and Combination Macro (see Section 10.34).

Alternatively, the bolus may not be associated with a Conceptual Volume. For example, a bolus may cover the entire area of radiation and not require a specific segmentation for definition.

C.36.2.2.17 RT Tolerance Set Macro

The RT Tolerance Set Macro contains information describing the maximum differences between planned and delivered values. This information is used in the context of delivery of the RT Radiation Set. If the absolute difference between a planned and delivered value exceeds the tolerance value, then it is expected that the delivery of the RT Radiation Set will be inhibited unless an authorized operator confirms that the tolerance may be exceeded.

Table C.36.2.2.17-1. RT Tolerance Set Macro Attributes

Attribute Name	Tag	Type	Attribute Description
RT Tolerance Set Label	(300A,062A)	1	User defined label for the Tolerance Set.
Attribute Tolerance Values Sequence	(300A,062B)	2	Tolerance values representing the allowed difference between the planned and actual values. The Selector Attribute Macro identifies the Attributes for which the tolerances are specified. Required if a tolerance value is specified for at least one Attribute which can be referenced by the Selector Attribute Macro. See Section C.36.2.2.17.1.1. Zero or more Items shall be included in this Sequence.
>Include Table 10-20 “Selector Attribute Macro Attributes”.			

Attribute Name	Tag	Type	Attribute Description
>Tolerance Value	(300A,062C)	1	Maximum permitted difference between the planned and the delivered value. Units are those specified for the corresponding Attribute referenced by the Selector Attribute Macro.
Patient Support Position Specification Method	(300A,065C)	1	Method of specification for patient support parameters. Enumerated Values: **ABSENT** No parameters are specified. **GLOBAL** Parameters are specified irrespective of the devices in use. **DEVICE_SPECIFIC** Parameters are specified per device.
Patient Support Position Device Tolerance Sequence	(300A,0660)	1C	Tolerance values for Patient Support devices. Required if Patient Support Position Specification Method (300A,065C) does not equal ABSENT. One or more Items shall be included in this Sequence if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. Only one Item shall be included in this Sequence if Patient Support Position Specification Method (300A,065C) equals GLOBAL. See Section C.36.2.2.17.1.2.
>Referenced Device Index	(300A,0607)	1C	The value of Device Index (3010,0039) in Patient Support Devices Sequence (300A,0686) corresponding to the Patient Support Device in use. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC.
>Device Order Index	(300A,065E)	1C	Index defining the order in which the Items in the Patient Support Position Device Tolerance Sequence (300A,0660) are applied. The value shall start at 1 and increase monotonically by 1. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. See Section 10.40.1.
>Patient Support Position Tolerance Sequence	(300A,062D)	1	Tolerance values for a particular Patient Support device. One or more Items shall be included in this Sequence.
>>Patient Support Position Tolerance Order Index	(300A,0661)	1C	Index defining the order in which the Items in the Patient Support Position Tolerance Sequence (300A,062D) are applied. The value shall start at 1 and increase monotonically by 1. Required if Patient Support Position Specification Method (300A,065C) equals DEVICE_SPECIFIC. See Section 10.40.1.
>>Include Table 10-2 “Content Item Macro Attributes Description”.			*BTID 15302 “Patient Support Position Parameters”.* Content items shall use UCUM units of mm and degrees where applicable.

C.36.2.2.17.1 RT Tolerance Set Attribute Description

C.36.2.2.17.1.1 Attribute Tolerance Values Sequence

The Attribute Tolerance Values Sequence (300A,062B) allows for the reference to any numerical parameter in an RT Radiation IOD. The RT Tolerance Set Macro is invoked to specify a tolerance value for this parameter. The reference specification is conveyed by the Selector Attribute Macro, which allows reference to a tag on any level of nested Sequences, and to refer to specific Items in the Sequence. The unit of the tolerance value is the unit as specified by the data element tag referenced in the Selector Attribute (0072,0026).

C.36.2.2.17.1.2 Patient Support Position Tolerance Sequence

When describing a tolerance for a specific patient support position value, the patient support device parameter is defined using the same code used in the Patient Support Position Macro in Section 10.40.

C.36.3 Enhanced RT Series Module

The RT Second Generation IODs use the General Series Module described in Section C.7.3.1, specialized by the Enhanced RT Series Module.

Table C.36.3-1 specifies the Attributes that identify and describe general information about the Enhanced RT Series.

Table C.36.3-1. Enhanced RT Series Module Attributes

Attribute Name	Tag	Type	Attribute Description
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the Instances in this Series. See Section C.36.3.1.1.
Series Number	(0020,0011)	1	A number that identifies this series.
Series Date	(0008,0021)	1	Date the Series started.
Series Time	(0008,0031)	1	Time the Series started.
Referenced Performed Procedure Step Sequence	(0008,1111)	1C	Uniquely identifies the Performed Procedure Step SOP Instance that resulted in creation of the Series (e.g. a Modality or Unified Procedure Step SOP Instance). Only a single Item shall be included in this Sequence. Required if the series has been created as a result of a single procedure step request and the Instance-Level Referenced Performed Procedure Step Sequence (3010,0044) is not present. If different Instances in the series are created as a result of a procedure step, the Instance-Level Referenced Performed Procedure Step Sequence (3010,0044) in the Radiotherapy Common Instance Module shall be used.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.36.3.1 Enhanced RT Series Attribute Descriptions

C.36.3.1.1 Modality

The Modality (0008,0060) is defined for each IOD including the Enhanced RT Series Module.

Enumerated Values:

RTINTENT
RTRAD
RTSEGANN

C.36.4 Radiotherapy Common Instance Module

Table C.36.4-1 specifies the Attributes that identify and describe general information in RT Second Generation IODs.

Table C.36.4-1. Radiotherapy Common Instance Module Attributes

Attribute Name	Tag	Type	Attribute Description
Instance Creation Date	(0008,0012)	1	Date the SOP Instance was created.
Instance Creation Time	(0008,0013)	1	Time the SOP Instance was created.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Author Identification Sequence	(3010,0019)	2	The person that created the entire clinical content of this document. Zero or more Items shall be included in this Sequence.
>Include Table C.17-3b.			*Context Group may be defined in the Macro invocation.* *The Observer Type (0040,A084) shall be PSN.*
Instance-Level Referenced Performed Procedure Step Sequence	(3010,0044)	1C	Uniquely identifies the Performed Procedure Step SOP Instance that resulted in creation of this Instance (e.g. a Modality or Unified Procedure Step SOP Instance). Required if this Instance has been created as a result of a procedure step request and the Referenced Performed Procedure Step Sequence (0008,1111) is not present. One or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

C.36.5 RT Physician Intent Module

The RT Physician Intent Module contains information about the overall intent of the treatment. The content is mostly descriptive text and allows for the presence of unstructured advice by the physician along the established nomenclature of the actual institution.

Table C.36.5-1. RT Physician Intent Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.2-1 “Extended Content Identification Macro Attributes”			
RT Treatment Phase Intent Presence Flag	(3010,0045)	1	Whether an RT Treatment Phase Intent definition is present. Enumerated Values: **YES** **NO**
RT Physician Intent Sequence	(3010,0057)	1	The overall goals or aims intended by the physician, for the Radiotherapy. One or more Items shall be included in this Sequence. See Section C.36.5.1.1.
>RT Physician Intent Index	(3010,0058)	1	Index of the RT Physician Intent in the Sequence. The value shall start at 1 and increase monotonically by 1.

Attribute Name	Tag	Type	Attribute Description
>Treatment Site	(3010,0077)	1	A free-text label describing the anatomical treatment site.
>Treatment Site Code Sequence	(3010,0078)	2	Coded description of the treatment site. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>>Treatment Site Modifier Code Sequence	(3010,0078)	3	Coded description of the treatment site. One or more Items are permitted in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 2 "Anatomic Modifier"*
>RT Physician Intent Narrative	(3010,005A)	2	Narrative of RT Physician Intent.
>RT Treatment Intent Type	(3010,0059)	2	Type of treatment intent. Defined Terms: **CURATIVE** **PALLIATIVE** **PROPHYLACTIC**
>RT Physician Intent Predecessor Sequence	(3010,0055)	1C	Reference to the RT Physician Intent SOP Instance which was replaced by this RT Physician Intent. Required if this RT Physician Intent replaces a previous version. Only a single Item shall be included in this Sequence.
>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Reason for Superseding	(3010,005C)	2	Reason that the previous RT Physician Intent was superseded by this RT Physician Intent.
>RT Treatment Approach Label	(3010,0056)	2	Characterization of the case and intended treatment approach. See Section C.36.5.1.4.
>RT Protocol Code Sequence	(3010,005B)	2	The protocol(s) selected by the RT Physician. Zero or more Items shall be included in this Sequence. See Section C.36.5.1.2.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>RT Diagnosis Code Sequence	(3010,005D)	2	Diagnosis codes to describe the condition handled by this RT Physician Intent. Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
>RT Physician Intent Input Instance Sequence	(3010,005F)	2	References to SOP Instances used to establish the RT Physician Intent. Zero or more Items shall be included in this Sequence. See Section C.36.5.1.3.
>>Include Table 10.37-1 "Related Information Entities Macro Attributes"			*DCID 9509 "Purpose of Reference For RT Physician Intent Input".*

C.36.5.1 RT Physician Intent Attribute Descriptions

C.36.5.1.1 RT Physician Intent Sequence

The RT Physician Intent Sequence (3010,0057) allows one or more clinical intents to be identified for treatment in a treatment course. For example, the simultaneous treatment of multiple primary targets may require separate intents to be defined, each with its own prescription(s) and having different sets of reference imaging studies.

C.36.5.1.2 RT Protocol Code Sequence

RT Protocol Code Sequence (3010,005B) contains a coded description of the radiotherapy clinical protocol being followed for the patient. This is not necessarily the same as the Procedure Step protocol.

C.36.5.1.3 RT Physician Intent Input Instance Sequence

The purpose of this Sequence is to reference all the Instances that have been used by the RT Physician to establish the Intent. It may include the Images that were used in the treatment planning process, which are also referenced in the Planning Input Information Sequence (3010,0076) of the RT Enhanced Prescription Module.

When there are multiple Purposes of References, one Item will be included for each purpose.

C.36.5.1.4 RT Treatment Approach Label

The RT Treatment Approach Label (3010,0056) is a short human-readable text label that is meaningful in the context of the patient's disease and the treatment site. Such labels may be found in the literature, or defined as local departmental naming conventions. They are usually not standardized. Examples are terms like Conformal, Conical_Arc, Conformal_Arc, Electron Boost for Breast, TBI, TMI, TSE, CSI, IMAT_VMAT, Total_Spine.

C.36.6 RT Enhanced Prescription Module

The RT Enhanced Prescription Module describes the delivery objectives and labels for intended treatment for a specific target, as defined by the physician.

Table C.36.6-1. RT Enhanced Prescription Module Attributes

Attribute Name	Tag	Type	Attribute Description
RT Prescription Sequence	(3010,006B)	1	Prescriptions to deliver therapeutic radiation. One or more Items shall be included in this Sequence.
>RT Prescription Label	(3010,0054)	1	User-defined label for this prescription. See Section 10.31.1.1.
>RT Prescription Index	(3010,003C)	1	Index of the prescription in the Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced RT Physician Intent Index	(3010,005E)	1C	The value of the RT Physician Intent Index (3010,0058) in the RT Physician Intent Sequence (3010,0057) corresponding to the intent for which this prescription is created. Required if Referenced Parent RT Prescription Index (3010,0042) is absent. See Section C.36.6.1.5.

Attribute Name	Tag	Type	Attribute Description
>Referenced Parent RT Prescription Index	(3010,0042)	1C	The value of the RT Prescription Index (3010,003C) corresponding to a prescription that is the parent prescription to this one. This attribute shall reference a Prescription that contains Referenced RT Physician Intent Index (3010,005E). Required if the Referenced RT Physician Intent Index (3010,005E) is absent. See Section C.36.6.1.5.
>Referenced Dosimetric Objectives Sequence	(3010,0071)	2	References to Dosimetric Objectives in the Dosimetric Objective Sequence (3010,006C) applicable to this prescription. See Section C.36.6.1.6. Zero or more Items shall be included in this Sequence.
>>Referenced Dosimetric Objective UID	(3010,006F)	1	Reference to a Dosimetric Objective UID (3010,006E) in the Dosimetric Objective Sequence (3010,006C).
>>Dosimetric Objective Weight	(3010,0074)	1C	Weight of importance to be applied to the Dosimetric Objective. A higher value means that this objective is more important. Values are only meaningful within the Items in this Sequence. The use of weight value in the process of optimization and treatment parameter definition is implementation-dependent. Required if Absolute Dosimetric Objective Flag (3010,0073) is NO.
>RT Anatomic Prescription Sequence	(3010,0060)	1	Prescriptions for an anatomic region. One or more Items shall be included in this Sequence.
>>Include Table 10.31-1 “Entity Labeling Macro Attributes”			
>>Therapeutic Role Category Code Sequence	(3010,0064)	1	The general category of the therapeutic role of this anatomic region. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*DCID 9503 “Radiotherapy Therapeutic Role Categories”.*
>>Therapeutic Role Type Code Sequence	(3010,0065)	1	The specific property type of the therapeutic role of this anatomic region. Only a single Item shall be included in this Sequence. See Section C.36.6.1.1.
>>>Include Table 8.8-1 “Code Sequence Macro Attributes”			*Context Groups are specified in Section C.36.6.1.1.*
>>Conceptual Volume Optimization Precedence	(3010,0066)	2	Value used to resolve usage of overlapping regions of Conceptual Volumes during dose optimization. An overlapping region is part of the Conceptual Volume(s) with the lowest number. An overlapping region is not part of any other Conceptual Volume with a higher number. Overlapping regions with equal precedence are part of all Conceptual Volumes with the same value. Any number takes precedence over an empty value.
>>Recommended Display CIELab Value	(0062,000D)	3	A default triplet value in which it is recommended that the anatomy be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab. See Section C.10.7.1.1.

Attribute Name	Tag	Type	Attribute Description
>>Conceptual Volume Blocking Constraint	(3010,0068)	2	Constraints on primary radiation passing through the current Conceptual Volume. Enumerated Values: **NONE** No constraint. **UPSTREAM** The optimization is constrained to minimize primary radiation from the source passing through the current Conceptual Volume. The Conceptual Volume is upstream of the target. **DOWNSTREAM** The optimization is constrained to minimize primary radiation from the source passing through the current Conceptual Volume. The Conceptual Volume is downstream of the target. **TOTAL** The optimization is constrained to minimize primary radiation passing through the current Conceptual Volume. Primary Radiation is defined as modulated or shaped radiation, as opposed to scattered radiation or transmission radiation.
>>Conceptual Volume Category Code Sequence	(3010,0067)	2	The general category of this Conceptual Volume for radiotherapy purposes. Zero or one Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 9501 "Prescription Anatomy Categories".*
>>Conceptual Volume Type Code Sequence	(3010,0069)	1C	The specific type of this Conceptual Volume for radiotherapy purposes. Only a single Item shall be included in this Sequence. Required if Conceptual Volume Category Code Sequence (3010,0067) sequence contains one Item. See Section C.36.6.1.2.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Context groups are specified in Section C.36.6.1.2.*
>>Conceptual Volume Type Modifier Code Sequence	(3010,006A)	3	The modifier of the specific type of this Conceptual Volume for radiotherapy purposes. Only a single Item is permitted in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 244 "Laterality".*
>>Conceptual Volume Sequence	(3010,0025)	1	Conceptual Volume for which therapeutic goals are prescribed. See Section C.36.6.1.3. Only a single Item shall be included in this Sequence. The same Conceptual Volume UID (3010,0006) shall not appear in more than one Item of the RT Anatomic Prescription Sequence (3010,0060).
>>>Include Table 10.34-1 "Conceptual Volume Segmentation Reference And Combination Macro Attributes"			
>>Conceptual Volume Description	(3010,0017)	2	Description of the Conceptual Volume.

Attribute Name	Tag	Type	Attribute Description
>Referenced RT Treatment Phase Sequence	(3010,0049)	1C	Referenced treatment phase(s) to which this prescription applies. Required if RT Treatment Phase Intent Presence Flag (3010,0045) of this RT Physician Intent SOP Instance equals YES. One or more Items shall be included in this Sequence.
>>Referenced RT Treatment Phase Index	(3010,0040)	1	Value of RT Treatment Phase Index (3010,003A) in the Intended RT Treatment Phase Sequence (3010,004B) where this prescription is related to.
>Fraction-Based Relationship Sequence	(3010,0082)	2	The relationship of this prescription to another prescription, expressed in fractions. Zero or one Item shall be included in this Sequence. See Section C.36.6.1.4.
>>Referenced RT Prescription Index	(3010,0041)	1	Value of RT Prescription Index (3010,003C) in the RT Prescription Sequence (3010,006B) specifying the prescription to which the current prescription is related.
>>Fraction-Based Relationship Interval Anchor	(3010,0083)	1	The anchor point of this RT Prescription Sequence Item with respect to the prescription referenced by Referenced RT Prescription Index (3010,0041). Enumerated Values: **START** The interval is specified with respect to the start of the referenced prescription. **END** The interval is specified with respect to the end of the referenced prescription.
>>Number of Interval Fractions	(3010,007C)	1	The interval expressed in number of fractions. The Fraction-Based Relationship Interval Anchor (3010,0083) establishes the anchor point to which the interval is tied. A value of 0 means that the current prescription is intended to start simultaneously with the anchor of the related prescription. If Fraction-Based Relationship Interval Anchor (3010,0083) equals START, the value shall be 0 or positive. This is the number of fractions after the first fraction of the delivery of the referenced prescription that the delivery of the current prescription is intended to start. If Fraction-Based Relationship Interval Anchor (3010,0083) equals END, the value shall be negative or 0. This is the number of fractions prior to the last fraction of the delivery of the referenced prescription that the delivery of the current prescription is intended to start.
>Prior Treatment Dose Description	(3010,0061)	2	Description of radiotherapy treatment previously delivered to the patient for the purpose of evaluation of prior dose.
>Prior Treatment Reference Sequence	(3010,0062)	2	References to SOP Instances representing prior treatments, e.g. for the purpose of extracting information about prior dose. Zero or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>Planning Input Information Sequence	(3010,0076)	2	References to SOP Instances to be used during planning for the delivery of this prescription. When there are multiple Purposes of References, one Item will be included for each purpose. Zero or more Items shall be included in this Sequence.
>>Include Table 10.37-1 "Related Information Entities Macro Attributes"			*DCID 9510 "Purpose of Reference For RT Treatment Planning Input".*
>Prescription Notes	(3010,007B)	3	Notes on this prescription, such as special provisions for this patient's treatment or other patient conditions.
>Number of Fractions	(3010,007D)	3	Number of Fractions in this prescription.
>Intended Delivery Duration	(3010,007E)	3	Number of days across which the fractions in this prescription will be delivered.
>Fractionation Notes	(3010,007F)	3	Notes describing the fractionation approach.
>Delivery Time Structure Code Sequence	(3010,0088)	3	The time structure, i.e. fractionation type, to be used for the delivery of treatment. Zero or one Items shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 9533 "Delivery Time Structure"*
>Include Table C.36.2.1.1-1 "Radiation Fraction Pattern Macro Attributes"			
>Treatment Technique Notes	(3010,007A)	3	Notes on the treatment technique to be used.
>Radiotherapy Treatment Type	(3010,0046)	3	Type of radiotherapy. Enumerated Values: **TELETHERAPY** Treatment in which the source of the radiation is at a distance from the body. **BRACHYTHERAPY** Treatment in which the source of radiation is placed close to the surface of the body or within the body.
>Teletherapy Radiation Type	(3010,0047)	3	Type of Radiation used to deliver Teletherapy. Defined Terms: **PHOTON** **NEUTRON** **ELECTRON** **ION** Maybe present only if Radiotherapy Treatment Type (3010,9980) has a value of TELETHERAPY.
>Brachytherapy Source Type	(3010,0048)	3	Type of Source used to deliver Brachytherapy. Defined Terms: **ISOTOPIC** **ELECTRONIC** Maybe present only if Radiotherapy Treatment Type (3010,9980) has a value of BRACHYTHERAPY.
>RT Treatment Technique Code Sequence	(3010,0080)	3	Treatment technique to be used. One or more Items are ~~permiited~~permitted in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 9524 "Radiotherapy Procedure Techniques".*
>Patient Treatment Orientation Sequence	(3010,0032)	2	Orientation of the Patient for the treatment. Zero or one Item shall be included in this Sequence.
>>Patient Orientation Code Sequence	(0054,0410)	1	Orientation of the patient with respect to gravity. See Section C.8.4.6.1.1 for further explanation. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 19 "Patient Orientation".*
>>>Patient Orientation Modifier Code Sequence	(0054,0412)	1C	Sequence describing the orientation of the patient with respect to gravity. Required if needed to fully specify the orientation of the patient with respect to gravity. Only a single Item shall be included in this Sequence.
>>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 20 "Patient Orientation Modifier".*
>>Patient Equipment Relationship Code Sequence	(3010,0030)	1	Orientation of the patient with respect to equipment. Only a single Item shall be included in this Sequence. See Section C.36.6.1.8.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 21 "Patient Equipment Relationship".*
>Prescription Notes Sequence	(3010,0081)	3	Annotations on aspects of the prescription, like preparation and execution of the treatment. One or more Items are permitted in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes Description"			*DTID 15300 "RT Prescription Annotation"*
Dosimetric Objective Sequence	(3010,006C)	1C	Dosimetric Objectives defined for one or more prescription within module. Each Dosimetric Objective referenced in the Referenced Dosimetric Objectives Sequence (3010,0071) shall have a corresponding Item in this Sequence. Only Dosimetric Objectives which are referenced in the Referenced Dosimetric Objectives Sequence (3010,0071) shall be present in this sequence. Required if any Item in the Referenced Dosimetric Objectives Sequence (3010,0071) references a Dosimetric Objective. One or more Items shall be included in this Sequence. See Section C.36.6.1.6.
>Include Table C.36.2.1.4-1 "Dosimetric Objective Macro Attributes"			
>Referenced Conceptual Volume UID	(3010,000B)	1C	The UID of the Conceptual Volume in the RT Anatomic Prescription Sequence (3010,0060) to which this Dosimetric Objective applies. Required if the Dosimetric Objective applies to a specific anatomy.

Attribute Name	Tag	Type	Attribute Description
>Dosimetric Objective Evaluation Scope	(3010,0063)	1	Whether the Dosimetric Objective is intended to be evaluated over a lifetime scope or only in respect to the current prescriptions. Enumerated Values: **CURRENT** The Dosimetric Objective applies to the referencing prescriptions. **LIFETIME** The Dosimetric Objective applies to the referencing prescriptions and accumulated lifetime dose. See Section C.36.6.1.7.

C.36.6.1 RT Enhanced Prescription Attribute Descriptions

C.36.6.1.1 Therapeutic Role Type Code Sequence

The Therapeutic Role Type Code Sequence (3010,0065) further specifies the role of the anatomy along the Therapeutic Role Category (3010,0064). Table C.36.6-3 describes the codes permitted in the Therapeutic Role Type Code Sequence (3010,0065), when the code used in the Therapeutic Role Category Code Sequence (3010,0064) is as specified.

Table C.36.6-2. Therapeutic Role Type Codes

Code Value of Therapeutic Role Category Sequence (3010,0064)	Context Group for Therapeutic Role Property Type Sequence (3010,0065)
(130041, DCM, "RT Target")	DCID 9534 “Radiotherapy Targets”
(130042, DCM, "RT Dose Calculation Structure")	DCID 9535 “Radiotherapy Dose Calculation Roles”

C.36.6.1.2 Conceptual Volume Type Code Sequence

The Conceptual Volume Type Code Sequence (3010,0069) further specifies the type of the anatomy along the Conceptual Volume Category Code Sequence (3010,0067). Table C.36.6-3 describes the codes permitted in the Conceptual Volume Type Code Sequence (3010,0069), when the code used in the Conceptual Volume Type Code Sequence (3010,0069) is as specified.

Table C.36.6-3. Anatomy Property Type Codes

Code Value of Conceptual Volume Category Code Sequence (3010,0067)	Context Group for Conceptual Volume Type Code Sequence (3010,0069)
(123037004, SCT, "Anatomical Structure")	BCID 9514 “Anatomical Structures For Radiotherapy”
(130047, DCM, "External Body Model")	DCID 9507 “External Body Models”
(260787004, SCT, "Physical Object")	BCID 7193 “Physical Object Segmentation Property Types”
(130046, DCM, "Non-specific Volume")	DCID 9508 “Non-specific Volumes”

For code values of the Conceptual Volume Type Code Sequence (3010,0069) not listed in Table C.36.6-3, no Baseline or Defined Context Group is specified.

C.36.6.1.3 Conceptual Volume Sequence

The Conceptual Volume Sequence (3010,0025) identifies the Conceptual Volume associated with an RT Anatomy Prescription Item. If the Conceptual Volume is associated with a segment, the segment is defined by the Referenced Segment Reference Index (3010,0020) in the Conceptual Volume Reference Combination and Segmentation Macro (see Section 10.34). Alternatively, the anatomy volume may not (yet) be associated with a segment. For example, an initial prescription may be entered prior to the definition of an organ at risk.

C.36.6.1.4 Fraction-based Relationship Sequence

The Fraction-Based Relationship Sequence (3010,0082) is used to specify the relationship between two prescriptions.

The following example shows a treatment performed in 2 phases with a break of 7 days between phases.

In RT Treatment Phase 1, the treatment of Prescription B is intended to start 10 fractions prior to the end of Prescription A.

The Section C.36.7 RT Treatment Phase Intent Module is used to specify the relationship of treatment phases to each other.

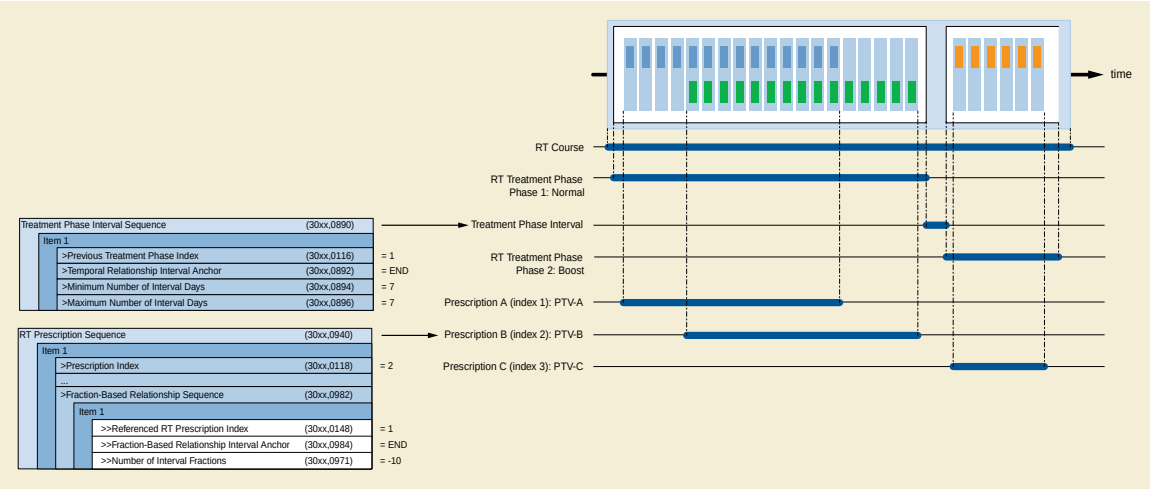


Figure C.36.6.1-1. Relationship of Phases and Prescriptions

C.36.6.1.5 Parent RT Prescription

The RT Enhanced Prescription Module supports a two-level prescription model (see Figure C.36.6.1-2) in order to document an approach where a high-level prescription is created and then more details may be added. The first level would typically be created during the time of prescription definition with only high-level prescription information based on the RT Physician Intent. The second level, if present, would represent a derived prescription containing more detailed information, such as constraints and objectives. A third or subsequent levels are not permitted.

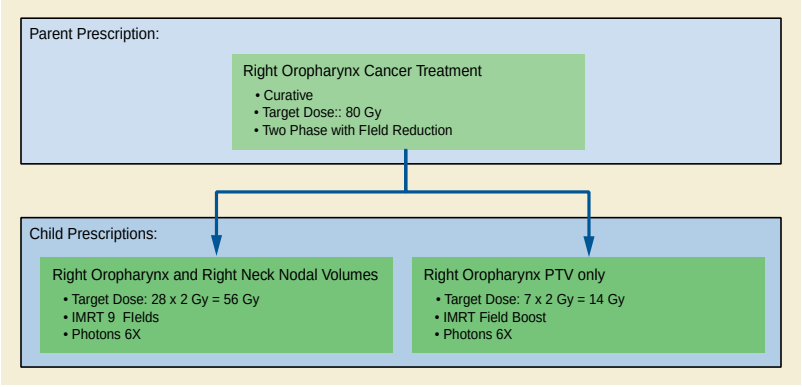


Figure C.36.6.1-2. Parent and Child RT Prescriptions

C.36.6.1.6 Dosimetric Objective Sequence

The Dosimetric Objective Sequence (3010,006C) specifies a set of intended dosimetric goals.

Each item of the Dosimetric Objective Sequence (3010,006C) shall be referenced by at least one item of the Referenced Dosimetric Objectives Sequence (3010,0071) in the current Instance.

Within an RT Physician Intent SOP Instance, a Dosimetric Objective is applicable to all Prescriptions in which the Dosimetric Objective UID (3010,006E) is referenced.

A Dosimetric Objective is intended to be satisfied by the combined effect of all treatments associated with prescriptions that reference the Dosimetric Objective UID (3010,006F).

For example, if there are primary and boost prescriptions that reference the same Dosimetric Objective UID (3010,006E) then the combined effect of both prescriptions is intended to comply with the limit in this Dosimetric Objective.

C.36.6.1.7 Dosimetric Objective Evaluation Scope

For Dosimetric Objectives that include a dose value, the value defines the total dose for all fractions of all prescriptions referencing this Dosimetric Objective, and potentially dose from previous treatment, depending on the value of Dosimetric Objective Evaluation Scope (3010,0063).

If Dosimetric Objective Evaluation Scope (3010,0063) has a value of LIFETIME, information from prior treatments shall be included in the ~~evalution~~evaluation of the Dosimetric Objective.

For example, if an organ has received dose in a prior treatment, and Dosimetric Objective Evaluation Scope (3010,0063) is marked as LIFETIME, then the previously delivered dose shall be included in the ~~evalution~~evaluation of this objective. Information about prior treatments may be described in Prior Treatment Dose Description (3010,0061) or by Instances referenced by the Prior Treatment Reference Sequence (3010,0062) in RT Prescription Sequence (3010,006B).

If Dosimetric Objective Evaluation Scope (3010,0063) has a value of CURRENT, the objective includes only those prescriptions which reference the same Dosimetric Objective, even if information of a prior treatment is available.

C.36.6.1.8 Patient Equipment Relationship Code Sequence

The Patient Equipment Relationship Code Sequence (3010,0030) specifies the orientation of the patient relative to the front of the equipment viewed from the patient support device. For example, in case of the equipment being a gantry, this is the direction from the table (being the patient support device) towards the gantry. In cases where it is not possible to understand ~~unambigously~~unambiguously the direction for a certain equipment, the equipment vendor shall document this direction in its Conformance Statement.

C.36.7 RT Treatment Phase Intent Module

RT Treatment Phases define the intended phases of treatment and their temporal relationship.

Table C.36.7-1. RT Treatment Phase Intent Module Attributes

Attribute Name	Tag	Type	Attribute Description
Intended RT Treatment Phase Sequence	(3010,004B)	1	RT Treatment Phase definitions. RT Treatment Phases define the relationships between RT Radiation Set Instances which contain the treatment parameters for the radiation to be concurrently and/or subsequently delivered. The RT Treatment Phase Index (3010,003A) shall define the temporal sequencing of the phases. One or more Items shall be included in this Sequence.
>Include Table C.36.2.1.2-1 "RT Treatment Phase Macro Attributes"			*The RT Treatment Phase Index (3010,003A) shall start at 1 and increase monotonically by 1 for successive Items in this Sequence.*
Include Table C.36.2.1.3-1 "RT Treatment Phase Interval Macro Attributes"			

C.36.8 RT Segment Annotation Module

The RT Segment Annotation Module references segments and provides radiotherapy-specific annotations for them. The geometry of each segment is defined by a referenced Segmentation, Surface Segmentation, RT Structure Set or any other general-purpose Instance that represents geometric information.

The values of the following Attribute shall take precedence over values in the referenced SOP Instances:

- Segment Annotation Category Code Sequence (3010,002B)
- Segment Annotation Type Code Sequence (3010,002C)

Table C.36.8-1. RT Segment Annotation Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.2-1 "Extended Content Identification Macro Attributes"			
Content Creator's Name	(0070,0084)	2	Name of the most recent person to significantly modify the content of this SOP Instance.
RT Segment Annotation Sequence	(3010,002A)	1	Annotations for segments are described in this Sequence. One or more Items shall be included in this Sequence.
>RT Segment Annotation Index	(3010,003D)	1	Index of the Segment. The value shall start at 1 and increase monotonically by 1.
>Include Table 10.32-1 "Entity Long Labeling Macro Attributes"			
>Referenced Segment Reference Index	(3010,0020)	1	The Segment Reference Index (3010,0022) in the Segment Reference Sequence (3010,0021) corresponding to the segment this Sequence Item relates to.
>Segment Annotation Category Code Sequence	(3010,002B)	2	Category of the annotation of this segment. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 9502 "RT Segment Annotation Categories".*
>Segment Annotation Type Code Sequence	(3010,002C)	1C	Specific type of the annotation of this segment. Required if Segment Annotation Category Code Sequence (3010,002B) has a value. Only a single Item shall be included in this Sequence. See Section C.36.8.1.1.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*Context Groups are specified in Section C.36.8.1.1.*
>>Segment Annotation Type Modifier Code Sequence	(3010,002F)	3	Modifier of the type of the annotation of this segment. One or more Items are permitted in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 244 "Laterality"*
>Segmentation Creation Template Label	(3010,001E)	3	Label for the template used to define the set of segments to be created from patient images and the names, codes, default presentation parameters associated with those segments.
>Segmented RT Accessory Device Sequence	(3010,0026)	2	RT accessory device identification information. Zero or more Items shall be included in this Sequence. See Section C.36.8.1.2.
>>Device Index	(3010,0039)	1	Index of the Device. The value shall start at 1 and increase monotonically by 1.
>>Include Table 10.35-1 "Device Model Macro Attributes"			
>>Include Table 10.36-1 "Device Identification Macro Attributes"			*DCID 9520 "Segmented RT Accessory Devices"* .

Attribute Name	Tag	Type	Attribute Description
>Segment Characteristics Precedence	(3010,0029)	2	Value used to resolve usage of characteristic of overlapping regions of Conceptual Volumes. In overlapping regions, the characteristic of the Conceptual Volume with the lowest number has ~~precendence~~precedence. Any number takes precedence over an empty value. The effect of precedence on the use of the characteristics is not defined in the Standard. Non-empty values shall be unique within all Items of this Sequence.
>Segment Characteristics Sequence	(3010,0027)	3	Characteristics associated with the current segment. One or more Items are permitted in this Sequence.
>>Include Table 10.2.1-1 "Content Item with Modifiers Macro Attributes"			*DTID 15301 "RT Segment Characteristics"*
>Recommended Display Grayscale Value	(0062,000C)	3	A default single gray unsigned value in which it is recommended that the maximum pixel value in this surface be rendered on a monochrome display. The units are specified in P-Values from a minimum of 0000H (black) up to a maximum of FFFFH (white). Note The maximum P-Value for this Attribute may be different from the maximum P-Value from the output of the Presentation LUT, which may be less than 16 bits in depth.
>Recommended Display CIELab Value	(0062,000D)	3	A default triplet value in which it is recommended that the surface be rendered on a color display. The units are specified in PCS-Values, and the value is encoded as CIELab.
>Recommended Presentation Opacity	(0066,000C)	3	Specifies the opacity in which it is recommended that the surface be rendered. See Section C.27.1.1.3.
>Recommended Presentation Type	(0066,000D)	3	Specifies the representation type in which it is recommended that the surface be rendered. See Section C.27.1.1.3.

C.36.8.1 RT Segment Annotation Attribute Descriptions

C.36.8.1.1 RT Segment Annotation Type Code Sequence

In Table C.36.8-2, if the Segment Annotation Category Code Sequence (3010,002B) has the code value specified in the left column, the Context Group for Segment Annotation Type Code Sequence (3010,002C) shall be the one specified in the right column.

Table C.36.8-2. RT Segment Annotation Type CIDs

Code Value of Segment Annotation Category Code Sequence (3010,002B)	Context Group for Segment Annotation Type Code Sequence (3010,002C)
(130041, DCM, "RT Target")	DCID 9534 "Radiotherapy Targets"
(130042, DCM, "RT Dose Calculation Structure")	DCID 9535 "Radiotherapy Dose Calculation Roles"

Code Value of Segment Annotation Category Code Sequence (3010,002B)	Context Group for Segment Annotation Type Code Sequence (3010,002C)
(130043, DCM, "RT Geometric Information")	DCID 9504 “RT Geometric Information”
(130047, DCM, "External Body Model")	DCID 9507 “External Body Models”
(130405, DCM, "Patient-Attached Dose Control Object")	DCID 9516 “Radiotherapy Bolus Device Types”
(130044, DCM, "Fixation or Positioning Device")	DCID 9505 “Fixation or Positioning Devices”
(130045, DCM, "Brachytherapy Device")	DCID 9506 “Brachytherapy Devices”
(130046, DCM, "Non-specific Volume")	DCID 9508 “Non-specific Volumes”

For code values in Segment Annotation Category Code Sequence (3010,002B) that are not present in Table C.36.8-2, Segment Annotation Type Code Sequence (3010,002C) BCID 7150 “Segmentation Property Categories” may be used where applicable.

C.36.8.1.2 Segmented RT Accessory Device Sequence

RT accessory device identification information when this segment represents a device.

Note

For an RT accessory device, typically the Segmented Property Category Code Sequence (0062,0003) has one of the following values:

- (130044, DCM, "Fixation or Positioning Device")
- (130045, DCM, "Brachytherapy Device")
- (260787004, SCT, "Physical Object")

C.36.9 Segment Reference Module

The Segment Reference Module references geometrical representations, such as regions of interest, surfaces, lines, or points, which have been associated with a Conceptual Volume.

These referenced representations are referred to as segments.

Table C.36.9-1. Segment Reference Module Attributes

Attribute Name	Tag	Type	Attribute Description
Segment Reference Sequence	(3010,0021)	1	References to segments. One or more Items shall be included in this Sequence. See Section C.36.9.1.3.
>Segment Reference Index	(3010,0022)	1	Index of the segment reference in the Sequence. The value shall start at 1 and increase monotonically by 1.
>Direct Segment Reference Sequence	(3010,0023)	1C	Directly identifies a specific segment in a specific SOP Instance. Required if Combination Segment Reference Sequence (3010,0024) is not present. Only a single Item shall be included in this Sequence. See Section C.36.9.1.3.
>>Include Table 10.33-1 “Conceptual Volume Macro Attributes”			

Attribute Name	Tag	Type	Attribute Description
>>Referenced SOP Sequence	(0008,1199)	1	The SOP Instance that contains the referenced segment. Only a single Item shall be included in this Sequence. See Section C.36.9.1.1.
>>>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>>Referenced Segment Number	(0062,000B)	1C	Segment Number (0062,0004) in the referenced SOP Instance. Required as described in Section C.36.9.1.1. Only a single Item shall be included in this Sequence.
>>Referenced Fiducials UID	(3010,0031)	1C	Fiducials UID (0070,031A) in the referenced SOP Instance. Required as described in Section C.36.9.1.1. See Section C.36.9.1.1.
>>Referenced ROI Number	(3006,0084)	1C	ROI Number (3006,0022) in the referenced SOP Instance. Required as described in Section C.36.9.1.1. See Section C.36.9.1.1.
>>Referenced Surface Number	(0066,002C)	1C	Surface Number (0066,0003) in the referenced SOP Instance. Required as described in Section C.36.9.1.1. See Section C.36.9.1.1.
>Combination Segment Reference Sequence	(3010,0024)	1C	Defines a segment as a combination of other segment Items present in ~~theSegment~~the Segment Reference Sequence (3010,0021). Required if the Direct Segment Reference Sequence (3010,0023) is not present. Only a single Item shall be included in this Sequence. See Section C.36.9.1.3.
>>Include Table 10.34-1 "Conceptual Volume Segmentation Reference And Combination Macro Attributes"			*See Section C.36.9.1.2.*
>>Segmented Property Category Code Sequence	(0062,0003)	2	Sequence defining the general category of the property the segment combination represents. Zero or one Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7150 "Segmentation Property Categories".*
>>Segmented Property Type Code Sequence	(0062,000F)	1C	Sequence defining the modifier of the property type the segment combination represents. Required if Segmented Property Category Code Sequence (0062,0003) has a value. Only a single Item shall be included in this Sequence.
>>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 7151 "Segmentation Property Types".*

Attribute Name	Tag	Type	Attribute Description
Referenced Spatial Registration Sequence	(0070,0404)	1C	Registrations between Frames of Reference of Instances referenced in the Referenced SOP Sequence (0008,1199) in the Direct Segment Reference Sequence (3010,0023). Required if any Item in the Combination Segment Reference Sequence (3010,0024) combines segments that do not have the same Frame of Reference UID (0020,0052). May be present otherwise. One or more Items shall be included in this Sequence.
>Include Table 10-11 "SOP Instance Reference Macro Attributes"			

C.36.9.1 Segment Reference Attribute Descriptions

C.36.9.1.1 Segmentation SOP Instance Reference Sequence

Only the SOP Classes contained in Table C.36.9-2 shall be referenced.

Table C.36.9-2. Permitted SOP Classes

SOP Class Name	SOP Class UID	Referenced Attribute	Required Referencing Attribute
Segmentation Storage	1.2.840.10008.5.1.4.1.1.66.4	Segment Number (0062,0004)	Referenced Segment Number (0062,000B)
Surface Segmentation Storage	1.2.840.10008.5.1.4.1.1.66.5	Segment Number (0062,0004)	Referenced Segment Number (0062,000B)
Spatial Fiducials Storage	1.2.840.10008.5.1.4.1.1.66.2	Fiducials UID (0070,031A)	Referenced Fiducials UID (3010,0031)
RT Structure Set	1.2.840.10008.5.1.4.1.1.481.3	ROI Number (3006,0022)	Referenced ROI Number (3006,0084)
Surface Scan Mesh Storage	1.2.840.10008.5.1.4.1.1.68.1	Surface Number (0066,0003)	Referenced Surface Number (0066,002C)
Surface Scan Point Cloud Storage	1.2.840.10008.5.1.4.1.1.68.2	None	None

The column Referenced Attribute identifies the Attribute used to identify the geometric representation in the SOP Instance referenced in the Segmentation Referenced SOP Sequence (0008,1199).

Depending on the SOP Class UID (0008,0016) in the Referenced SOP Sequence (0008,1199) the corresponding attribute as specified in the Required Referencing Attribute column is required to be present.

It is anticipated that in future additional referencing Attributes may be needed to accommodate new representations of segmentations. Hence the collection of Required Referencing Attributes in Table C.36.9-1 Segment Reference Module Attributes and the conditionally required Type 1C Attributes in the Segment Reference Module may be extended.

C.36.9.1.2 Combination Segment Reference Sequence

A Conceptual Volume may be expressed as a combination of other segmented Conceptual Volumes. Those other segments are referenced in the Conceptual Volume Segmentation Reference and Combination Macro (see section 10.34).

The Conceptual Volume Combination Flag (3010,000E) shall be YES. The Conceptual Volume Segmentation Defined Flag (3010,0010) shall be NO. The Conceptual Volume Constituent Segmentation Reference Sequence (3010,0012) in the Conceptual Volume Constituent Sequence (3010,0008) shall not be present since the segmented representation of a constituent of a combination is specified by an Item of the Segment Reference Sequence (3010,0021) as follows: If a constituent in the Conceptual Volume Constituent Sequence (3010,0008) is a combination its constituents must

- either contain a reference to an Item in the Segment Reference Sequence (3010,0021) which contains a Direct Segment Reference Sequence (3010,0023), or
- be present in an Item of the Segment Reference Sequence (3010,0021) which contains the Combination Segment Reference Sequence (3010,0024).

All Conceptual Volume References in this Macro shall reference only segments that are defined in Items in the Direct Segment Reference Sequence (3010,0023).

C.36.9.1.3 Conceptual Volumes

The Conceptual Volume UIDs of the Conceptual Volumes instantiated in either the Direct Segment Reference Sequence (3010,0023) or the Combination Segment Reference Sequence (3010,0024) shall be unique within the Segment Reference Sequence (3010,0021).

C.36.10 RT Radiation Set Module

The RT Radiation Set Module describes treatment fractions that contain a set of beams or brachytherapy setups used within a treatment session to help achieve the dosimetric requirements of a given Treatment Phase. The Module references a set of RT Radiation Instances that describe the geometric and physical parameters that define the delivery of dose for a single fraction. In addition, the overall number of treatment fractions is defined, as well as possibly the fractionation scheme according to which, fractions will be delivered.

A Treatment Phase is achieved by delivering one or more RT Radiation Sets. The chronological relationships between RT Radiation Sets (the actual start of each set, the order or timing among sets, etc.) are recorded in Attributes outside the RT Radiation Set Module.

Table C.36.10-1. RT Radiation Set Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.1-1 “Enhanced Content Identification Macro Attributes”.			
Intended Number of Fractions	(300A,0636)	1C	Number of Fractions for which this RT Radiation Set is intended to be repeated. Required if Referenced RT Physician Intent Sequence (300A,063B) is empty. May be present otherwise. See Section C.36.10.1.4.
Include Table C.36.2.1.1-1 “Radiation Fraction Pattern Macro Attributes”.			*See Section C.36.10.1.4.*
Referenced RT Physician Intent Sequence	(300A,063B)	2	RT Physician Intent Instance this Radiation Set is based upon. Zero or more Items shall be included in this Sequence.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”.			
>Referenced RT Prescription Sequence	(300A,068A)	1	Sequence of RT Prescription Prescription Indices. One or more Items shall be included in this Sequence.
>>Referenced RT Prescription Index	(3010,0041)	1	Value of RT Prescription Index (3010,003C) in the RT Prescription Sequence (3010,006B) specifying the prescription to which this RT Radiation Set is related.
RT Radiation Set Intent	(300A,0637)	1	A general indication of the type of information contained within this RT Radiation Set. See Section C.36.10.1.1.
Treatment Position Group Sequence	(300A,060A)	2	Treatment Position Groups defined for the included Radiation Instances. Zero or more Items shall be included in this Sequence. See Section C.36.10.1.3.

Attribute Name	Tag	Type	Attribute Description
>Treatment Position Group UID	(300A,0609)	1	Unique identifier of the Treatment Position Group.
>Treatment Position Group Label	(300A,0608)	1	User-defined label of the Treatment Position Group.
>Referenced RT Radiation Sequence	(300A,0630)	1	RT Radiation Instances that belong to the Treatment Position Group. Each referenced Radiation Instance shall appear once and only once in the Treatment Position Group Sequence (300A,060A). One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”.			
RT Radiation Sequence	(300A,0616)	1	RT Radiation Instances which are referenced by this RT Radiation Set. One or more Items shall be included in this Sequence. See Section C.36.10.1.2.
>Include Table 10-11 “SOP Instance Reference Macro Attributes”.			

C.36.10.1 RT Radiation Set Attribute Descriptions

C.36.10.1.1 RT Radiation Set Intent, RT Radiation Record Set Usage and RT Radiation Usage

Defined Terms for RT Radiation Set Intent (300A,0637), RT Radiation Set Usage (300A,0707) and RT Radiation Usage (300A,0701)

TREATMENT This Instance is for performing or recording treatment delivery. This does not constitute an approval for treatment. All parameters necessary to guide the delivery of RT Radiations are included.

PLAN_QA This Instance is for validating or recording the patient-specific dose. For example, by delivering the RT Radiations to a phantom and comparing the calculated dose to the phantom with actual measurements made in the phantom.

MACHINE_QA This Instance is for performing or recording system quality assurance and calibration (geometric, dosimetric or both) procedures of the delivery machine and is not patient-specific.

RESEARCH This Instance is for performing or recording research and is not delivered to a patient.

SERVICE This Instance is for performing or recording diagnostics, calibration or machine assessment by a service technician.

C.36.10.1.2 RT Radiation Sequence

All SOP Instances referenced in this Sequence shall:

- share the same Frame of Reference (defined by the Frame of Reference UID (0020,0052) in the Frame Of Reference Module), and
- be defined for the same treatment device (specified by the Treatment Device Identification Macro within the RT Delivery Device Common Module).

The SOP Classes referenced in this Sequence shall contain the following Modules:

- Section C.36.3 Enhanced RT Series Module.
- Section C.36.4 Radiotherapy Common Instance Module.
- Section C.36.12 RT Delivery Device Common Module.
- Section C.36.13 RT Radiation Common Module.

C.36.10.1.3 Treatment Position Groups

Radiation Instances that share a fixed spatial relation and thus can share the result of a position verification can be assigned to the same Treatment Position Group because the relationship of positions in one Instance to those in other Instances in the Treatment Position Group can be known with sufficient certainty to allow deterministic movement.

Whether it is reasonable to put Instances together in Treatment Position Group can depend on several factors and may involve a degree of judgment.

For example,

1. In a Radiation Set treating a single target with two beams at the same spatial location, both Radiation Instances belong to the same Treatment Position Group.

2. In a Radiation Set treating two targets in different anatomical regions (e.g., lung and pelvis), typically the Radiation Instances belong to different Treatment Position Groups, because a separate setup verification is required to establish the treatment position for each Radiation.

3. In a Radiation Set treating two targets whose spatial relationship is fixed such that a single setup verification is sufficient, the Radiation Instances may belong to the same Treatment Position Group, but the planner may choose to assign them to different Treatment Position Groups.

C.36.10.1.4 Intended Number of Fractions and Radiation Fraction Pattern Macro

The values of Intended Number of Fractions (300A,0636) and the attributes in Radiation Fraction Pattern Macro provide information about the planned treatment at the time the RT Radiation Set Instance was created.

C.36.11 RT Dose Contribution Module

The RT Dose Contribution Module contains information about the contribution of dose of the RT Radiations referenced by this RT Radiation Set IOD. Dose contributions refer to the RT Radiations delivering the dose and to anatomical structures receiving the dose.

Note that an anatomical structure (as defined by the Conceptual Volume Macro) can either be a textually tagged definition, or a reference to a Conceptual Volume defined in the RT Segment Annotation IOD. In all cases, Conceptual Volumes are identified by a UID which allows accumulation of dose to a given Conceptual Volume across RT Radiation Sets and comparison with prescribed Dosimetric Objectives.

Dose contributions are defined using Meterset values. The definition points in the Meterset to Dose Mapping Sequence may or may not align with the Meterset values at the Control Points of the RT Radiation SOP Instance. For example, where a dose deposition between Control Points cannot be determined individually per segment or where this definition is not useful, the lookup table may just contain the Meterset of first and last Control Points. The Meterset and dose contribution of the first Control Point are always zero. For further details see Section C.36.11.1.1.

Table C.36.11-1. RT Dose Contribution Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiation Dose Identification Sequence	(300A,0618)	1	Identifies the dose values that are delivered by this RT Radiation Set SOP Instance. One or more Items shall be included in this Sequence.
>Radiation Dose Identification Index	(300A,0603)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Radiation Dose Identification Label	(300A,0619)	1	Label of this Radiation Dose for the user.

Attribute Name	Tag	Type	Attribute Description
>Reference Dose Type	(300A,061A)	1	Type of reference dose. Defined Terms: **PER_RADIATION** Dose values are calculated individually for each referenced RT Radiation SOP Instance. **NOMINAL** Dose values are calculated on the Fraction level and assigned to individual RT Radiation SOP Instances without Instance-specific calculations.
>Reference Dose Point Coordinates	(300A,061E)	1C	The x, y, and z coordinates, in mm of the reference dose point in the DICOM Patient Coordinate System at which the dose values are calculated. Required if dose is calculated at a point.
>Conceptual Volume Sequence	(3010,0025)	1	Reference to a Conceptual Volume that receives dose. See Section C.36.11.1.2. Only a single Item shall be included in this Sequence. Each Conceptual Volume UID (3010,0006) shall appear only once in the Radiation Dose Identification Sequence (300A,0618).
>>Include Table 10.34-1 “Conceptual Volume Segmentation Reference And Combination Macro Attributes”.			
Radiation Dose Sequence	(300A,0617)	1	Parameters that describe dose contributed by referenced RT Radiation SOP Instances. For every SOP Instance referenced in RT Radiation Sequence (300A,0616) exactly one item shall be present in this Sequence.
>Referenced RT Radiation Sequence	(300A,0630)	1	References the RT Radiation SOP Instance that describes parameters for dose delivery. Only a single Item shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”.			
>Radiation Dose Values Parameters Sequence	(300A,061F)	1	Dose values of this RT Radiation with respect to the dose identification items defined in the Radiation Dose Identification Sequence (300A,0618). The number of Items included in this Sequence shall be the same as the number of Items in the Radiation Dose Identification Sequence (300A,0618).
>>Primary Dose Value Indicator	(300A,061B)	1	Whether the dose value serves as the primary dose indicator for the RT Radiation SOP Instance. Enumerated Values: **YES** **NO** Exactly one item in the Radiation Dose Values Parameters Sequence (300A,061F) shall have the value YES. See Section C.36.11.1.3.
>>Referenced Radiation Dose Identification Index	(300A,060C)	1	The value of Radiation Dose Identification Index (300A,0603) in the Radiation Dose Identification Sequence (300A,0618) identifying the dose contribution to which this Item in the Radiation Dose Values Parameters Sequence (300A,061F) applies.

Attribute Name	Tag	Type	Attribute Description
>>Dose Values Sequence	(300A,061C)	1C	Dose values. Required if the Meterset to dose mapping is defined. One or more Items shall be present. Each Radiobiological Dose Effect Flag (3010,0002) value shall appear no more than once in this Sequence.
>>>Dose Value Purpose	(300A,061D)	1	Purpose(s) for which dose values in this Sequence Item are provided. Defined Terms: **TRACKING** The dose values are used for tracking. **QA** The dose values are used for quality assurance.
>>>Include Table C.36.2.1.5-1 "Radiobiological Dose Effect Description Macro Attributes".			
>>>Meterset to Dose Mapping Sequence	(300A,0620)	1	Mapping of Cumulative Meterset (300A,063C) to Radiation Dose Value (300A,0625). See Section C.36.11.1.1. Two or more Items shall be included in this Sequence.
>>>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered. See Section C.36.11.1.1.
>>>>Radiation Dose Value	(300A,0625)	1	Dose value (in Gy) delivered at the corresponding Cumulative Meterset (300A,063C). See Section C.36.11.1.5.
>Expected In-Vivo Measurement Values Sequence	(300A,0621)	1C	Expected values against which in-vivo measurements may be compared. Required if expected values are calculated for in-vivo measurement for this RT Radiation SOP Instance. One or more Items shall be included in this Sequence.
>>Expected In-Vivo Measurement Value Index	(300A,0622)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>>Radiation Dose In-Vivo Measurement Label	(300A,0623)	1	Label to identify the in-vivo measurement point. See Section 10.31.1.1.
>>Radiation Dose Central Axis Displacement	(300A,0624)	1C	Displacement (x,y) in mm of the measurement point from the central axis along the x-axis and y-axis of the Beam Modifier Definition Plane. Required if a central beam axis is defined for the Treatment Delivery Device and the Radiation Dose Measurement Point Coordinates (300A,0627) is not present.
>>Meterset to Dose Mapping Sequence	(300A,0620)	1	Mapping of Cumulative Meterset (300A,063C) to Radiation Dose Value (300A,0625). One or more Items shall be included in this Sequence.
>>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered. See Section C.36.11.1.1.

Attribute Name	Tag	Type	Attribute Description
>>>Radiation Dose Value	(300A,0625)	1	Dose Value in Gy at the measurement point. See Section C.36.11.1.5.
>>Radiation Dose Source to Skin Distance	(300A,0626)	2	Distance in mm from the nominal Radiation Source location to the patient skin along the central beam axis from the source to the measurement point.
>>Radiation Dose Source to External Contour Distance	(300A,0628)	2	Distance in mm from the nominal Radiation Source location to the External ~~Contouralong~~Contour along the central beam axis from the source to the measurement ~~pointincluding~~point including devices associated with the patient anatomy model. For dosimetric purposes this value may differ from ~~theRadiation~~the Radiation Dose Source to Skin Distance(300A,0626). See Section C.36.11.1.4.
>>Radiation Dose Measurement Point Coordinates	(300A,0627)	1C	Coordinates (x,y,z) in mm in the DICOM Patient Coordinate System of the measurement point. Required if Radiation Dose Central Axis Displacement (300A,0624) is not present.

C.36.11.1 RT Dose Contribution Attribute Description

C.36.11.1.1 Meterset to Dose Mapping Sequence

The Meterset to Dose Mapping Sequence (300A,0620) contains for each Meterset value the corresponding dose value.

In the first item, the value of Cumulative Meterset (300A,063C) and of Radiation Dose Value (300A,0625) shall be zero.

In the last item, the value of Cumulative Meterset (300A,063C) shall be the Meterset of the final Control Point. The value of Radiation Dose Value (300A,0625) in the last item represents the dose delivered to the referenced anatomy when one fraction is completely delivered.

Cumulative Meterset Values shall be strictly monotonically increasing. Radiation Dose Values shall be monotonically non-decreasing. The increase of dose between two adjacent points of the lookup table shall be interpreted as linear.

C.36.11.1.2 Conceptual Volume Sequence

The Conceptual Volume Sequence (3010,0025) identifies a Conceptual Volume that defines a volume for which dose is tracked during treatments.

If the Conceptual Volume is associated with a segment, the segment is defined by the Referenced Segment Reference Index (3010,0020) in the Conceptual Volume Segmentation Reference and Combination Macro (see Section 10.34).

Alternatively, the Conceptual Volume may not be associated with a segment. For example, dose tracking may specify a nominal dose to an anatomical region of interest and the tracking coefficients approximated by Meterset values.

C.36.11.1.3 Primary Dose Value Indicator

The Primary Dose Value Indicator (300A,061B) is intended to indicate the representative dose value out of the list of dose values which is used for display purposes. Typically this value refers to the primary target while the other non-primary values may refer to e.g., organs at risk.

C.36.11.1.4 Radiation Dose Source to External Contour Distance

The Radiation Dose Source to External Contour Distance (gggg,9B7E) is the distance to the beam entry point, which may include Bolus, Patient Positioning Devices, Patient Immobilization Devices or other devices. This value is useful for including the attenuation effects of external devices on the dose calculation and for patient setup.

C.36.11.1.5 Radiation Dose Value

The Radiation Dose Value (300A,0625) represents the cumulative dose delivered from the beginning of radiation delivery to the Cumulative Meterset (300A,063C).

C.36.12 RT Delivery Device Common Module

The RT Delivery Device Common Module contains general information pertaining to the physical device used to deliver the treatment.

Table C.36.12-1. RT Delivery Device Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.36.2.2.1-1 "Treatment Device Identification Macro Attributes".			
Radiation Dosimeter Unit Sequence	(300A,0658)	1	Measurement units of the machine dosimeter. Only a single item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes".			CID is specified in the IOD
RT Device Distance Reference Location Code Sequence	(300A,0659)	1	Point of reference used for measuring the distance to various devices. Only a single item shall be included in this Sequence.
>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 9544 "Radiotherapy Distance Reference Locations".*
RT Beam Modifier Definition Distance	(300A,0688)	1	Absolute distance in mm along the z-axis of the Base Beam Modifier Coordinate System from the reference location as specified by RT Device Distance Reference Location Code Sequence (300A,0659) to the Beam ~~ModifierDefinition~~Modifier Definition Plane. The value shall be greater than or equal to zero. See Section C.36.1.1.9.
Equipment Frame of Reference UID	(300A,0675)	1	Frame of Reference identifier for the Treatment Delivery Device. See Section C.36.12.1.1.
Equipment Frame of Reference Description	(300A,0676)	3	Description of Equipment Coordinate System identified by the Equipment Frame of Reference UID (300A,0675). See Section C.36.12.1.2.
Equipment Reference Point Coordinates Sequence	(300A,0677)	2	Coordinates of device-specific reference points. Zero or more Items shall be included in this Sequence.
>3D Point Coordinate	(0068,6590)	1	Coordinates (x,y,z) in mm of the device-specific reference point in the Equipment Coordinate System.
>Equipment Reference Point Code Sequence	(300A,0678)	1	Identifies the type of reference point. Only a single Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes".			*DCID 9554 "Equipment Reference Points".*
Include Table C.36.2.2.2-1 "RT Patient Support Devices Macro Attributes".			

C.36.12.1 RT Delivery Device Common Module Attribute Descriptions

C.36.12.1.1 Equipment Frame of Reference UID

The Equipment Frame of Reference UID (300A,0675) identifies the Equipment Coordinate System for a Treatment Delivery Device, see Section 10.39.1.1.

The RT Radiation SOP Classes are bound by the Standard to specific Well-known Frames of Reference as defined in Table A-2 in PS3.6. For C-Arm based devices delivering radiation at a single machine isocenter this may be the [IEC 61217] coordinate system. Devices are calibrated to a specific Well-known Frame of Reference and thus use the corresponding Well-known UID in Equipment Frame of Reference UID (300A,0675).

For RT Radiation SOP Classes the result of the transformation between the Patient-based Coordinate System and the Equipment Coordinate System is used to describe the intended treatment position. If two or more transformation matrices describe the relation between two or more Patient-based coordinate systems and a single Equipment Coordinate System, any calculations assuming transitivity via the Equipment Coordinate System must be performed with great care because the patients anatomy may have changed.

For RT Radiation Record SOP Classes the result of the transformation between the Patient-based Coordinate System and the Equipment Coordinate System is used to describe the actual treatment position. In this case the transformation matrices between different Patient-Based coordinate Systems and a single Equipment Coordinate System shall not be considered transitive from an anatomical point of view and may only be used to compare different treatment positions with respect to the treatment delivery device.

C.36.12.1.2 Equipment Frame of Reference Description

The Equipment Frame of Reference Description (300A,0676) is informal and shall not be used for any normative description of the Equipment Coordinate System.

C.36.12.2 Well-known Frame of Reference For Equipment

The following sections contain specifications of Well-known Frames of Reference used as the Equipment Frame of Reference.

C.36.12.2.1 IEC 61217 Fixed Reference System Frame of Reference

The Well-known Value of 1.2.840.10008.1.4.3.1 for Equipment Frame of Reference UID (300A,0675) defines the IEC 61217 Fixed Coordinate System Frame of Reference as follows:

- The Equipment Coordinate System is the [IEC 61217] FIXED coordinate system.
- The Base Beam Modifier Coordinate System for all beam modifiers is the [IEC 61217] GANTRY coordinate system. However, RT Radiation SOP Classes allow each Beam Modifier Coordinate System to rotate independently from the Base Beam Modifier Coordinate System.

Note

1. [IEC 61217] refers to the X-axis, Y-axis and Z-axis of the various coordinate systems. When referenced in this Standard the capital X/Y/Z is preserved which is not otherwise a DICOM convention.
2. For the C-arm Photon-Electron Radiation IOD and the Tomotherapeutic Radiation IOD, the RT Beam Modifier Definition Distance (300A,0688) is the same as the Radiation Source-Axis Distance (300A,0640).

C.36.12.2.2 Standard Robotic-Arm Coordinate System Frame of Reference

The Well-known Value of 1.2.840.10008.1.4.3.2 for Equipment Frame of Reference UID (300A,0675) identifies the Standard Robotic-Arm Coordinate System Frame of Reference to which each device is calibrated during installation.

This coordinate system definition requires that two X-Ray detectors are present at the same height and the X-ray beams intersect.

The right-handed coordinate system axes are oriented as follows, when viewed from the patient support device pedestal towards the delivery device:

- the x-axis is increasing to the right, parallel to the line between the centers of the X-ray detectors and perpendicular to gravity

- the z-axis is increasing away from the direction of gravity
- the y-axis is the cross-product of the z- and x-axis

The origin of the coordinate system is the intersection of the central beams from each X-ray source, where the central beam is the line from the X-ray source to the center of the corresponding detector. The coordinate system definition is independent of the location of the delivery device and the patient support system.

Movements of the robot head are described in the Standard Robotic-Arm Coordinate System. The rotation of the robot head is expressed by a rotation of the Radiation Source Coordinate System with respect to the Standard Robotic-Arm Coordinate System. The origin of the Radiation Source Coordinate System is defined at the RT Device Distance Reference Location. The axes of the Radiation Source Coordinate System coincide with the Standard Robotic-Arm Coordinate System under the following conditions:

- the source position equals 0,0,0, and
- the pitch, roll, and yaw angles equal zero.

The Radiation Source Coordinate System is the parent system of the Base Beam Modifier Coordinate System. The Base Beam Modifier Coordinate System is negatively offset along the z-axis of the Radiation Source coordinate system by the RT Beam Modifier Definition Distance (300A,0688).

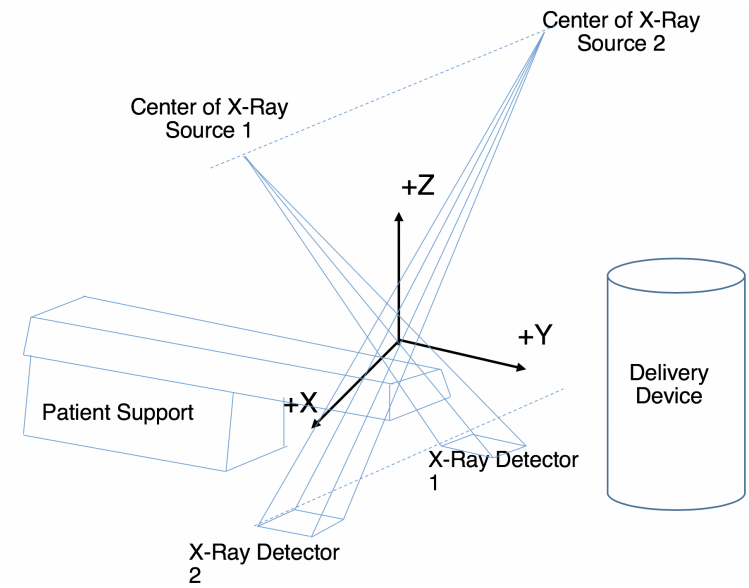


Figure C.36.12.2-1. Standard Robotic-Arm Coordinate System

C.36.13 RT Radiation Common Module

The RT Radiation Common Module contains the Attributes shared by all RT Radiation IODs used for radiation treatment delivery.

Table C.36.13-1. RT Radiation Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table 10.9.1-1 "Enhanced Content Identification Macro Attributes".			
~~*Include* Table C.36.2.1.6-1 "RT Radiation Common Base Macro Attributes".~~			
Include Table C.36.2.1.6-1 "RT Radiation Common Base Macro Attributes".			
Treatment Time Limit	(300A,062E)	3	The maximum delivery time in seconds. See Section C.36.13.1.3.

C.36.13.1 RT Radiation Common Attribute Descriptions

C.36.13.1.1 Radiotherapy Procedure Technique Sequence

See Section C.36.2.1.6.1.1.

C.36.13.1.2 RT Treatment Position Macro

See Section C.36.2.1.6.1.2.

C.36.13.1.3 Treatment Time Limit

The Treatment Time Limit (300A,062E) is the maximum time span allowed to deliver a single fraction of this RT Radiation SOP Instance. The behavior of the treatment delivery device on exceeding the Treatment Time Limit is up to the implementation. Treatment is expected to terminate upon reaching the Treatment Time Limit (300A,062E) independent of the Meterset and so this Attribute should have a value that accommodates normal variations in delivery.

C.36.13.1.4 Treatment Machine Special Mode Sequence

See Section C.36.2.1.6.1.3.

C.36.14 C-Arm Photon-Electron Delivery Device Module

The C-Arm Photon-Electron Delivery Device Module contains C-Arm-specific parameters pertaining to the physical device. These parameters are used to specify or record photon and electron treatments, including geometrical parameters of the collimation system.

Table C.36.14-1. C-Arm Photon-Electron Delivery Device Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiation Source-Axis Distance	(300A,0640)	1	Distance in mm from the nominal Radiation Source location to the gantry rotation axis.
~~*Include* Table C.36.2.2.7-1 “Radiation Generation Mode Macro Attributes”.~~			~~*Radiation Type Code Sequence (300A,067F) D*CID 9525 “Radiation Therapy Particle”.~~ ~~*Energy Unit Code Sequence (300A,0684) D*CID 9521 “Radiotherapy Treatment Energy Unit”.~~ ~~*Radiation Fluence Modifier Code Sequence (300A,0683) D*CID 9549 “Radiation Generation Mode Types”.~~
Include Table C.36.2.2.7-1 “Radiation Generation Mode Macro Attributes”.			*Radiation Type Code Sequence (300A,067F) D*CID 9525 “Radiation Therapy Particle”. *Energy Unit Code Sequence (300A,0684) D*CID 9521 “Radiotherapy Treatment Energy Unit”. *Radiation Fluence Modifier Code Sequence (300A,0683) D*CID 9549 “Radiation Generation Mode Types”.
~~*Include* Table C.36.2.2.8-1 “RT Beam Limiting Devices Definition Macro Attributes”.~~			~~*Device Type Code Sequence (3010,002E) within RT Accessory Device Identification Macro D*CID 9541 “Beam Limiting Device Types”.~~
Include Table C.36.2.2.8-1 “RT Beam Limiting Devices Definition Macro Attributes”.			*Device Type Code Sequence (3010,002E) within RT Accessory Device Identification Macro D*CID 9541 “Beam Limiting Device Types”.
Include Table C.36.2.2.10-1 “Wedges Definition Macro Attributes”.			
Include Table C.36.2.2.12-1 “Compensators Definition Macro Attributes”.			

Attribute Name	Tag	Type	Attribute Description
Include Table C.36.2.2.13-1 “Blocks Definition Macro Attributes”.			
Include Table C.36.2.2.14-1 “RT Accessory Holders Definition Macro Attributes”.			
Include Table C.36.2.2.15-1 “General Accessories Definition Macro Attributes”.			
Include Table C.36.2.2.16-1 “Boluses Definition Macro Attributes”.			

C.36.15 C-Arm Photon-Electron Beam Module

The C-Arm Photon-Electron Beam Module specifies how a C-Arm photon or electron treatment beam is to be delivered.

Table C.36.15-1. C-Arm Photon-Electron Beam Module Attributes

Attribute Name	Tag	Type	Attribute Description
Number of RT Control Points	(300A,0604)	1	Number of RT Control Points in the C-Arm Photon-Electron Control Point Sequence (300A,062F). The value shall be equal to or greater than 2.
C-Arm Photon-Electron Control Point Sequence	(300A,062F)	1	Control Points used to model the beam delivery. The number of Items included in this Sequence shall equal the value of Number of RT Control Points (300A,0604).
>Include Table C.36.2.2.6-1 “External Beam Control Point General Macro Attributes”.			*DCID 9550 “C-Arm Photon-Electron Delivery Rate Units”.*
>Referenced Radiation Generation Mode Index	(300A,0605)	1C	The value of Radiation Generation Mode Index (300A,0601) in the Radiation Generation Mode Sequence (300A,067B) in this IOD that defines the Radiation Generation Mode used for this Control Point. Required if Number of Radiation Generation Modes (300A,0685) is present and the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Include Table C.36.2.2.9-1 “RT Beam Limiting Device Opening Macro Attributes”.			
>Include Table C.36.2.2.11-1 “Wedge Positions Macro Attributes”.			
>Source Roll Angle	(300A,067A)	1C	Source roll angle in degrees of the Radiation Source at the Control Point with respect to the Equipment Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.15.1.1 and Section C.36.12.1.1. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.
>RT Beam Limiting Device Angle	(300A,0679)	1C	Angle in degrees of the Base Beam Modifier Coordinate System about the z-axis relative to the parent coordinate system. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.15.1.2. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Source to Patient Surface Distance	(300A,0634)	2C	Distance in mm from the nominal Radiation Source location to the Patient surface (skin) along the central beam axis from the source. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.

Attribute Name	Tag	Type	Attribute Description
>Source to External Contour Distance	(300A,0132)	2C	Distance in mm along ~~thecentral beam axisfrom~~the central beam axis from the nominal Radiation Source location to the external contour including devices associated with the patient anatomy model. For dosimetric purposes this value may differ from the Source to Patient Surface Distance (300A,0634). See Section C.36.11.1.4. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.

C.36.15.1 C-Arm Photon-Electron Beam Attribute Description

C.36.15.1.1 Source Roll Angle

For an Equipment Frame of Reference UID (300A,0675) of 1.2.840.10008.1.4.3.1 (IEC 61217 Fixed Coordinate System Frame of Reference), the source roll angle is the rotation of the [IEC 61217] GANTRY coordinate system about the Y-axis of the [IEC 61217] FIXED coordinate system.

C.36.15.1.2 RT Beam Limiting Device Angle

For an Equipment Frame of Reference UID (300A,0675) of 1.2.840.10008.1.4.3.1 (IEC 61217 Fixed Coordinate System Frame of Reference), the RT Beam Limiting Device Angle (300A,0679) is the rotation of the Base Beam Modifier Coordinate System about the Z-axis of the [IEC 61217] GANTRY coordinate system.

C.36.16 Tomotherapeutic Delivery Device Module

The Tomotherapeutic Delivery Device Module contains tomotherapy-specific information pertaining to the physical device. These parameters are used to specify or record the treatment, including geometrical parameters of the collimation system.

Table C.36.16-1. Tomotherapeutic Delivery Device Module Attributes

Attribute Name	Tag	Type	Description
Radiation Source-Axis Distance	(300A,0640)	1	Distance in mm from the nominal Radiation Source location to the gantry rotation axis.
Include Table C.36.2.2.7-1 “Radiation Generation Mode Macro Attributes”.			*Radiation Type Code Sequence (300A,067F) DCID 9525 “Radiation Therapy Particle”.* *Energy Unit Code Sequence (300A,0684) DCID 9521 “Radiotherapy Treatment Energy Unit”.* *Radiation Fluence Modifier Code Sequence (300A,0683) DCID 9549 “Radiation Generation Mode Types”.*
Include Table C.36.2.2.8-1 “RT Beam Limiting Devices Definition Macro Attributes”.			*Device Type Code Sequence (3010,002E) within RT Accessory Device Identification Macro DCID 9541 “Beam Limiting Device Types”.*

C.36.17 Tomotherapeutic Beam Module

The Tomotherapeutic Beam Module specifies or records how a tomotherapeutic treatment is to be or was delivered.

Table C.36.17-1. Tomotherapeutic Beam Module Attributes

Attribute Name	Tag	Type	Description
Table Speed	(0018,9309)	1C	Nominal table speed in mm/s. Required if RT Record Flag (300A,0639) equals NO. May be present otherwise.
Revolution Time	(0018,9305)	1C	Nominal time in seconds of one rotation of the gantry. Required if RT Treatment Technique Code Sequence (3010,0080) contains (130108, DCM, "Helical Beam") and if RT Record Flag (300A,0639) equals NO. May be present if RT Treatment Technique Code Sequence (3010,0080) contains (130108, DCM, "Helical Beam") and if RT Record Flag (300A,0639) equals YES.
Number of RT Control Points	(300A,0604)	1	Number of RT Control Points in the Tomotherapeutic Control Point Sequence (3010,0098). The value shall be equal to or greater than 2.
Tomotherapeutic Control Point Sequence	(3010,0098)	1	Control Points for the beam delivery. The number of Items included in this Sequence shall equal the value of Number of RT Control Points (300A,0604).
>Include Table C.36.2.2.6-1 “External Beam Control Point General Macro Attributes”.			*Defined CID 9558 "Tomotherapeutic Dose Rate Units"*
>Include Table C.36.2.2.9-1 “RT Beam Limiting Device Opening Macro Attributes”.			
>Referenced Radiation Generation Mode Index	(300A,0605)	1C	The value of Radiation Generation Mode Index (300A,0601) in the Radiation Generation Mode Sequence (300A,067B) in this IOD that defines the Radiation Generation Mode used for this Control Point. Required if Number of Radiation Generation Modes (300A,0685) is present and the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Source Roll Angle	(300A,067A)	1C	Source roll angle in degrees of the Radiation Source at the Control Point with respect to the Equipment Coordinate System. The angle is a Continuous Rotation Angle, see Section C.36.1.1.5. See Section C.36.15.1.1 and Section C.36.12.1.1. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Tomotherapeutic Leaf Open Durations	(3010,0099)	1C	The time in seconds each leaf is open during the Control Point interval, see Section C.36.17.1. The number of leaves (N) is equal to Number of Parallel RT Beam Delimiters (300A,0648). N values shall be provided in the order of Parallel RT Beam Delimiter Boundaries (300A,0649). Required if RT Record Flag (300A,0639) equals NO and the conditions in Section C.36.2.2.5.1.1 are satisfied.

Attribute Name	Tag	Type	Description
>Tomotherapeutic Leaf Initial Closed Durations	(3010,009A)	1C	The time in seconds each leaf is closed at the beginning of the Control Point interval, see Section C.36.17.1. The number of leaves (N) is equal to Number of Parallel RT Beam Delimiters (300A,0648). The N values shall be provided in the order of Parallel RT Beam Delimiter Boundaries (300A,0649). Required if RT Record Flag (300A,0639) equals NO and at least one leaf open time is not symmetrical about the mid-point of the Control Point interval and the conditions in Section C.36.2.2.5.1.1 are satisfied.

C.36.17.1 Tomotherapeutic Leaf Closed and Open Durations

Typically, the Tomotherapeutic Leaf Open Durations (3010,0099) are symmetric about the mid-point of the Control Point interval. If they are not, Tomotherapeutic Leaf Initial Closed Durations (3010,009A) is present, which specifies the duration of time that each leaf is closed starting from this Control Point. Tomotherapeutic Leaf Open Durations (3010,0099) then specifies the duration of time that each leaf is open after Tomotherapeutic Leaf Initial Closed Durations (3010,009A).

For each leaf, the sum of the Tomotherapeutic Leaf Initial Closed Durations (3010,009A) and the Tomotherapeutic Leaf Open Durations (3010,0099) shall not exceed the Control Point interval.

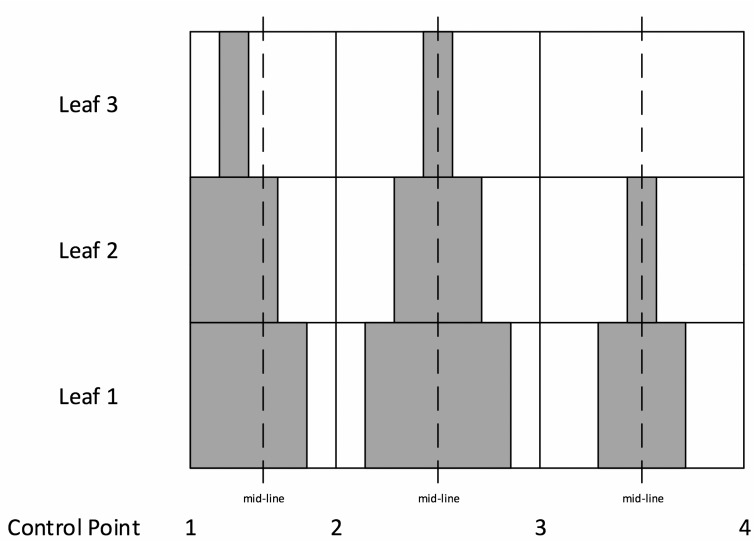


Figure C.36.17-1. Diagram of Tomotherapeutic Leaf Open and Closed Durations

Table C.36.17-2. Tomotherapeutic Leaf Open and Closed Durations

N Control Point Index	Attribute	Leaf 1	Leaf 2	Leaf 3
1	Tomotherapeutic Leaf Open Durations	0.4s	0.3s	0.1s
	Tomotherapeutic Leaf Initial Closed Durations	0	0	0.1s
2	Tomotherapeutic Leaf Open Durations	0.5s	0.3s	0.1s
	Tomotherapeutic Leaf Initial Closed Durations	Not present		
3	Tomotherapeutic Leaf Open Durations	0.3s	0.1s	0
	Tomotherapeutic Leaf Initial Closed Durations	Not present		

In Figure C.36.17-1, the ~~grey~~gray sections indicate when the leaves are open during radiation delivery. Table C.36.17-2 illustrates the use of Tomotherapeutic Leaf Open Durations (3010,0099) and Tomotherapeutic Leaf Initial Closed Durations (3010,009A) based on the diagram. In the Control Point interval between Control Point 1 and 2, the leaf openings are not symmetric within the Control Point interval, so Tomotherapeutic Leaf Initial Closed Durations (3010,009A) is provided.

In the Control Point interval between Control Point 2 and 3, all leaf opening durations are symmetric about the mid-point of the Control Point interval, therefore only Tomotherapeutic Leaf Open Durations (3010,0099) is provided.

C.36.18 Robotic-Arm Delivery Device Module

The Robotic-Arm Delivery Device Module contains robot-specific information pertaining to the physical device. These parameters are used to specify or record the treatment, including geometric parameters of the collimation system.

Table C.36.18-1. Robotic-Arm Delivery Device Module Attributes

Attribute Name	Tag	Type	Description
Robotic Base Location Indicator	(3010,0090)	1	Informative manufacturer-specific description of the location of the base of the robot. The value is independent of the Equipment Coordinate System. Defined Terms: **FLOOR_LEFT** Looking from the table towards the robot, the robot is floor-mounted to the viewer's left. **FLOOR_RIGHT** Looking from the table towards the robot, the robot is floor-mounted to the viewer's right. **FLOOR_CENTER** Looking from the table towards the robot, the robot is floor-mounted straight ahead of the viewer.
Include Table C.36.2.2.7-1 “Radiation Generation Mode Macro Attributes”.			*Radiation Type Code Sequence (300A,067F) DCID 9525 “Radiation Therapy Particle”.* *Energy Unit Code Sequence (300A,0684) DCID 9521 “Radiotherapy Treatment Energy Unit”.* *Radiation Fluence Modifier Code Sequence (300A,0683) DCID 9549 “Radiation Generation Mode Types”.*
Include Table C.36.2.2.8-1 “RT Beam Limiting Devices Definition Macro Attributes”.			*Device Type Code Sequence (3010,002E) within RT Accessory Device Identification Macro DCID 9541 “Beam Limiting Device Types”.*
Include Table C.36.2.2.14-1 “RT Accessory Holders Definition Macro Attributes”.			

C.36.19 Robotic-Arm Path Module

The Robotic-Arm Path Module specifies or records how a Robotic Path treatment is to be delivered. Multiple paths are encoded as separate RT Radiation Instances referred to in the RT Radiation Set IOD.

Table C.36.19-1. Robotic-Arm Path Module Attributes

Attribute Name	Tag	Type	Description
Robotic Path Node Set Code Sequence	(3010,0091)	1C	Node Set from which the Robotic Nodes referenced in the Robotic Path Control Point Sequence (3010,0097) were selected. Only a single Item shall be included in this Sequence. Required if RT Record Flag (300A,0639) is NO. May be present otherwise.
>Include Table 8.8-1 “Code Sequence Macro Attributes”.			*DCID 9556 “Radiotherapy Robotic Node Sets”.*

Attribute Name	Tag	Type	Description
Number of RT Control Points	(300A,0604)	1	Number of RT Control Points in the Robotic Path Control Point Sequence (3010,0097). The value shall be greater than or equal to 2.
Robotic Path Control Point Sequence	(3010,0097)	1	Control Points for the radiation delivery. The number of Items included in this Sequence shall equal the value of Number of RT Control Points (300A,0604).
>Include Table C.36.2.2.6-1 "External Beam Control Point General Macro Attributes".			*DCID 9560 "Robotic Delivery Device Dose Rate Units".*
>Referenced Radiation Generation Mode Index	(300A,0605)	1C	The value of Radiation Generation Mode Index (300A,0601) in the Radiation Generation Mode Sequence (300A,067B) in this IOD that defines the Radiation Generation Mode used for this Control Point. Required if Number of Radiation Generation Modes (300A,0685) is present and the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Robotic Node Identifier	(3010,0092)	1C	Identifier of the individual Robotic Node (point in space) along the Robotic Path. See Note 1. Required if the conditions in Section C.36.2.2.5.1.1 are satisfied.
>RT Treatment Source Coordinates	(3010,0093)	1C	Coordinates (x,y,z) in mm of the Radiation Source Coordinate System origin ~~inthe~~in the Equipment Coordinate System. Required if RT Record Flag (300A,0639) is NO and the conditions in Section C.36.2.2.5.1.1 are satisfied. May be present if RT Record Flag (300A,0639) is YES and the conditions in Section C.36.2.2.5.1.1 are satisfied. See Section C.36.12.2.2.
>Radiation Source Coordinate System Yaw Angle	(3010,0094)	1C	Rotation angle in degrees of the Radiation Source Coordinate System about the z-axis of the Equipment Coordinate System, see Section C.36.12.2.2. Required if RT Record Flag (300A,0639) is NO and the conditions in Section C.36.2.2.5.1.1 are satisfied. May be present if RT Record Flag (300A,0639) is YES and the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Radiation Source Coordinate System Roll Angle	(3010,0095)	1C	Rotation angle in degrees of the Radiation Source Coordinate System about its y-axis after the Radiation Source Coordinate System Yaw Angle (3010,0094) is applied. Required if RT Record Flag (300A,0639) is NO and the conditions in Section C.36.2.2.5.1.1 are satisfied. May be present if RT Record Flag (300A,0639) is YES and the conditions in Section C.36.2.2.5.1.1 are satisfied.

Attribute Name	Tag	Type	Description
>Radiation Source Coordinate System Pitch Angle	(3010,0096)	1C	Rotation angle in degrees of the Radiation Source Coordinate System about its x-axis after the Radiation Source Coordinate System Roll Angle (3010,0095) is applied. Required if RT Record Flag (300A,0639) is NO and the conditions in Section C.36.2.2.5.1.1 are satisfied. May be present if RT Record Flag (300A,0639) is YES and the conditions in Section C.36.2.2.5.1.1 are satisfied.
>Include Table C.36.2.2.9-1 "RT Beam Limiting Device Opening Macro Attributes".			

Note

1. The values of Robotic Node ~~Identifer~~Identifier (3010,0092) within the Robotic Path Control Point Sequence (3010,0097) may identify Robotic Node positions that are pre-defined in the device configuration. This Attribute is distinct from the RT Control Point Index (300A,0600) , which simply indexes items within the Robotic Path Control Point Sequence (3010,0097).

C.36.20 RT Radiation Record Set Module

The RT Radiation Record Set Module contains treatment-modality-independent information about a set of delivered RT Radiations.

The RT Radiation Record Set may refer to an RT Radiation Set SOP Instance that has been used to define the treatment delivery. It may also record ad hoc delivery.

Table C.36.20-1. RT Radiation Record Set Module Attributes

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table 10.9.2-1, "Extended Content Identification Macro Attributes"~~			
Include Table 10.9.2-1, "Extended Content Identification Macro Attributes"			
Treatment Session UID	(300A,0700)	1	A unique identifier of the RT Treatment Session to which this Instance belongs.
Referenced RT Radiation Set Sequence	(300A,0702)	1C	The RT Radiation Set that contains the RT Radiation Instance(s) referenced by the Instances of the Referenced RT Radiation Record Sequence (300A,0703). Required if an RT Radiation Set Instance provided instructions to the treatment delivery system. Only a single Item shall be included in this Sequence.
~~>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"~~			
>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"			
RT Radiation Set Usage	(300A,0707)	1	A general indication of how the referenced RT Radiation Set was used. The Defined Terms are specified in Section C.36.10.1.1. This value may differ from the RT Radiation Set Intent (300A,0637) within the Instance referenced by the Referenced RT Radiation Set Sequence (300A,0702). See Section C.36.20.1.4.

Attribute Name	Tag	Type	Attribute Description
Referenced RT Radiation Record Sequence	(300A,0703)	1	RT Radiation Record SOP Instance(s) representing the record of the current treatment set that has been delivered. One or more Items shall be included in this Sequence. See Section C.36.20.1.1.
~~>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"~~			
>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"			
RT Radiation Set Delivery Number	(300A,0704)	1C	Count of the delivery of the referenced RT Radiation Set as represented by the current SOP Instance. Required if Referenced RT Radiation Set Sequence (300A,0702) is present and RT Radiation Set Usage (300A,0707) is TREATMENT. May be present otherwise. See Section C.36.20.1.2.
Clinical Fraction Number	(300A,0705)	1C	Count of the RT Treatment Fractions that have been delivered, irrespective of the RT Radiation Set(s) used. Required if Referenced RT Radiation Set Sequence (300A,0702) is present and RT Radiation Set Usage (300A,0707) is TREATMENT. May be present otherwise. See Section C.36.20.1.2.
RT Treatment Fraction Completion Status	(300A,0706)	1	Defines if the current SOP Instance records a complete treatment delivery of a RT Treatment Fraction. Enumerated Values: **COMPLETE** **PARTIAL** See Section C.36.20.1.3.

C.36.20.1 RT Radiation Record Set Attribute Descriptions

C.36.20.1.1 Referenced RT Radiation Record Sequence

All SOP Instances referenced in this Sequence shall be recorded by the same treatment device (specified by the Treatment Device Identification Macro within the RT Delivery Device Common Module).

An RT Radiation Record instance shall be referenced in exactly one RT Radiation Record Set instance.

The Treatment Session UID within the RT Radiation Record Set shall be identical to those in the Referenced RT Radiation Record instances.

The SOP Classes referenced in this Sequence shall contain the following Modules:

- Enhanced RT Series Module specified in Section C.36.3.
- Radiotherapy Common Instance Module specified in Section C.36.4.
- RT Delivery Device Common Module specified in Section C.36.12.
- RT Radiation Record Common Module specified in Section C.36.22.

C.36.20.1.2 RT Radiation Set Delivery Number and Clinical Fraction Number

The Clinical Fraction Number (300A,0705) tracks the clinical progress of treatment delivery. It is a counter that represents the number of times that an RT Radiation Set Instance or any Instance derived within an adaptive radiotherapy treatment process was delivered.

The RT Radiation Set Delivery Number (300A,0704) is a counter that represents the number of times the referenced RT Radiation Set Instance has been delivered.

The RT Radiation Set Delivery Number (300A,0704) of the delivered RT Treatment Fraction shall start with 1 for its first fraction and increase monotonically by 1, throughout all RT Radiation Record Set Instances referencing the same RT Radiation Set Instance identified by its SOP Instance UID (0008,0018), see Section 7.14.10.

If the same RT Radiation Set is used for all treatments, the values of RT Radiation Set Delivery Number (300A,0704) and the Clinical Fraction Number (300A,0705) have the same values.

For some adaptive treatment approaches, details of the device parameters may be altered at the treatment session to accommodate the current position and shape of the patient. In this case, a new RT Radiation Set SOP Instance is used for the subsequent RT Treatment Fractions and the RT Radiation Set Delivery Number(300A,0704) re-starts at 1.

The Clinical Fraction Number (300A,0705) is continuously incremented to reflect the clinical progress of a therapeutic series of treatments. In the RT Radiation Record Set for the last of the intended RT Treatment Fractions, this value will be equal to the Number of Fractions (3010,007D) present in the corresponding RT Prescription.

Example

RT Radiation Set P contains RT Radiations A, B; Adapted RT Radiations indicated by (') and (") ; RT Radiation Sets created are P, P' and P".

Table C.36.20-2. Delivery of Multiple RT Radiation Set Instances

Treatment Session	RT Radiation Set	Delivered RT Radiations	Clinical Fraction Number (300A,0705)	RT Radiation Set Delivery Number (300A,0704)
1	P	A,B	1	1 (of P)
2	P	A,B	2	2 (of P)
3	P'	A',B'	3	1 (of P')
4	P'	A',B'	4	2 (of P')
5	P"	A",B"	5	1 (of P")
6	P	A,B	6	3 (of P)

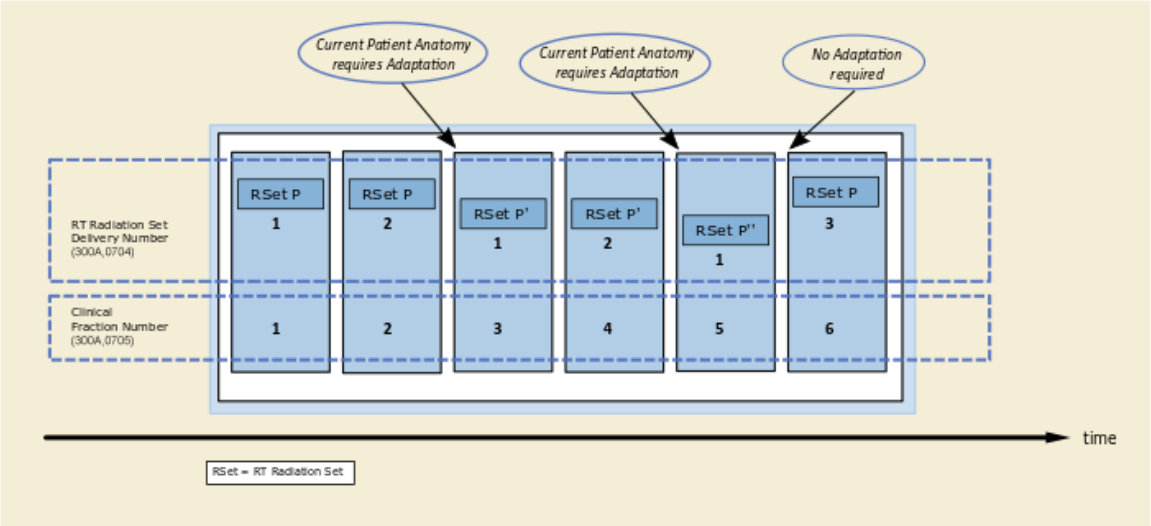


Figure C.36.20-1. Delivery of a Single RT Radiation Set Instance with Adaptive Treatments

C.36.20.1.3 Complete Versus Partial Fraction

When there is an RT Radiation Record Instance present for all of the RT Radiation Instances for this RT Treatment Fraction and they all have a Treatment Delivery Continuation Flag (300A,0708) of NO and have an RT Treatment Termination Status (300A,0714) of NORMAL the value of RT Radiation RT Treatment Fraction Completion Status (300A,0706) shall be COMPLETE. The expression "all of the RT Radiation Instances" refers to the referenced Instances in the RT Radiation Set, to which this current RT Radiation Record Set refers.

Otherwise the value of RT Treatment Fraction Completion Status (300A,0706) shall be PARTIAL.

Example

RT Radiation Set P contains RT Radiations A and B.

RT Radiation Record Sets created are W, X, Y, and Z.

Table C.36.20-3. Delivery of a Single RT Radiation Set Instance with Partial Treatments

Treatment Session	RT Radiation Set	Delivered RT Radiations	Treatment Delivery Continuation Flag (300A,0708)	RT Treatment Termination Status (300A,0714)	RT Radiation Record Set	RT Treatment Fraction Completion Status (300A,0706)	Clinical Fraction Number (300A,0705)	RT Radiation Set Delivery Number (300A,0704)
1	P	A	NO	NORMAL	W	PARTIAL	1	1
		B	NO	ABNORMAL				
2	P	B	YES	NORMAL	X	PARTIAL	1	1
		A	NO	NORMAL	Y	COMPLETE	2	2
		B	NO	NORMAL				
3	P	A	NO	NORMAL	Z	COMPLETE	3	3
		B	NO	NORMAL				

C.36.20.1.4 RT Radiation Set Usage

A typical example for different values of RT Radiation Set Usage (300A,0707) in the current RT Radiation Record Set SOP Instance versus in the SOP Instance referenced by the Referenced RT Radiation Set Sequence (300A,0702) is as follows: The treatment defined by the RT Radiation Set SOP Instance, in which RT Radiation Set Usage (300A,0707) has the value TREATMENT, may be

sent to the treatment device and applied for quality assurance without a patient being present. In this case, RT Radiation Set Usage (300A,0707) in the current SOP Instance has the value PLAN_QA.

C.36.21 RT Dose Contribution Record Module

The RT Dose Contribution Record Module contains information about the delivered dose.

Table C.36.21-1. RT Dose Contribution Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
Radiation Dose Identification Sequence	(300A,0618)	1	Identifies the dose values that are recorded by this RT Radiation Record Set IOD. One or more Items shall be included in this Sequence.
>Radiation Dose Identification Index	(300A,0603)	1	Index of this Item in this Sequence. The value shall start at 1 and increase monotonically by 1.
>Referenced Radiation Dose Identification Index	(300A,060C)	1C	Radiation Dose Identification Index value that links the Radiation Dose Identification defined by this Sequence Item to the corresponding Item in an RT Radiation Set Instance. Required if the Instance referenced in Referenced RT Radiation Set Sequence (300A,0702) contains a Radiation Dose Identification Sequence Item that corresponds to this Radiation Dose Identification Item.
>Radiation Dose Identification Label	(300A,0619)	1	User-defined label ~~forthe~~for the Radiation Dose Identification. See Section C.36.2.1.1.1.
>Conceptual Volume Sequence	(3010,0025)	1	Reference to a Conceptual Volume which received dose during treatment delivery. See Section C.36.21.1.1. Only a single Item shall be included in this Sequence.
~~>>*Include* Table 10.34-1, "Conceptual Volume Segmentation Reference And Combination Macro Attributes"~~			
>>*Include* Table 10.34-1, "Conceptual Volume Segmentation Reference And Combination Macro Attributes"			
Radiation Dose Sequence	(300A,0617)	1	Describes dose contributed by referenced RT Radiation Record SOP instances. For every SOP instance referenced in Referenced RT Radiation Record Sequence (300A,0703) exactly one item shall be present in this Sequence.
>Referenced RT Radiation Record Sequence	(300A,0703)	1	The RT Radiation Record SOP Instance that describes parameters for dose delivery of the recorded Radiotherapy treatment for the Fraction specified in RT Radiation Set Delivery Number (300A,0704). Only a single Item shall be included in this Sequence. See Section C.36.20.1.1.
~~>>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"~~			
>>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Radiation Dose Values Parameters Sequence	(300A,061F)	1C	Dose values of this RT Radiation Record with respect to the dose identification items defined in the Radiation Dose Identification Sequence (300A,0618). Required if Measured Meterset to Dose Mapping Sequence (300A,0772) is not present. May be present otherwise. The number of Items included in this Sequence shall be the same as the number of Items in the Radiation Dose Identification Sequence (300A,0618).
>>Referenced Radiation Dose Identification Index	(300A,060C)	1	The value of Radiation Dose Identification Index (300A,0603) in the Radiation Dose Identification Sequence (300A,0618) identifying the dose contribution to which this Item in the Radiation Dose Values Parameters Sequence (300A,061F) applies.
>>Meterset to Dose Mapping Sequence	(300A,0620)	1	Mapping of Cumulative Meterset (300A,063C) to Radiation Dose Value (300A,0625). This may be as defined in the RT Radiation Set for the RT Radiation or calculated for this RT Radiation Record Set. See Section C.36.11.1.1. Two or more Items shall be included in this Sequence.
>>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered. See Section C.36.11.1.1.
>>>Radiation Dose Value	(300A,0625)	1	Dose value (in Gy) delivered at the corresponding Cumulative Meterset (300A,063C). See Section C.36.11.1.5.
~~>>>*Include* Table C.36.2.1.5-1, “Radiobiological Dose Effect Description Macro Attributes”~~			
>>>*Include* Table C.36.2.1.5-1, “Radiobiological Dose Effect Description Macro Attributes”			
>Measured Meterset to Dose Mapping Sequence	(300A,0772)	1C	Measured dose values of this delivered radiation mapped to Meterset values. Required if Dose Mapping Sequence (300A,0620) is not present. May be present otherwise. One or more Items shall be included in this Sequence.
>>Referenced Expected In-Vivo Measurement Value Index	(300A,0773)	3	Expected In-Vivo Measurement Value Index (300A,0622) in the Expected In-Vivo Measurement Value Sequence (300A,0621) from the RT Radiation Set Instance that is being recorded.
>>Cumulative Meterset	(300A,063C)	1	Cumulative Meterset where a dose value is delivered.
>>Radiation Dose Value	(300A,0625)	1	Dose value in Gy delivered at the corresponding Cumulative Meterset (300A,063C) of the current SOP Instance.
>>Dose Measurement Device Code Sequence	(300A,0774)	2	Device used to measure the dose data. Zero or one Itemshall be included in this Sequence.
~~>>>*Include* Table 8.8-1, “Code Sequence Macro Attributes”~~			~~*D*CID 7026 “Radiotherapeutic Dose Measurement Devices”~~
>>>*Include* Table 8.8-1, “Code Sequence Macro Attributes”			*D*CID 7026 “Radiotherapeutic Dose Measurement Devices”
>>Measured Dose Description	(~~3008,9012~~3008,0012)	3	User-defined description of Measured Dose (e.g. "Exit dose", "Point A").

C.36.21.1 RT Dose Contribution Record Module Attribute Descriptions

C.36.21.1.1 Conceptual Volume Sequence

The Conceptual Volume Sequence (3010,0025) identifies a Conceptual Volume defining a volume for which dose has been recorded during treatments.

If the Conceptual Volume is associated with a segment, the segment is defined by the Referenced Segment Reference Index (3010,0020) in the Conceptual Volume Segmentation Reference and Combination Macro (see Section 10.34).

Alternatively, the Conceptual Volume might not be associated with a segment; for example, when dose recording is specified using a nominal dose to a volume and the tracking coefficients are approximated by Meterset values.

Typically, this Module references Conceptual Volumes which have been used in the RT Dose Contribution Module of the RT Radiation Set SOP Instance referenced by the Referenced RT Radiation Set Sequence (300A,0702).

C.36.22 RT Radiation Record Common Module

The RT Radiation Record Common Module contains treatment-modality-independent information about a delivered RT Radiation. A delivered RT Radiation may be radiation to a patient or radiation without a patient being present (e.g. for QA purposes).

Table C.36.22-1. RT Radiation Record Common Module Attributes

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table 10.9.2-1, "Extended Content Identification Macro Attributes"~~			
Include Table 10.9.2-1, "Extended Content Identification Macro Attributes"			
~~*Include* Table C.36.2.1.6-1, "RT Radiation Common Base Macro Attributes"~~			
Include Table C.36.2.1.6-1, "RT Radiation Common Base Macro Attributes"			
Treatment Session UID	(300A,0700)	1	Uniquely identifies the RT Treatment Session to which this instance belongs.
Referenced RT Instance Sequence	(300A,0631)	1C	The RT Radiation SOP Instance that provided the instruction to deliver the radiation. Required if an RT Radiation SOP Instance was used to provide the instructions to the delivery system. Only a single Item shall be included in this Sequence. See Section C.36.10.1.2.
~~>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"~~			
>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"			
RT Radiation Usage	(300A,0701)	1	A general indication of how the referenced RT Radiation was used. The Defined Terms are specified in Section C.36.10.1.1. This value may differ from the RT Radiation Set Intent (300A,0637) within the Instance referenced by the Referenced RT Radiation Set Sequence (300A,0702). See Section C.36.20.1.4.

Attribute Name	Tag	Type	Attribute Description
Treatment Record Content Origin	(300A,0709)	1	The origin of the content of this SOP Instance. Enumerated Values: **DEVICE** The content has been recorded by the treatment device which performed the treatment delivery. **USER** The content has been constructed based on user inputs.
Treatment Delivery Continuation Flag	(300A,0708)	1	Indicates whether this SOP Instance represents the record of a treatment delivery which was a continuation of a previously interrupted treatment delivery of the RT Treatment Fraction specified by the RT Radiation Set Delivery Number (300A,0704). Enumerated Values: **YES** The record represents a continuation. **NO** The record represents a treatment delivery that was started at the first RT Control Point.
RT Treatment Termination Status	(300A,0714)	1	Termination status of the recorded treatment. Enumerated Values: **NORMAL** The delivery of the fraction represented by the referenced RT Radiation IOD terminated as expected and the fraction has been correctly delivered. **ABNORMAL** The delivery of the fraction represented by the referenced RT Radiation IOD did not terminate as expected and the fraction has been incorrectly delivered.
RT Treatment Termination Reason Code Sequence	(300A,0715)	2C	Treatment machine termination code. This code is dependent upon the particular application and equipment. Required if RT Treatment Termination Status (300A,0714) is ABNORMAL. Zero or more items shall be included in this Sequence.
~~>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*D*CID 9561 "Treatment Termination Reasons"~~
>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*D*CID 9561 "Treatment Termination Reasons"
Machine-Specific Treatment Termination Code Sequence	(300A,0716)	3	Machine-specific termination codes. One or more Items are permitted in this Sequence.
~~>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*No Baseline CID is defined.*~~
>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*No Baseline CID is defined.*
Treatment Termination Description	(300A,0730)	2C	A user-readable description for an abnormal termination. Required if RT Treatment Termination Status (300A,0714) is ABNORMAL.

Attribute Name	Tag	Type	Attribute Description
Treatment Tolerance Violation Sequence	(300A,0731)	2	Reports violations of tolerances that occurred during treatment delivery. Zero or more items shall be included in this Sequence.
>Treatment Tolerance Violation DateTime	(300A,0736)	1	Datetime when Treatment Tolerance Violation occurred.
>Treatment Tolerance Violation Category	(300A,0732)	1	The category of tolerance violation which was exceeded. Defined Terms: **CLINICAL** Delivery went out of clinically allowed tolerance. **MACHINE** Delivery went out of machine tolerance.
>Treatment Tolerance Violation Type Code Sequence	(300A,0761)	1	Type of treatment tolerance violation. One or more Items shall be included in this Sequence.
~~>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*If Treatment Tolerance Violation Category (300A,0732) has the value CLINICAL, Defined CID is 9566 "Clinical Tolerance Violation Types"*~~ ~~*If Treatment Tolerance Violation Category (300A,0732) has the value MACHINE, Defined CID is 9567 "Machine Tolerance Violation Types"*~~
>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*If Treatment Tolerance Violation Category (300A,0732) has the value CLINICAL, Defined CID is 9566 "Clinical Tolerance Violation Types"* *If Treatment Tolerance Violation Category (300A,0732) has the value MACHINE, Defined CID is 9567 "Machine Tolerance Violation Types"*
>Treatment Tolerance Violation Cause Code Sequence	(300A,0762)	1	Cause of treatment tolerance violation. One or more Items shall be included in this Sequence.
~~>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*D*CID 9565 "Treatment Tolerance Violation Causes"~~
>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*D*CID 9565 "Treatment Tolerance Violation Causes"
>Treatment Tolerance Violation Attribute Sequence	(300A,0733)	2C	The Attribute whose value exceeded the tolerance. Required if the violation corresponds to an Attribute in the current SOP Instance. Zero or one Item shall be included in this Sequence.
~~>>*Include* Table 10-20a, "Extended Selector Attribute Macro Attributes"~~			
>>*Include* Table 10-20a, "Extended Selector Attribute Macro Attributes"			
>Treatment Tolerance Violation Identification	(300A,0735)	1C	An identification of the parameter(s) which exceeded the tolerance, intended for structured processing. Required if Treatment Tolerance Violation Attribute Sequence (300A,0733) is not present or has zero Items. May be present otherwise.

Attribute Name	Tag	Type	Attribute Description
>Treatment Tolerance Violation Description	(300A,0734)	1C	User-defined description of the treatment tolerance violation. This information is intended for display to human readers. Shall not be used for structured processing. Required if Treatment Tolerance Violation Attribute Sequence (300A,0733) is not present or has zero Items. May be present otherwise.
>Override Sequence	(3008,0060)	2	Overrides of this treatment tolerance violation, including the authorization by a qualified person to continue treatment delivery. Zero or one Items shall be included in this Sequence.
>>Operator Identification Sequence	(0008,1072)	1	Identification of the operator who authorized the override. One or more Items shall be present.
~~>>>*Include* Table C.17-3b, "Identified Person or Device Macro Attributes"~~			~~*The Observer Type (0040,A084) shall be PSN.*~~
>>>*Include* Table C.17-3b, "Identified Person or Device Macro Attributes"			*The Observer Type (0040,A084) shall be PSN.*
>>Override DateTime	(300A,0760)	1	Date and Time when the user authorized the override.
>>Override Reason	(3008,0066)	2	User-defined reason of the override. May contain notes, e.g. on the justification why the treatment was delivered in the presence of an interlock or unexpected machine condition.
>>Alternate Value Sequence	(300A,073E)	2	The alternate value for the parameter as accepted by the user when the override was entered. The actual value applied during treatment may be different. Zero or one Item shall be included in this Sequence.
~~>>>*Include* Table 10-2, "Content Item Macro Attributes Description"~~			~~*B*CID 9570 "RT Overridden Treatment Parameters"~~
>>>*Include* Table 10-2, "Content Item Macro Attributes Description"			*B*CID 9570 "RT Overridden Treatment Parameters"
Confirmation Sequence	(300A,073F)	2	Records confirmations (sign-offs) by treatment session operators of details that may not be verified electronically (e.g. the presence of devices). Zero or more Items shall be included in this Sequence.
~~>*Include* Table 10.30-1, "Assertion Macro Attributes"~~			~~*Assertion Code Sequence (0044,0101) B*CID 9564 "Treatment Session Confirmation Assertions".~~
>*Include* Table 10.30-1, "Assertion Macro Attributes"			*Assertion Code Sequence (0044,0101) B*CID 9564 "Treatment Session Confirmation Assertions".
Interlock Sequence	(300A,0740)	2	Interlocks which occurred prior, during or after the delivery of radiation covered by this SOP Instance. Zero or more Items shall be included in this Sequence.
>Interlock DateTime	(300A,0741)	1	Date and Time when the Interlock occurred. The date and time of occurrence may be when the interlock occurred (e.g. by a real-time system) or when the interlock was recorded. See Section C.7.4.2.1.4.
>Interlock Description	(300A,0742)	1	User-readable description of the interlock.

Attribute Name	Tag	Type	Attribute Description
>Interlock Origin Description	(300A,0783)	1C	Description of the origin of the interlock. Required if Interlock Originating Device Sequence (300A,0743) is not present.
>Interlock Originating Device Sequence	(300A,0743)	1C	Contains the attributes that identify the device that originated the interlock. Only a single Item shall be included in this Sequence. Required if Interlock Origin Description (300A,0783) is not present.
~~>>*Include* Table 10.36-1, "Device Identification Macro Attributes"~~			~~*No Baseline CID is defined.*~~
>>*Include* Table 10.36-1, "Device Identification Macro Attributes"			*No Baseline CID is defined.*
>Interlock Code Sequence	(300A,0744)	1	Code(s) that describe the interlock(s) that occurred. One or more Items shall be included in this Sequence.
~~>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*B*CID 9568 "Treatment Interlocks".~~
>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*B*CID 9568 "Treatment Interlocks".
>Interlock Resolution Code Sequence	(300A,0745)	1	The action applied to resolve the interlock. One or more Items shall be included in this Sequence.
~~>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"~~			~~*D*CID 9563 "Interlock Resolutions"~~
>>*Include* Table 8.8-1, "Code Sequence Macro Attributes"			*D*CID 9563 "Interlock Resolutions"
>Interlock Resolution User Sequence	(300A,0746)	1	The user that resolved the interlock. One or more Items shall be included in this Sequence.
~~>>*Include* Table 10-1, "Person Identification Macro Attributes Description"~~			
>>*Include* Table 10-1, "Person Identification Macro Attributes Description"			
Additional Parameter Recording Instance Sequence	(300A,0780)	3	SOP Instances that contain additional recording of treatment parameters. One or more Items are permitted in this Sequence. See Section C.36.22.1.1.
~~>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"~~			
>*Include* Table 10-11, "SOP Instance Reference Macro Attributes"			
>Creator-Version UID	(0008,9123)	1C	Unique identification of the equipment and version of the software that has created the referenced Instance that contains the additional parameters. The UID allows one to avoid attempting to interpret the additional parameters with an unknown format. Required if the Referenced SOP Class UID (0008,1150) is Raw Data Storage ("1.2.840.10008.5.1.4.1.1.66"). May be present otherwise. Note This value corresponds to the Creator-Version UID of a referenced Raw Data SOP Instance.

C.36.22.1 RT Radiation Record Common Attribute Descriptions

C.36.22.1.1 Additional Parameter Recording Instance Sequence

The Additional Parameter Recording Instance Sequence (300A,0780) allows referencing of a SOP Instance which contains additional parameters recorded during the delivery. For example, the recording may be high-frequency samples of certain parameters to allow in-depth analysis for quality assurance or other purposes.

C.36.23 RT Radiation Salvage Record Module

The RT Radiation Salvage Record Module contains information about the values which have been recorded when recording by the modality-specific RT Radiation Record IOD was not possible and thus only a minimal subset of attributes is present.

Table C.36.23-1. RT Radiation Salvage Record Module Attributes

Attribute Name	Tag	Type	Attribute Description
~~*Include* Table C.36.2.2.7-1, "Radiation Generation Mode Macro Attributes".~~			
Include Table C.36.2.2.7-1, "Radiation Generation Mode Macro Attributes".			
Starting Meterset Value Known Flag	(300A,0723)	1	Whether it is known that the value of the Cumulative Meterset at the first recorded RT Control Point represents the actual value at the start of the treatment delivery. Enumerated Values: **NO** The Cumulative Meterset at the first recorded RT Control Point may have an estimated or arbitrary value. **YES** The Cumulative Meterset at the first recorded RT Control Point has the actual value at which the treatment was started or resumed.
~~*Optionally, all other Attributes at Instance level that are part of the RT Radiation SOP Instance referenced in Referenced RT Instance Sequence (300A,0631), describing the delivery device. See* Section C.36.23.1.1.~~			
Optionally, all other Attributes at Instance level that are part of the RT Radiation SOP Instance referenced in Referenced RT Instance Sequence (300A,0631), describing the delivery device. See Section C.36.23.1.1.			
Number of RT Control Points	(300A,0604)	1	Number of RT Control Points in the RT Radiation Salvage Record Control Point Sequence (300A,0722). The value shall be equal to or greater than 2.
RT Radiation Salvage Record Control Point Sequence	(300A,0722)	1	Control Points used to record the beam delivery. The number of Items included in this Sequence shall equal the value of Number of RT Control Points (300A,0604).
~~>*Include* Table C.36.2.2.5-1, "RT Control Point General Macro Attributes"~~			
>*Include* Table C.36.2.2.5-1, "RT Control Point General Macro Attributes"			

Attribute Name	Tag	Type	Attribute Description
>Referenced Radiation Generation Mode Index	(300A,0605)	1C	The value of Radiation Generation Mode Index (300A,0601) in the Radiation Generation Mode Sequence (300A,067B) in this IOD that defines the Radiation Generation Mode used for this Control Point. Required if Number of Radiation Generation Modes (300A,0685) is present and the conditions in Section C.36.2.2.5.1.1are satisfied.
~~*>Optionally, all other Attributes at RT Control Point level that are part of the RT Radiation SOP Instance referenced in Referenced RT Instance Sequence (300A,0631). See* Section C.36.23.1.1.~~			
>Optionally, all other Attributes at RT Control Point level that are part of the RT Radiation SOP Instance referenced in Referenced RT Instance Sequence (300A,0631). See Section C.36.23.1.1.			

C.36.23.1 RT Radiation Salvage Record Module Attribute Descriptions

C.36.23.1.1 Recorded Parameter

Additional optional attributes contain values which are known after the termination of the treatment delivery. Any subset of Attributes of the referenced RT Radiation SOP Instance may be provided. If present, an Attribute shall be enclosed in the nested Sequence as it appears in the referenced RT Radiation SOP Instance. If additional parameters are supported these are expected to be documented in an implementation's Conformance Statement.

Example

The following example shows the recording of a Source Gantry Angle of 5 deg and the Y Jaw Openings of 2/3 mm at Control Point 7.

Table C.36.23-2. Additional Optional Parameter Example

Attribute	Tag	Additional Optional Parameter	Value
...			
Starting Meterset Value Known Flag	(300A,0723)	No	YES
...			
RT Beam Limiting Device Definition Sequence	(300A,0641)	Yes	
>Device Index	(3010,0039)	Yes	2
>Beam Modifier Orientation Angle	(300A,0645)	Yes	90
>Device Type Code Sequence	(3010,002E)	Yes	(130330, DCM, "Jaw Pair")
>Parallel RT Beam Delimiter Device Sequence	(300A,0648)	Yes	
>>Parallel RT Beam Delimiter Device Orientation Label Code Sequence	(300A,0644)	Yes	(130335, DCM, "Y Orientation")
...			
RT Radiation Salvage Record Control Point Sequence	(300A,0722)	No	
>RT Control Point Index	(300A,0600)	No	7
...			
>Source Roll Angle	(300A,067A)	Yes	5
>RT Beam Limiting Device Opening Sequence	(300A,0656)	Yes	
>>Referenced Device Index	(300A,0607)	Yes	2

Attribute	Tag	Additional Optional Parameter	Value
>>Parallel RT Beam Delimiter Positions	(300A,064A)	Yes	2/3

D Codes and Controlled Terminology (Informative)

Retired. See PS3.16.

E Explanation of Patient Orientation (Normative)

Retired. See PS3.17.

F Basic Directory Information Object Definition (Normative)

F.1 Scope of the Basic Directory Information IOD

The Basic Directory Information Object Definition may be used for DICOM Media Storage (see PS3.10) and the Media Storage Service Class (see PS3.4). It is an abstraction of the information to:

a. Identify a File-set

b. Provide a directory that facilitates access to the information stored in the files of a File-set based on key medical information. Such a directory facility relies on a hierarchical information model of medical summary information referencing the content of the Files stored in a File-set on a storage medium. Standardizing such a directory function is a key element to facilitate the interchange of medical imaging data and is intended to support the complete range of modality imaging information.

Note

The directory information has been defined so that a future version may be extended to support the distribution of the directory information among a logical tree of several files (with the DICOMDIR file at its root). However in this version, the entire directory information is specified to be stored in a single File with a DICOMDIR File ID.

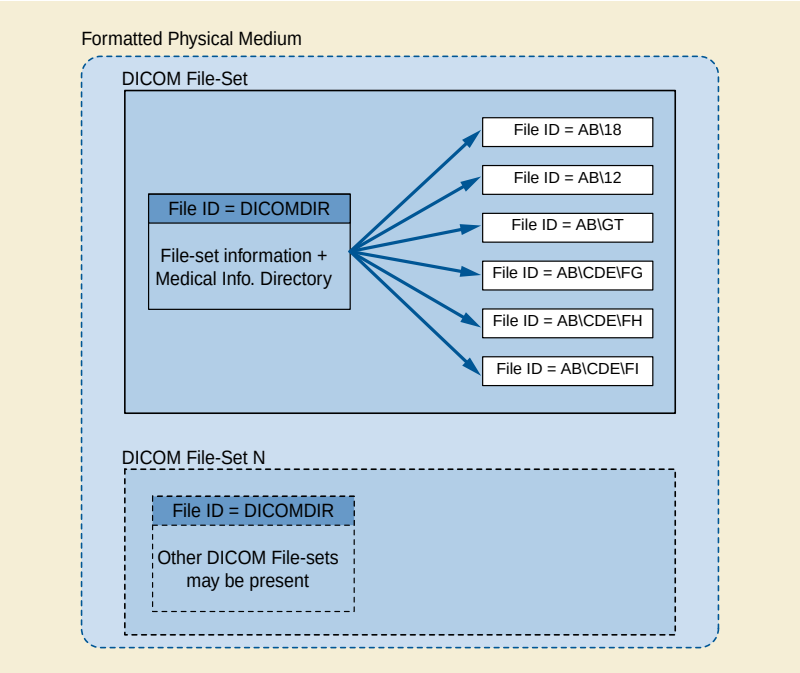


Figure F.1-1. The DICOMDIR File. A Central Role in a DICOM File-set

Note

1. Whether a single File-set or multiple File-sets are allowed on a formatted Physical Media is defined by the Media Format specification (used for each specific Physical Media) in PS3.12.

2. The DICOMDIR File is identified by a single component File ID, DICOMDIR. Other files in the File-set may have File IDs made of a single component (e.g., "ABGT" in Figure F.1-1) or multiple components (e.g., AB\12 or AB\CDE\FI) not to exceed 8 components (see PS3.10).

This Basic Directory Information Object:

a. is based on a structure of basic medical information. It is not a file system directory such as the one that may be used by the Media Format Layer;

b. is simple enough to meet the requirements of elementary Media Interchange applications;

c. is efficient in supporting update to the directory on rewritable media without a complete rewrite of the entire DICOMDIR File;

d. is extendible for specific applications with specialized selection keys in addition to the standard keys;

e. does not mandate any relationship between the hierarchy of the medical information in the DICOM Directory and the hierarchy of the File ID Components;

   Note

   Such an independence between the structure of the file identifiers, from which no semantic information shall be inferred, and the DICOM Directory that conveys medical imaging information, ensures that the broadest interoperability is possible between conforming DICOM media storage implementations.

F.2 Basic Directory IOD Overview

The general organization of the Basic Directory IOD is introduced in this Section. A simple example is also provided to illustrate the application of this organization.

F.2.1 Basic Directory IOD Organization

The Basic Directory IOD organization is based on a hierarchy of Directory Entities. At the origin of this inverted tree is a root Directory Entity. Each Directory Entity includes one or more Directory Records, which in turn may each reference a lower level Directory Entity.

Directory Records serve to reference objects stored in the Files of the File-set. The organization of the Directory is depicted by the Basic Directory IOD entity/relationship model presented in Figure F.2-1.

Each Directory Record, irrespective of the Directory Entity it is included in, contains four types of information:

a. A reference to a lower level Directory Entity or Referenced Directory Entity. This reference may be absent if such a lower level Directory Entity does not exist for an instance of a directory record;

b. A reference to a File of the File-set in which is stored a "Referenced Object" (formally called in DICOM a Referenced SOP Instance). This reference may be absent if no File is referenced. Files may be referenced directly by their File ID;

c. A set of "selection keys", specific to a Referenced Object, which will allow its selection among all the records included in a given Directory Entity;

d. A mechanism to chain the various Directory Records that belong to the same Directory Entity.

This generic content of a Directory Record is further specialized based on its specific type in the context the Basic Directory IOD Information Model specified in Section F.4 (e.g., a Study Record, a Series Record, etc.). A Directory Entity may include Directory Records of different Types. By standardizing a number of specific Directory Records (see Section F.5) in the context of the Basic Directory IOD Information Model, one allows the definition of a variety of directory contents while maintaining a framework for interoperability.

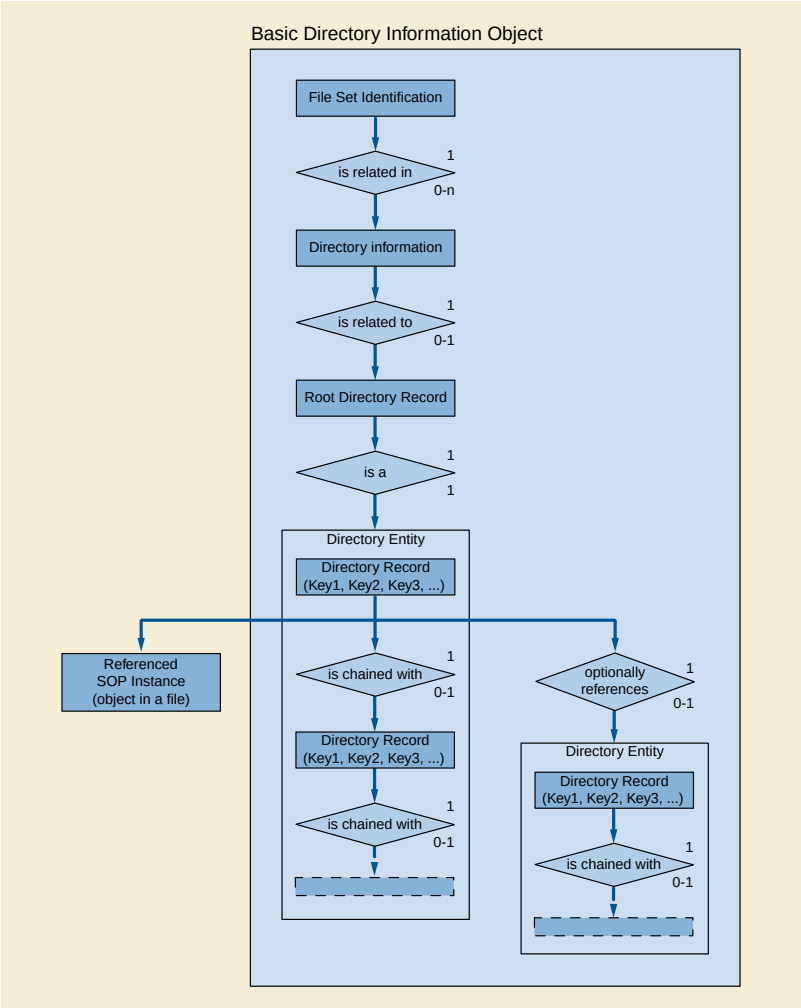


Figure F.2-1. Basic Directory Information Object E-R Model

To facilitate the management and update of the Directory Information a number of rules are defined:

a. Any Lower-Level Directory Entity shall be referenced by at most one higher-level Directory Record. Not allowing multiple higher-level Directory Records to reference the same Lower-Level Directory Entity simplifies the management of the deletion (or inactivation) of Directory Records and Lower-Level Directory Entities and associated Directory Records

b. Any Directory Record shall belong to a single Directory Entity. This rule and the above rule, makes the Basic Directory IOD itself strictly hierarchical

c. All files referenced by a Directory shall be present in the same File-Set to which the directory belongs

d. Non-DICOM files that are not referenced by the Directory may be included in the File-set space. The means of access to such Files and the semantics associated with their absence from the Directory is beyond the scope of the DICOM Standard

e. If a DICOMDIR contains a Directory Information Module, all DICOM Files of the File-set shall be referenced by a Directory Record

f. Any File of the File-set shall be directly referenced by at most one Directory Record of the Directory.

Note

Referenced Files may contain SOP Instances of SOP Classes that provide the means to reference by UIDs other SOP Instances that may not be stored in files of the same File-set.

F.2.2 Example of A Directory

The example provided in this Section is only one simple example of a possible directory content and organization. This Section is not normative in nature. Therefore, this example is not meant to specify a conformant directory nor to restrict the range of possible directory organizations supported by this Part of the DICOM Standard.

The overall organization is illustrated at a logical level in Section F.2.2.1. The actual structure of the content is discussed in Section F.2.2.2. Annex A “Example of DICOMDIR File Content (Informative)” in PS3.10 depicts further details of the encoding of the file content.

F.2.2.1 Illustration of the Overall Directory Organization

A simple directory content is used as an example of Directory organization. It is depicted by Figure F.2-2. The left hand side part of Figure F.2-2 depicts the various Objects stored in Files of the File-set. The right hand side presents an example of organization of the directory that facilitates access to the Files of the File-set.

This example shows how stored Files are referenced by Directory Records that are grouped into Directory Entities. The two Study Directory Records (Study 1 and Study 2) are part of the Directory Entity relative to the Patient A.

Thin curved lines depict the referencing mechanism based on File IDs that allow reference to Files containing stored objects. Thick curved lines depict the internal referencing mechanisms that support the reference to a lower-level Directory Entity by a Directory Record.

Keys that are used to select a specific Directory Record from among the Directory Records of a Directory Entity are not shown on Figure F.2-2.

One may note in this example that certain Directory Records such as the Series Directory Records do not reference Files containing stored objects. Other Directory Records such as the Image Directory Records do not reference lower level Directory Entities. However, a number of Directory Records reference both one lower level Directory Entity and one File containing a stored object. This flexibility allows the definition of a variety of directories.

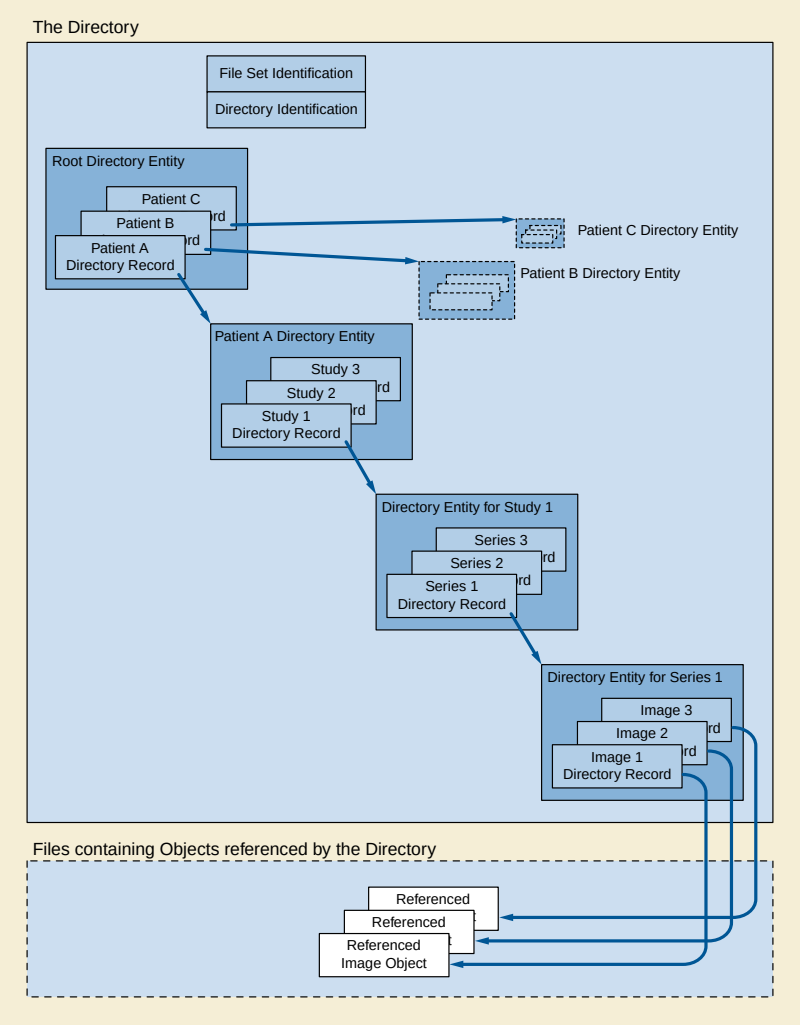


Figure F.2-2. Example of a Directory Organization and Content

F.2.2.2 Example of a DICOMDIR File Structure

Based on the example discussed in Section F.2.2.1, the internal data structure used by the Basic Directory IOD is depicted in Figure F.2-3. It shows a set of Directory Records where each Directory Record is linked by three different types of "referencing" mechanisms:

a. The chaining of Directory Records to form a Directory Entity. In particular, this facilitates the addition of new Directory Records at the level of any Directory Entity by placing them at the end of the DICOMDIR File. On Figure F.2-3, this chaining is shown by yellow lines:

   1. #1 shows the chaining of the Directory Records forming the root Directory Entity

   2. #2 shows the chaining of the Directory Records for the Directory Entity related to Patient A

   3. #3 shows the chaining of the Directory Records for the Directory Entity related to Study 1

   4. #4 shows the chaining of the Directory Records for the Directory Entity related to Series 1

b. Green lines depict the reference by a Directory Record to a lower level Directory Entity

c. Blue lines depict the reference by a Directory Record to a stored file containing a SOP Class

This example of a DICOMDIR File structure shows one example of a specific order of the Directory Records. Other orderings of Directory Records could result in a functionally equivalent directory.

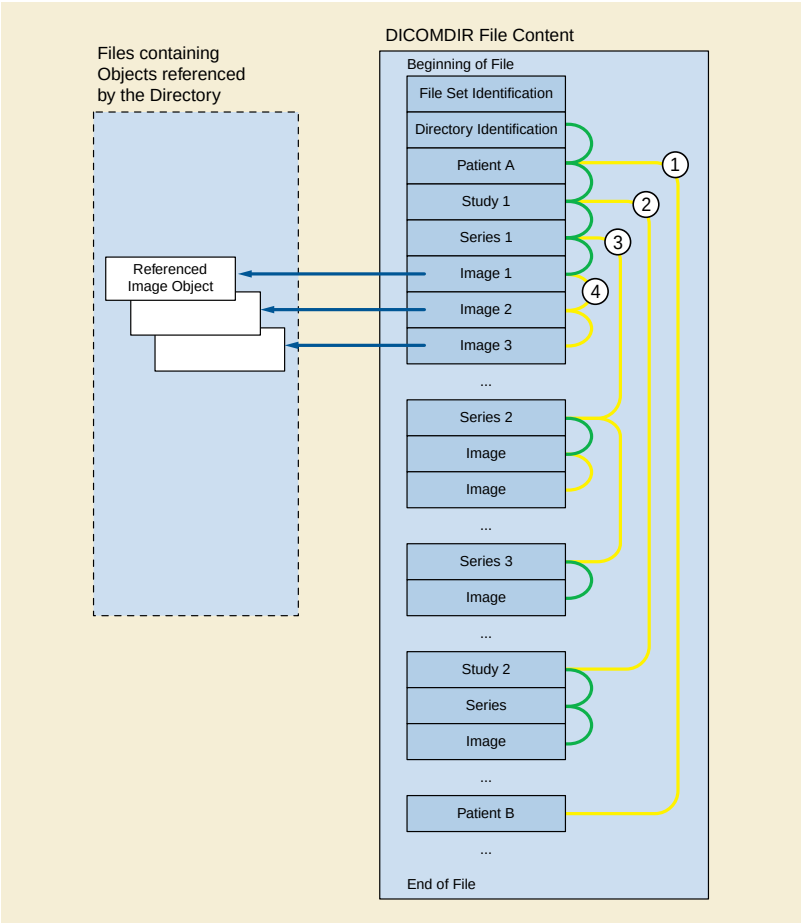


Figure F.2-3. Example of Data Structure for the DICOM Directory Information

F.3 Basic Directory IOD

This IOD is based on the Directory Information organization introduced in Section F.2. The model for this Basic Directory IOD is described Section F.2.1 by the Entity/Relationship model in Figure F.2-1. The rules specified in Section F.2.1 apply to this Information Object Definition.

F.3.1 Module Table

The Basic Directory IOD includes the Modules specified by Table F.3-1.

Table F.3-1. Basic Directory IOD Modules

Module	Reference	Usage	Module Description
File-set Identification	F.3.2.1	M	File-set identification information

Module	Reference	Usage	Module Description
Directory Information	F.3.2.2	U	Directory Information followed by a Sequence of Directory Records. Note The Directory Information Module is optional. This Directory Information Module should be present in all but primitive environments where a directory is not needed. In this case, only the File-set Identification Information is present.

F.3.2 Modules of the Basic Directory Information Object

Attributes of the Basic Directory IOD are defined with a Type designation that indicates if a specific Attribute is required for all Media Storage Operations (see Chapter 5).

F.3.2.1 File-set Identification Module

Table F.3-2. File-Set Identification Module Attributes

Attribute Name	Tag	Type	Attribute Description
File-set ID	(0004,1130)	2	User or implementation specific Identifier (up to 16 characters). For definition, see PS3.10. The File-set ID is intended to be a short human readable label to easily (but not necessarily uniquely) identify a specific File-set to facilitate operator manipulation of the physical media on which the File-set is stored. Assignment of Value and semantics are environment specific.
File-set Descriptor File ID	(0004,1141)	3	ID of a File (in the same File-set) used for user comments related to the File-set (e.g., a README file). The Specific Character set used may be specified in the Specific Character Set of the File-set Descriptor File (0004,1142). Note This File is not DICOM formatted (no Preamble, nor DICM Prefix and Meta Information).
Specific Character Set of File-set Descriptor File	(0004,1142)	1C	Character set used in the File-set Descriptor File with a File ID as specified in File-set Descriptor File ID (0004,1141). Required to specify the expanded or replacement character set. If absent, only the Basic Graphic set is used. See Section C.12.1.1.2 for Defined Terms.

Note

Every File-set is assigned a File-set UID when created. The File-set UID need not be duplicated as a Type 1 Attribute of the File-set Identification Module. It is conveyed as the SOP Instance UID of the Basic Directory IOD. It is included in the DICOMDIR File Meta Information (see PS3.10)

F.3.2.2 Directory Information Module

This Module contains a Sequence of Directory Records forming one or more Directory Entities. This Module defines at least one Directory Entity, the Root Directory Entity (which may be empty). Each Directory Record is composed of Directory Elements (marked by a ">"). They include:

a. an offset pointer to another Directory Record of the Same Directory Entity

b. an offset pointer to a lower level Directory Entity

c. a Referenced File pointed to by the Directory Record

d. a set of keys representative of the information contained in the Referenced File

Table F.3-3. Directory Information Module Attributes

Attribute Name	Tag	Type	Attribute Description
Offset of the First Directory Record of the Root Directory Entity	(0004,1200)	1	Offset of the first byte (of the Item Data Element) of the first Directory Record of the Root Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. When the Root Directory Entity contains no Directory Record, this offset shall be set to 00000000H. Note This offset includes the File Preamble and the DICM Prefix.
Offset of the Last Directory Record of the Root Directory Entity	(0004,1202)	1	Offset of the first byte (of the Item Data Element) of the last Directory Record of the Root Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. When the Root Directory Entity contains no Directory Record, this offset shall be set to 00000000H. Note This offset includes the File Preamble and the DICM Prefix.
File-set Consistency Flag	(0004,1212)	1	Enumerated Values: **0000H** no known inconsistencies The value FFFFH shall never be present. Note Formerly, this Attribute was intended to signal that the directory was in an inconsistent state with a value of FFFFH. This usage has been retired. See PS3.3-2008.
Directory Record Sequence	(0004,1220)	2	Sequence of zero or more Items where each Item contains a Directory Record by including the Directory Elements from (0004,1400) to (0004,1511) and Record selection Keys as defined below (marked with a >). A zero length Value indicates that no Directory Records are contained in the Root Directory Entity.
>Offset of the Next Directory Record	(0004,1400)	1	Offset of the first byte (of the Item Data Element) of the next Directory Record of the same Directory Entity. This Offset is an unsigned integer representing a number of bytes starting with the first byte of the File Meta-information. A zero offset shall be used to mean that there is no other Directory Record in this Directory Entity. This Offset may be used to keep an inactive Record (0004,1410) chained with the next Directory Record of the same Directory Entity. Note This offset includes the File Preamble and the DICM Prefix.
>Record In-use Flag	(0004,1410)	1	Enumerated Values: **FFFFH** record is in use. The value 0000H shall never be present. Note Formerly, this Attribute was intended to facilitate the deletion of files, with a value 0000H signally an inactive record. This usage has been retired. See PS3.3-2008. Other Values are reserved and shall not be set by File-set Creators, but if present shall be interpreted as FFFFH by File-set Readers or Updaters.

Attribute Name	Tag	Type	Attribute Description
>Offset of Referenced Lower-Level Directory Entity	(0004,1420)	1	Offset of the first byte (of the Item Data Element) of the first Directory Record of the Referenced Lower Level Directory Entity. This Offset is a number of bytes starting with the first byte of the File Meta Information. When no lower-level Directory Entity (containing at least one Directory Record) is referenced, this Attribute shall have a Value of 00000000H. Note This offset includes the File Preamble and the DICM Prefix.

Attribute Name	Tag	Type	Attribute Description
>Directory Record Type	(0004,1430)	1	Defines a specialized type of Directory Record by reference to its position in the Media Storage Directory Information Model (see Section F.4). Enumerated Values: **PATIENT** **STUDY** **SERIES** **IMAGE** **RADIOTHERAPY** **RT DOSE** **RT STRUCTURE SET** **RT PLAN** **RT TREAT RECORD** **PRESENTATION** **WAVEFORM** **SR DOCUMENT** **KEY OBJECT DOC** **SPECTROSCOPY** **RAW DATA** **REGISTRATION** **FIDUCIAL** **HANGING** **PROTOCOL** **ENCAP DOC** **VALUE MAP** **STEREOMETRIC** **PALETTE** **IMPLANT** **IMPLANT GROUP** **IMPLANT ASSY** **MEASUREMENT** **SURFACE** **SURFACE SCAN** **TRACT** **ASSESSMENT** **PRIVATE** Privately defined record hierarchy position. Type shall be defined by Private Record UID (0004,1432). Note 1. Enumerated Values PRINT QUEUE, FILM SESSION, FILM BOX, and IMAGE BOX were previously defined. They are now retired. See PS3.3-1998. 2. Enumerated Values OVERLAY, MODALITY LUT, VOI LUT, CURVE, TOPIC, VISIT, RESULTS, INTERPRETATION, STUDY COMPONENT and STORED PRINT were previously defined. They are now retired. See PS3.3-2004. 3. Enumerated Value MRDR was previously defined, to allow indirect reference to a File by multiple Directory Records. It is now retired. FSUs and FSRs are unlikely to be capable of supporting this mechanism. See PS3.3-2004. 4. Enumerated Value HL7 STRUC DOC was previously defined. It is now retired. See PS3.3-2018b.

Attribute Name	Tag	Type	Attribute Description
>Private Record UID	(0004,1432)	1C	Required if the Directory Record Type (0004,1430) is of Value PRIVATE. This UID is used to define a non-standard type of Directory Record by reference to its position in a private extension to the Basic Directory IOD Information Model (see Section F.5). This UID shall be registered according to the procedures defined in PS3.5. Its meaning may or may not be specified in a Conformance Statement.
>Referenced File ID	(0004,1500)	1C	A Multiple Value (see PS3.5) that represents the ordered components of the File ID containing a "referenced object" or Referenced SOP Instance. A maximum of 8 components, each from 1 to 8 characters shall be used (see Section 8.2). Note The Referenced File ID provides the means to "locate" the File through the DICOM File Service provided by the Media Format Layer. All referenced Files shall be with the File-set to which the Directory belongs. Any File within the File-set (to which the Directory belongs) shall be referenced by at most one Directory Record. When the Directory Record does not reference any SOP Instance this Attribute shall not be present.
>Referenced SOP Class UID in File	(0004,1510)	1C	Unique ID for the SOP Class of the Instance stored in the referenced File. Required if the Directory Record references a SOP Instance.
>Referenced SOP Instance UID in File	(0004,1511)	1C	Unique Identifier for the SOP Instance stored in the referenced file. Required if the Directory Record references a SOP Instance.
>Referenced Transfer Syntax UID in File	(0004,1512)	1C	Unique Identifier for the Transfer Syntax used to encode the Instance stored in the referenced file. Required if the Directory Record references a SOP Instance.
>Referenced Related General SOP Class UID in File	(0004,151A)	1C	Unique ID for the Related General SOP Class(es) related to the SOP Class of the Instance stored in the referenced file. Required if the Directory Record references a SOP Instance that encodes the Related General SOP Class UID (0008,001A). Note This may be useful to an FSR that does not support the SOP Class of the referenced Instance, but does support one of the Related General SOP Classes.
>Record Selection Keys	See F.5	See F.5	A number of DICOM Data Elements that contain specific keys defined for each type of Directory Record (0004,1430) defined in Section F.5.

F.4 Basic Directory IOD Information Model

The Basic Directory IOD Information Model defines the relationship between the various types of Directory Records that may be used in constructing DICOM Directories. This model is based on the DICOM Application Model defined in this part of the DICOM Standard. Entities in this Model correspond to Directory Records (DR). These are shown as rectangular boxes. Each Directory Record in this model is part of a Directory Entity (not shown except for the Root Entity) that is referenced by a Directory Record of a higher-level Directory Entity (e.g., a Study Directory Record references a Directory Entity that includes Directory Records describing the content of the Study).

Each Directory Record has a number of mandatory and optional keys that are not shown on this model. They are defined in Section F.5. Conventions used are those used by this part of the DICOM Standard. The model is depicted as an entity/relationship model in Figure F.4-1. These Directory Record relationships are fully specified in Table F.4-1.

Table F.4-1. Relationship Between Directory Records

Directory Record Type	Section	Directory Record Types that may be included in the next lower-level directory Entity
(Root Directory Entity)		PATIENT, HANGING PROTOCOL, PALETTE, IMPLANT, IMPLANT ASSY, IMPLANT GROUP, PRIVATE
PATIENT	F.5.1	STUDY, PRIVATE
STUDY	F.5.2	SERIES, PRIVATE
SERIES	F.5.3	IMAGE, RT DOSE, RT STRUCTURE SET, RT PLAN, RT TREAT RECORD, PRESENTATION, WAVEFORM, SR DOCUMENT, KEY OBJECT DOC, SPECTROSCOPY, RAW DATA, REGISTRATION, FIDUCIAL, ENCAP DOC, VALUE MAP, STEREOMETRIC, PLAN, MEASUREMENT, SURFACE, TRACT, ASSESSMENT, RADIOTHERAPY, PRIVATE
IMAGE	F.5.4	PRIVATE
RT DOSE	F.5.19	PRIVATE
RT STRUCTURE SET	F.5.20	PRIVATE
RT PLAN	F.5.21	PRIVATE
RT TREAT RECORD	F.5.22	PRIVATE
PRESENTATION	F.5.23	PRIVATE
WAVEFORM	F.5.24	PRIVATE
SR DOCUMENT	F.5.25	PRIVATE
KEY OBJECT DOC	F.5.26	PRIVATE
SPECTROSCOPY	F.5.27	PRIVATE
RAW DATA	F.5.28	PRIVATE
REGISTRATION	F.5.29	PRIVATE
FIDUCIAL	F.5.30	PRIVATE
HANGING PROTOCOL	F.5.31	PRIVATE
ENCAP DOC	F.5.32	PRIVATE
VALUE MAP	F.5.34	PRIVATE
STEREOMETRIC	F.5.35	PRIVATE
PALETTE	F.5.36	PRIVATE
IMPLANT	F.5.37	PRIVATE
IMPLANT ASSY	F.5.38	PRIVATE
IMPLANT GROUP	F.5.39	PRIVATE
PLAN	F.5.40	PRIVATE
MEASUREMENT	F.5.41	PRIVATE
SURFACE	F.5.42	PRIVATE
SURFACE SCAN	F.5.43	PRIVATE
TRACT	F.5.44	PRIVATE
ASSESSMENT	F.5.45	PRIVATE
RADIOTHERAPY	F.5.46	PRIVATE
PRIVATE	F.6.1	PRIVATE, (any of the above as privately defined)

Note

1. Directory Record Types PRINT QUEUE, FILM SESSION, FILM BOX, and IMAGE BOX were previously defined. They have been retired. See PS3.3-1998.

2. Directory Record Types OVERLAY, MODALITY LUT, VOI LUT, CURVE, TOPIC, VISIT, RESULTS, INTERPRETATION, STUDY COMPONENT, STORED PRINT and MRDR were previously defined. They have been retired. See PS3.3-2004.

3. Directory Record Type HL7 STRUC DOC was previously defined. It has been retired. See PS3.3 2018b.

F.5 Definition of Specific Directory Records

The following Sections specify a number of Directory Records that were introduced by the Basic Directory IOD Information Model presented in Section F.4. For each one, it identifies the SOP Classes that may be referenced and the related mandatory keys. Keys are assigned a Type designation that indicates if it is required for all Media Storage Operations of the Directory (see Section 5).

Type 2 and Type 3 Keys may be changed to Type 1 and Type 2 or 3 respectively by Application Profiles defined in PS3.11. Keys based on Private Data Elements, or Private Keys may also be used in addition to Standard defined Keys. However such Private keys may be ignored by any File-set Reader or Updater.

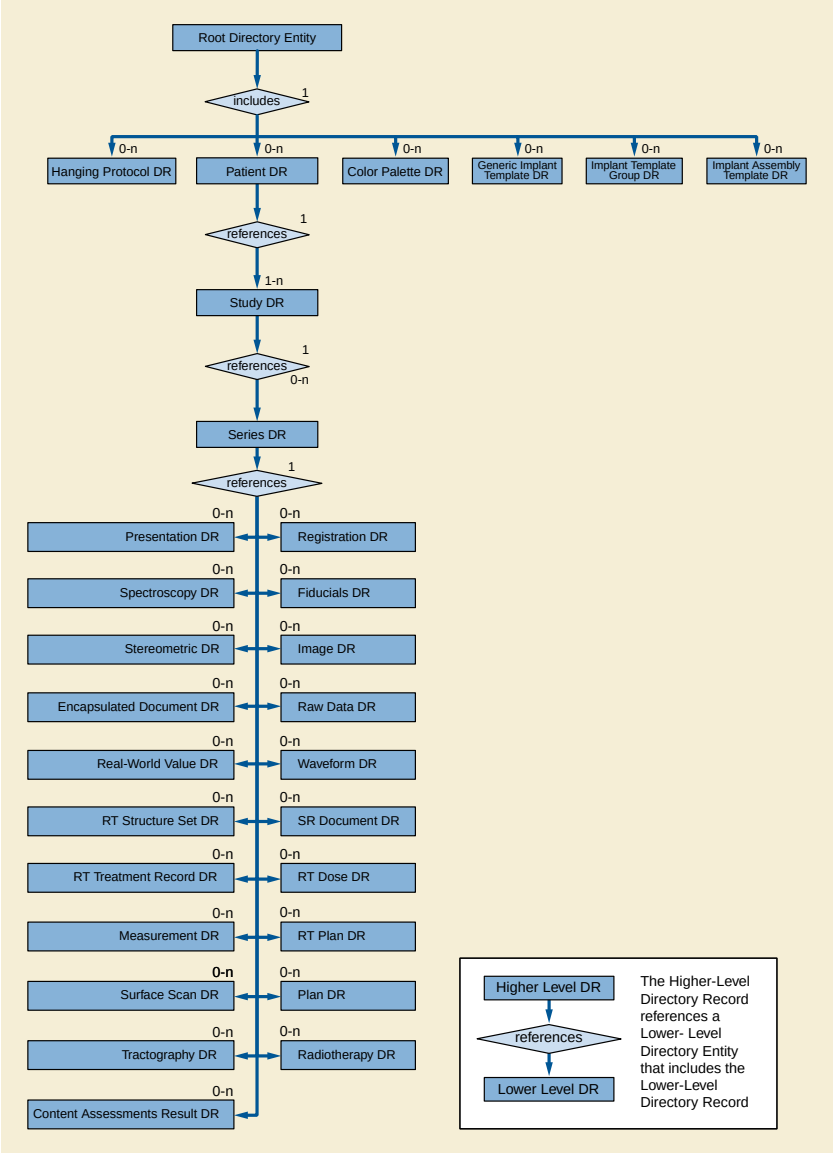


Figure F.4-1. Basic Directory IOD Information Model

Note

Normalized Print media storage was previously defined in DICOM. It is now retired. See PS3.3-1998.

F.5.1 Patient Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PATIENT." Table F.5-1 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Patient IOD or the Patient IE of Image IODs. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-1. Patient Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys

Key	Tag	Type	Attribute Description
Patient's Name	(0010,0010)	2	
Patient ID	(0010,0020)	1	
Any other Attribute of the Patient IE Modules		3	

For a given File-set, the Patient ID shall be unique. This means that it shall not appear in different Patient Directory Records.

F.5.2 Study Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "STUDY." Table F.5-2 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Study IE of Composite IODs. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1. Only one Study Directory Record per Study Instance UID shall be present in a Basic Directory Instance; this implies that a Study belongs to a single patient and shall be referenced only once for that patient.

Table F.5-2. Study Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Study Date	(0008,0020)	1	
Study Time	(0008,0030)	1	
Study Description	(0008,1030)	2	
Study Instance UID	(0020,000D)	1C	Required only if (0004,1511) is absent (see Note).
Study ID	(0020,0010)	1	
Accession Number	(0008,0050)	2	
Any other Attribute of the Study IE Modules		3	

Note

The Study Instance UID shall be present as a mandatory key only if no file is referenced by this Directory Record. In the case where this Directory Record references a file, the Directory Record contains in the Referenced SOP Instance UID in File (0004,1511). In this case (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3) and need not be duplicated.

F.5.3 Series Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SERIES." Table F.5-3 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Series IE and Equipment IE of Composite IODs. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1. Only one Series Directory Record per Series Instance UID shall be present in a Basic Directory Instance; this implies that a Series belongs to a single Study and shall be referenced only once for that Study.

Table F.5-3. Series Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Modality	(0008,0060)	1	
Series Instance UID	(0020,000E)	1	

Key	Tag	Type	Attribute Description
Series Number	(0020,0011)	1	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Series. It may or may not correspond to one of the images of the Series. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section F.7.*
Any other Attribute of the Series IE Modules		3	

F.5.4 Image Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "IMAGE." Table F.5-4 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Image IE of Image IODs. This Directory Record shall be used to reference an Image SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-4. Image Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section F.7.*
Any other Attribute of the Image IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.5 Standalone Overlay Directory Record Definition

Retired. See PS3.3-2004.

F.5.6 Standalone Modality LUT Directory Record Definition

Retired. See PS3.3-2004.

F.5.7 Standalone VOI LUT Directory Record Definition

Retired. See PS3.3-2004.

F.5.8 Standalone Curve Directory Record Definition

Retired. See PS3.3-2004.

F.5.9 Topic Directory Record Definition

Retired. See PS3.3-2004.

F.5.10 Visit Directory Record Definition

Retired. See PS3.3-2004.

F.5.11 Results Directory Record Definition

Retired. See PS3.3-2004.

F.5.12 Interpretation Directory Record Definition

Retired. See PS3.3-2004.

F.5.13 Study Component Directory Record Definition

Retired. See PS3.3-2004.

F.5.14 Print Queue Directory Record Definition

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

F.5.15 Film Session Directory Record Definition

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

F.5.16 Film Box Directory Record Definition

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

F.5.17 Basic Image Box Directory Record Definition

This section was previously defined in DICOM. It is now retired. See PS3.3-1998.

F.5.18 Stored Print Directory Record Definition

Retired. See PS3.3-2004.

F.5.19 RT Dose Directory Record Definition

This Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RT DOSE". Table F.5-19 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Dose IE of the RT Dose IOD. This Directory Record shall be used to reference a RT Dose SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-19. RT Dose Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Dose Summation Type	(3004,000A)	1	
Dose Comment	(3004,0006)	3	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the RT Dose. Only a single Item is permitted in this Sequence.

Key	Tag	Type	Attribute Description
>Include Table C.7-11b “Image Pixel Macro Attributes”			*See Section F.7.*
Any other Attribute of the Dose IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.20 RT Structure Set Directory Record Definition

This Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RT STRUCTURE SET". Table F.5-20 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Structure Set IE of the RT Structure Set IOD. This Directory Record shall be used to reference a RT Structure Set SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-20. RT Structure Set Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Structure Set Label	(3006,0002)	1	
Structure Set Date	(3006,0008)	2	
Structure Set Time	(3006,0009)	2	
Any other Attribute of the Structure Set IE Modules		3	

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.21 RT Plan Directory Record Definition

This Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RT PLAN". Table F.5-21 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Plan IE of the RT Plan IOD. This Directory Record shall be used to reference a RT Plan SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-21. RT Plan Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Instance Number	(0020,0013)	1	
RT Plan Label	(300A,0002)	1	
RT Plan Date	(300A,0006)	2	
RT Plan Time	(300A,0007)	2	
Any other Attribute of the Plan IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.22 RT Treatment Record Directory Record Definition

This Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RT TREAT RECORD". Table F.5-22 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Treatment Record IE of the RT Treatment Record IODs. This Directory Record shall be used to reference an RT Beams Treatment Record SOP Instance, RT Brachy Treatment Record SOP Instance, or RT Treatment Summary Record SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-22. RT Treatment Record Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Instance Number	(0020,0013)	1	
Treatment Date	(3008,0250)	2	
Treatment Time	(3008,0251)	2	
Any other Attribute of the Treatment Record IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.23 Presentation State Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PRESENTATION". Table F.5-23 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to Softcopy Presentation State Storage and Structured Display IODs. This Directory Record shall be used to reference a Softcopy Presentation State Storage SOP Instance or a Structured Display SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-23. Presentation Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Presentation Creation Date	(0070,0082)	1	Date on which this presentation was created. Note This date may be different from the date that the DICOM SOP Instance was created, since the presentation information contained may have been recorded earlier.

Key	Tag	Type	Attribute Description
Presentation Creation Time	(0070,0083)	1	Time at which this presentation was created. Note This time may be different from the time that the DICOM SOP Instance was created, since the presentation information contained may have been recorded earlier.
Include Table 10-12 “Content Identification Macro Attributes”			
Referenced Series Sequence	(0008,1115)	1C	Sequence of Items where each Item includes the Attributes of one Series to which the Presentation applies. One or more Items shall be included in this Sequence. Required if the IOD of the Presentation SOP Instance referenced by this directory record includes the Presentation State Relationship Module.
>Series Instance UID	(0020,000E)	1	Unique identifier of a Series that is part of this Study.
>Referenced Image Sequence	(0008,1140)	1	Sequence of Items where each Item provides reference to an Image SOP Instance. One or more Items shall be included in this Sequence.
>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Blending Sequence	(0070,0402)	1C	Sequence of Items where each Item includes the Attributes of a Study to which the Presentation applies. Only two Items shall be included in this Sequence. Required if the SOP Instance referenced by this directory record includes Blending Sequence (0070,0402).
>Study Instance UID	(0020,000D)	1	Unique identifier for a Study that contains the images to which the Presentation applies.
>Referenced Series Sequence	(0008,1115)	1	Sequence of Items where each Item includes the Attributes of one Series to which the Presentation applies. Only a single Item shall be included in this Sequence.
>>Series Instance UID	(0020,000E)	1	Unique identifier of the Series
>>Referenced Image Sequence	(0008,1140)	1	Sequence of Items where each Item provides reference to an Image SOP Instance to which the Presentation applies. One or more Items shall be included in this Sequence.
>>>Include Table 10-11 “SOP Instance Reference Macro Attributes”			
Any other Attribute of the Presentation State IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.24 Waveform Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "WAVEFORM". Table F.5-24 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in PS3.3 of the DICOM Standard in the Modules related to the Waveform IE. This Directory Record shall be used to reference

a Waveform SOP Instance. This Type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-24. Waveform Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Content Date	(0008,0023)	1	
Content Time	(0008,0033)	1	
Any other Attribute of the Waveform IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.25 SR Document Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SR DOCUMENT". Table F.5-25 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Observation IE of Structured Report IOD. This Directory Record shall be used to reference an SR Document. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-25. SR Document Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Completion Flag	(0040,A491)	1	
Verification Flag	(0040,A493)	1	
Content Date	(0008,0023)	1	
Content Time	(0008,0033)	1	
Verification DateTime	(0040,A030)	1C	Most recent Date and Time of verification among those defined in the Verifying Observer Sequence (0040,A073). Required if Verification Flag (0040,A493) is VERIFIED.
Concept Name Code Sequence	(0040,A043)	1	Code describing the concept represented by the root Content Item (Document Title). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			

Key	Tag	Type	Attribute Description
Content Sequence	(0040,A730)	1C	Contains the Target Content Items that modify the Concept Name Code Sequence of the root Content Item (Document Title). One or more Items shall be included in this Sequence. All, and only, Content Items with the HAS CONCEPT MOD relationship from the root Content Item shall be included in this Sequence. Required if the root Content Item is the Source Content Item of HAS CONCEPT MOD relationships.
>Relationship Type	(0040,A010)	1	Enumerated Values: **HAS CONCEPT MOD**
>Include Table C.17-5 “Document Content Macro Attributes”			
Any Attribute of the Document IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.26 Key Object Document Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "KEY OBJECT DOC". Table F.5-25 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Document IE of the Key Object Selection IOD. This Directory Record shall be used to reference a Key Object Selection Document. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-26. Key Object Document Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Content Date	(0008,0023)	1	
Content Time	(0008,0033)	1	
Concept Name Code Sequence	(0040,A043)	1	Code describing the concept represented by the root Content Item (Document Title). Only a single Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			

Key	Tag	Type	Attribute Description
Content Sequence	(0040,A730)	1C	Contains the Target Content Items that modify the Concept Name Code Sequence of the root Content Item (Document Title). One or more Items shall be included in this Sequence. All, and only, Content Items with the HAS CONCEPT MOD relationship from the root Content Item shall be included in this Sequence. Required if the root Content Item is the Source Content Item of HAS CONCEPT MOD relationships.
>Relationship Type	(0040,A010)	1	Enumerated Values: **HAS CONCEPT MOD**
>Include Table C.17-5 “Document Content Macro Attributes”			
Any Attribute of the Document IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.27 Spectroscopy Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SPECTROSCOPY." Table F.5-27 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the MR Spectroscopy IE of MR Spectroscopy IODs. This Directory Record shall be used to reference a Spectroscopy SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-27. Spectroscopy Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Image Type	(0008,0008)	1	
Content Date	(0008,0023)	1	
Content Time	(0008,0033)	1	
Instance Number	(0020,0013)	1	
Referenced Image Evidence Sequence	(0008,9092)	1C	Required if present in the spectroscopy Instance. One or more Items shall be included in this Sequence.
>Include Table C.17-3 “Hierarchical SOP Instance Reference Macro Attributes”			
Number of Frames	(0028,0008)	1	
Rows	(0028,0010)	1	
Columns	(0028,0011)	1	
Data Point Rows	(0028,9001)	1	
Data Point Columns	(0028,9002)	1	

Key	Tag	Type	Attribute Description
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Spectroscopy Instance. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section F.7.*
Any other Attribute of the MR Spectroscopy IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.28 Raw Data Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RAW DATA." Table F.5-28 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Raw Data IE of Raw Data IODs. This Directory Record shall be used to reference a Raw Data SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-28. Raw Data Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	
Content Time	(0008,0033)	1	
Instance Number	(0020,0013)	2	
Icon Image Sequence	(0088,0200)	3	This Icon Image is representative of the Raw Data Instance. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section F.7.*
Any other Attribute of the Raw Data IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.29 Registration Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "REGISTRATION." Table F.5-29 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Spatial Registration IE of the Spatial Registration IOD. This Directory Record shall be used to reference a Spatial Registration SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-29. Registration Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Spatial Registration IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.30 Fiducial Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "FIDUCIAL." Table F.5-30 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Spatial Fiducials IE of Spatial Fiducials IOD. This Directory Record shall be used to reference a Spatial Fiducials SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-30. Fiducial Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Spatial Fiducials IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.31 Hanging Protocol Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "HANGING PROTOCOL". Table F.5-31 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Hanging Protocol IOD. This Directory Record shall be used to reference a Hanging Protocol SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-31. Hanging Protocol Keys

Attribute Name	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Hanging Protocol Name	(0072,0002)	1	
Hanging Protocol Description	(0072,0004)	1	
Hanging Protocol Level	(0072,0006)	1	

Attribute Name	Tag	Type	Attribute Description
Hanging Protocol Creator	(0072,0008)	1	
Hanging Protocol Creation DateTime	(0072,000A)	1	
Hanging Protocol Definition Sequence	(0072,000C)	1	Sequence that defines the type of imaging Studies to which this Hanging Protocol applies. One or more Items shall be included in this Sequence.
>Modality	(0008,0060)	1C	Required if Anatomic Region Sequence (0008,2218) is not present. May be present otherwise.
>Anatomic Region Sequence	(0008,2218)	1C	One or more Items shall be included in this Sequence. Required if Modality (0008,0060) is not present. May be present otherwise.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			
>Laterality	(0020,0060)	2C	Required if Anatomic Region Sequence (0008,2218) is present.
>Procedure Code Sequence	(0008,1032)	2	Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			
>Reason for Requested Procedure Code Sequence	(0040,100A)	2	Zero or more Items shall be included in this Sequence.
>>Include Table 8.8-1 “Code Sequence Macro Attributes”			
Number of Priors Referenced	(0072,0014)	1	
Hanging Protocol User Identification Code Sequence	(0072,000E)	2	Sequence that provides a coded identifier for the person, group, or site for which this Hanging Protocol was defined. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			
Any other Attribute of the Hanging Protocol IOD		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.32 Encapsulated Document Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "ENCAP DOC." Table F.5-32 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Encapsulated Document IE of Encapsulated IODs. This Directory Record shall be used to reference an Encapsulated Document SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Note

Other Encapsulated Document SOP Classes may be added to the Standard in the future and these will likely be referenced by this directory record. Therefore, the MIME Type should be checked rather than assuming that the referenced file contains PDF.

Table F.5-32. Encapsulated Document Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	2	The date the content creation started.
Content Time	(0008,0033)	2	The time the content creation started.
Instance Number	(0020,0013)	1	A number that identifies this Instance
Document Title	(0042,0010)	2	The title of the document.
HL7 Instance Identifier	(0040,E001)	1C	Instance Identifier from the referenced HL7 Structured Document, encoded as a UID (OID or UUID), concatenated with a caret ("^") and Extension value (if Extension is present in Instance Identifier). Required if encapsulated document is an HL7 Structured Document.
Concept Name Code Sequence	(0040,A043)	2	A coded representation of the document title. Zero or one Item shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			*BCID 7020 “Document Titles”.*
MIME Type of Encapsulated Document	(0042,0012)	1	The type of the encapsulated document stream described using the MIME Media Type (see RFC 2046).
Any other Attribute of the Encapsulated Document Module except Encapsulated Document (0042,0011)		3	

F.5.33 HL7 Structured Document Directory Record Definition

Retired. See PS3.3 2018b.

F.5.34 Real World Value Mapping Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "VALUE MAP." Table F.5-34 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Real World Value Mapping IE of Real World Value Mapping IOD. This Directory Record shall be used to reference a Real World Value Mapping SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-34. Real World Value Mapping Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Real World Value Mapping IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.35 Stereometric Relationship Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "STEREOMETRIC". Table F.5-35 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Stereometric Relationship IE of Stereometric Relationship IOD. This Directory Record shall be used to reference a Stereometric Relationship SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-35. Stereometric Relationship Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Any other Attribute of the Stereometric Relationship IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.36 Palette Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PALETTE". Table F.5-36 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Color Palette IOD. This Directory Record shall be used to reference a Color Palette SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-36. Palette Keys

Attribute Name	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys
Content Label	(0070,0080)	1	A label that is used to identify the palette.
Content Description	(0070,0081)	2	A description of the content of the palette.
Any other Attribute of the Color Palette IOD		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.37 Implant Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "IMPLANT". Table F.5-37 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Generic Implant Template IOD. This Directory Record shall be used to reference a Generic Implant Template SOP Instance.

Table F.5-37. Implant Keys

Key	Tag	Type	Attribute Description
Manufacturer	(0008,0070)	1	Name of the manufacturer that produces the implant.
Implant Name	(0022,1095)	1	The (product) name of the implant.

Key	Tag	Type	Attribute Description
Implant Size	(0068,6210)	1C	The size descriptor of the component. Required if present in the referenced Instance.
Implant Part Number	(0022,1097)	1	The (product) identifier of the implant.

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.38 Implant Assembly Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "IMPLANT ASSY". Table F.5-38 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Implant Assembly Template IOD. This Directory Record shall be used to reference an Implant Assembly Template SOP Instance.

Table F.5-38. Implant Assembly Keys

Key	Tag	Type	Attribute Description
Implant Assembly Template Name	(0076,0001)	1	A name given to the assembly described in this Instance.
Manufacturer	(0008,0070)	1	Name of the manufacturer that produces the implant.
Procedure Type Code Sequence	(0076,0020)	1	A code describing the Intervention in which the implant is used. One or more Items shall be included in this Sequence.
>Include Table 8.8-1 “Code Sequence Macro Attributes”			

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.39 Implant Group Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "IMPLANT GROUP". Table F.5-39 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Implant Template Group IOD. This Directory Record shall be used to reference an Implant Template Group SOP Instance.

Table F.5-39. Implant Group Keys

Key	Tag	Type	Attribute Description
Implant Template Group Name	(0078,0001)	1	Name of this group
Implant Template Group Description	(0078,0010)	3	Purpose or intent of this group.
Implant Template Group Issuer	(0078,0020)	1	Person or Organization that issued this group.

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.40 Plan Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "PLAN". Table F.5-40 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Plan IEs of RT Plan IOD and RT Ion Plan IOD. This Directory Record shall be used to reference one of the class of Plan SOP Instances having a Modality (0008,0060) of "PLAN", such as the RT Beams Delivery Instruction IOD. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-40. Plan Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Any other Attribute of the Plan IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.41 Measurement Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "MEASUREMENT". Table F.5-41 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Measurements IE of the Measurement IODs. This Directory Record shall be used to reference a Measurement SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-41. Measurement Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Measurements IE Modules		3	

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.42 Surface Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SURFACE". Table F.5-42 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Surface IE of the Surface Segmentation IOD. This Directory Record shall be used to reference a Surface Segmentation SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-42. Surface Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Surface IE Modules		3	

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.43 Surface Scan Mesh Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "SURFACE SCAN". Table F.5-43 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Surface IE of the Surface Scan Mesh and Surface Scan Point Cloud IODs. This Directory Record shall be used to reference a Surface Scan Mesh SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-43. Surface Scan Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Any other Attribute of the Surface IE Modules		3	

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.44 Tractography Results Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "TRACT". Table F.5-44 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Tractography Results IE of the Tractography Results IOD. This Directory Record shall be used to reference a Tractography Results SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-44. Tractography Results Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Include Table 10-12 “Content Identification Macro Attributes”			
Any other Attribute of the Tractography Results IE Modules		3	

Note

Because (0004,1511) Referenced SOP Instance UID in File may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.45 Content Assessment Results Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "ASSESSMENT". Table F.5-45 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Content Assessment Results IOD. This Directory Record shall be used to reference a Content Assessment Results SOP Instance. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-45. Content Assessment Results Directory Record Results Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
Instance Creation Date	(0008,0012)	1	
Instance Creation Time	(0008,0013)	2	
Any other Attribute of the Content Assessment Results IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (see Table F.3-3), it is not duplicated in this list of keys.

F.5.46 Radiotherapy Directory Record Definition

The Directory Record is based on the specification of Section F.3. It is identified by a Directory Record Type of Value "RADIOTHERAPY". Table F.5-46 lists the set of keys with their associated Types for such a Directory Record Type. The description of these keys may be found in the Modules related to the Instance-level IEs of the RT Second-Generation IODs. This Directory Record shall be used to reference one of the classes of RT Second-Generation SOP Instances having a Modality (0008,0060) as defined in Section A.86.1. This type of Directory Record may reference a Lower-Level Directory Entity that includes one or more Directory Records as defined in Table F.4-1.

Table F.5-46. Radiotherapy Keys

Key	Tag	Type	Attribute Description
Specific Character Set	(0008,0005)	1C	Required if an extended or replacement character set is used in one of the keys.
Instance Number	(0020,0013)	1	
User Content Label	(3010,0033)	1C	Required if User Content Label (3010,0033) is present.
User Content Long Label	(3010,0034)	1C	Required if User Content Long Label (3010,0034) is present.
Content Description	(0070,0081)	2	
Content Creator"s Name	(0070,0084)	2	
Any other Attribute of the RT Second-Generation IE Modules		3	

Note

Because Referenced SOP Instance UID in File (0004,1511) may be used as a "pseudo" Directory Record Key (See Table F.3-3), it is not duplicated in this list of keys.

F.6 Special Directory Records

F.6.1 Private Directory Record Definition

Private Directory Records may also be used in addition to Standard defined Directory Records. Such Private Records shall follow the specification of Section F.2 and Section F.3. In addition, if created by File-set Creators they shall be proper extensions to the DICOM Basic Directory IOD Information Model specified in Section F.4. By proper extensions it is meant that any File-set Creator creating private Directory Records shall still meet the PS3.10 conformance requirements. Thus a File-set Reader or File-set Updater that chooses to ignore such privately defined Directory Records will find a conformant Directory.

F.6.2 Multi-referenced File Directory Record Definition

Retired. See PS3.3-2004.

F.7 Icon Image Key Definition

An Icon Image may be used as a key representative of an Image, RT Dose, Spectroscopy, Raw Data or Series in a corresponding Directory Record to allow an application to display icons that enable a user to select one or more from amongst several of them. It is based on the general purpose Image Pixel Macro (see Annex C).

The Icon Image Key corresponds to Data Element (0088,0200). It is defined as a Sequence that contains a single Item encapsulating the Data Set made of the Data Elements of the Icon Image. The Data Elements are defined by the Image Pixel Macro (see Section C.7.6.3).

The Image Pixel Macro usage is restricted in a few areas to facilitate general use in Directory Record across various modality environments. These restrictions are:

a. Only monochrome and palette color images shall be used. Samples per Pixel (0028,0002) shall have a Value of 1, Photometric Interpretation (0028,0004) shall have a Value of either MONOCHROME 1, MONOCHROME 2 or PALETTE COLOR, Planar Configuration (0028,0006) shall not be present.

   Note

   True color icon images are not supported. This is due to the fact that the reduced size of the Icon Image makes the quality of a palette color image (with 256 colors) sufficient in most cases. This simplifies the handling of Icon Images by File-set Readers and File-set Updaters.

b. If an FSR/FSU supports Icons (i.e., does not ignore them) then it shall support at least a maximum size of 64 by 64 Icons. An FSC may write Icons of any size. Icons larger than 64 by 64 may be ignored by FSRs and FSUs unless specialized by Application Profiles.

c. Pixel samples shall have a Value of either 1 or 8 for Bits Allocated (0028,0100) and Bits Stored (0028,0101). High Bit (0028,0102) shall have a Value of one less than the Value used in Bit Stored.

d. Pixel Representation (0028,0103) shall specify an unsigned integer representation (Value 0000H).

e. Pixel Aspect Ratio (0028,0034) shall have a Value of 1:1.

f. If a Palette Color lookup Table is used, Bits Allocated (0028,0100) shall have a Value of 8.

G Integration of Modality Worklist and Modality Performed Procedure Step in the Original DICOM Standard (Informative)

Retired. See PS3.17.

H Retired Composite Information Object Definitions (Normative) (Retired)

Retired.

I Retired Modules (Normative) (Retired)

Retired.

J Waveforms (Informative)

Retired. See Annex C “Waveforms (Informative)” in PS3.17.

K SR Encoding Example (Informative)

Retired. See Annex D “SR Encoding Example (Informative)” in PS3.17.

L Mammography CAD (Informative)

Retired. See Annex E “Mammography CAD (Informative)” in PS3.17.

M Chest CAD (Informative)

Retired. See Annex F “Chest CAD (Informative)” in PS3.17.

N Explanation of Grouping Criteria for Multi-frame Functional Group IODs (Informative)

Retired. See Annex G “Explanation of Grouping Criteria For Multi-frame Functional Group IODs (Informative)” in PS3.17.

O Clinical Trial Identification Workflow Examples (Informative)

Retired. See Annex H “Clinical Trial Identification Workflow Examples (Informative)” in PS3.17.