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**Digital Imaging and Communications in Medicine (DICOM)**

8

*Supplement 165*

*Breast Projection X-Ray Image Storage SOP Class*

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## Scope and Field of Application

This supplement to the DICOM standard defines new storage SOP Classes for breast projection X-Ray modalities that produce multiple projection images in a single compression which represent a single data set, for example, digital breast tomosynthesis projection images. These new SOP Classes are using the multi-frame image features introduced with the Enhanced MR Storage SOP Classes:

- Shared and per-frame functional group sequences
- Multi-frame Dimension module

Many acquisition parameters are stored on a frame-by-frame basis. This approach allows a flexible way of storing information about the acquisition.

The dimension mechanism allows having other properties than a time vector as single dimension and the number of dimension is no longer limited to one.

The movements of the various parts of the equipment (C-arm) can be expressed in an iso-center based coordinate system.

The Breast Projection X-Ray Image IOD shares a significant amount of common information with the Digital Mammography X-Ray Image IOD.

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**Changes to NEMA Standards Publication PS 3.2-2011**

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**Part 2: Conformance**

118 **Item #1: Add new SOP Classes in Table A.1-2**

120

**Table A.1-2  
UID VALUES**

<b>UID Value</b>	<b>UID NAME</b>	<b>Category</b>
...		
1.2.840.10008.5.1.4.1.1.13.1.4	Breast Projection X-Ray Image Storage – For Presentation	Transfer
1.2.840.10008.5.1.4.1.1.13.1.5	Breast Projection X-Ray Image Storage – For Processing	Transfer
...		

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**Changes to NEMA Standards Publication PS 3.3-2011**

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**Part 3: Information Object Definitions**

134 **Item #2: Add new IODs in Table A.1-1**

<b>IODs Modules</b>	<b><u>Br</u> <u>Proj</u></b>
Patient	<u><b>M</b></u>
Clinical Trial subject	<u>U</u>
General Study	<u><b>M</b></u>
Patient Study	<u>U</u>
Clinical Trial Study	<u>U</u>
General Series	<u><b>M</b></u>
DX Series	<u><b>M</b></u>
Enhanced Mammography Series	<u><b>M</b></u>
Clinical Trial Series	<u>U</u>
Frame of Reference	<u><b>M</b></u>
Synchronization	<u><b>C</b></u>
General Equipment	<u><b>M</b></u>
Enhanced General Equipment	<u><b>M</b></u>
Image Pixel	<u><b>M</b></u>
<u><b>Enhanced Mammography Image</b></u>	<u><b>M</b></u>
Breast View	<u><b>M</b></u>
Enhanced Contrast/Bolus	<u><b>C</b></u>
Device	<u>U</u>
Intervention	<u>U</u>
Acquisition Context	<u><b>M</b></u>
Multi-frame Functional Groups	<u><b>M</b></u>
Multi-frame Dimension	<u>U</u>
Patient Orientation	<u><b>M</b></u>
Specimen	<u>U</u>
SOP Common	<u><b>M</b></u>
Common Instance Reference	<u>U</u>
Frame Extraction	<u><b>C</b></u>

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138 **Item #3: Rename functional group macros to reflect broader use**

**A.47.4 Enhanced XA Image Functional Group Macros**

140 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.

142 **Table A.47-2  
ENHANCED XA IMAGE FUNCTIONAL GROUP MACROS**

Functional Group Macro	Section	Usage
...		
<del>XA/XRF</del> 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
<del>XA/XRF</del> X-Ray Frame Pixel Data Properties	C.8.19.6.4	M

144 **A.48.4 Enhanced XRF Image Functional Group Macros**

146 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.

148 **Table A.48-2  
ENHANCED XRF IMAGE FUNCTIONAL GROUP MACROS**

Functional Group Macro	Section	Usage
...		
<del>XA/XRF</del> 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
<del>XA/XRF</del> X-Ray Frame Pixel Data Properties	C.8.19.6.4	M

150 **Item #4: Update Breast Tomosynthesis Image IOD**

**A.55 BREAST TOMOSYNTHESIS IMAGE INFORMATION OBJECT DEFINITION**

152 ...

**A.55.3.1 Breast Tomosynthesis Image IOD Content Constraints**

154 ...

**A.55.3.1.2 Image – Equipment Coordinate Relationship Module**

156 **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**



158 **1.2.840.10008.5.1.4.1.1.13.1.5) the isocenter coordinate system shall be used to describe the**  
 160 **positioning of the X-Ray Source, Detector and Breast Support (see C.8.X.6), and shall use only the**  
**value ISOCENTER for Equipment Coordinate System Identification (0028,9537).**

<b>Item #5: Add section to Annex A</b>
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## **A.X BREAST PROJECTION X-RAY IMAGE INFORMATION OBJECT DEFINITION**

### **A.X.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.

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The Breast Projection X-Ray Image IOD is used in two SOP Classes as defined in PS 3.4 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.X.2 Breast Projection X-Ray Image IOD Entity-Relationship Model**

The E-R Model in Section A.1.2 depicts those components of the DICOM Application Information Model that directly reference the Breast Projection X-Ray Image IOD. Additionally, "Image" in Figure A.1-1 may represent a Single Frame or a Multi-Frame image. A frame denotes a two-dimensional organization of pixels recorded as a single exposure.

### **A.X.3 Breast Projection X-Ray Image IOD Module Table**

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**Table A.X-1  
BREAST PROJECTION X-RAY IMAGE IOD MODULES**

<b>IE</b>	<b>Module</b>	<b>Reference</b>	<b>Usage</b>
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.X.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

182

**A.X.3.1 Breast Projection X-Ray Image IOD Content Constraints**

184 **A.X.3.1.1 Modality Type Attribute**

The Modality Type attribute (0008,0060) shall have the value MG.

186 **A.X.3.1.2 Overlay Plane Module, Curve Module and VOI LUT Module**

188 The Overlay Plane Module, Curve Module, 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.

190

**A.X.4 Breast Projection X-Ray Image Functional Group Macros**

192 Table A.X-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.

194

**Table A.X-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.X.2	C – Required if X-Ray Source moves relative to the patient. May be present otherwise.
Breast X-Ray Detector	C.8.X.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.X.4	M
Breast X-Ray Acquisition Dose	C.8.X.5	M
Breast X-Ray Isocenter Reference System	C.8.X.6	M
X-Ray Grid	C.8.X.7	U
X-Ray Filter	C.8.X.8	U

196

**A.X.4.1 Breast Projection X-Ray Image Functional Group Macros Content Constraints**

198 **A.X.4.1.1 Frame Anatomy Functional Group Macro**

The Defined Context ID for the Anatomic Region Sequence (0008,2218) shall be CID 4013.

200

**Item #6: Add Spatial Locations Preserved and Patient Orientation to Source Image Sequence**

202 **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.

204

**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 C.7.6.1.1.3 for further explanation.
>Derivation Code Sequence	(0008,9215)	1	A coded description of how this frame data was derived. See C.7.6.1.1.3 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.
<i>&gt;&gt;Include 'Code Sequence Macro' Table 8.8-1</i>			<i>Defined CID 7203.</i>
>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 C.7.6.1.1.4 for further explanation.
<i>&gt;&gt;Include 'Image SOP Instance Reference Macro' Table 10-3</i>			
>>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 played in the derivation of this image or frame.  Only a single Item shall be included in this <b>s</b> Sequence.
<i>&gt;&gt;&gt;Include 'Code Sequence Macro' Table 8.8-1</i>			<i>Defined CID 7202.</i>

<p><u>&gt;&gt;Spatial Locations Preserved</u></p>	<p><u>(0028,135A)</u></p>	<p><u>3</u></p>	<p><u>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.</u></p> <p><u>Enumerated Values:</u></p> <p><u>YES</u></p> <p><u>NO</u></p> <p><u>REORIENTED ONLY – A projection radiograph that has been flipped and/or rotated by a multiple of 90 degrees</u></p> <p><u>Notes: 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.</u></p> <p><u>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.</u></p>
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<b>&gt;&gt;Patient Orientation</b>	<b>(0020,0020)</b>	<b>1C</b>	<b><u>The Patient Orientation values of the source image.</u></b> <b><u>Required if the value of Spatial Locations Preserved (0028,135A) is REORIENTED_ONLY.</u></b>
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**Item #7: Modify X-Ray Field of View Macro**

208 **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.

210

**Table C.8.19.6-2  
X-RAY FIELD OF VIEW MACRO ATTRIBUTES**

Attribute Name	Tag	Type	Attribute Description
Field of View Sequence	(0008,9432)	1	Sequence containing the field of view for this frame. Only a single item shall be included in this sequence.
...			
>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 C.8.11.4.1.1 for further explanation. Required if X-Ray Receptor Type (0018,9420) is present and equals DIGITAL_DETECTOR. <b><u>May be present otherwise.</u></b>
...			

212

**Item #8: Update macro names to reflect broader use**

214 **C.8.19.6.1 ~~XA/XRF~~X-Ray Frame Characteristics Macro**

216 Table C.8.19.6-1 specifies the attributes of the ~~XA/XRF~~X-Ray Frame Characteristics Functional Group macro.

218

**Table C.8.19.6-1  
~~XA/XRF~~ 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.
...			

**C.8.19.6.4 XA/XRFX-Ray Frame Pixel Data Properties Macro**

220 Table C.8.19.6-4 specifies the attributes of the X-Ray Frame Pixel Data Properties Functional Group macro.

222

**Table C.8.19.6-4  
XA/XRFX-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 the Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the values of the Image Type (0008,0008) attribute. See C.8.19.2.1.1.
...			

224

**C.8.19.6.4.1 XA/XRFX-Ray Frame Pixel Data Properties Attributes**

226 **Item #9: Add to section C.8 MODALITY SPECIFIC MODULES**

**C.8.X.1 Enhanced Mammography Image Module**

228 Table C.8.X-1 specifies the Attributes that identify and describe general information about the Enhanced Mammography Image module.

230

**Table C.8.X-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.X.1.1 for Defined Terms.
Positioner Type	(0018,1508)	1	Enumerated Values: MAMMOGRAPHIC
Content Qualification	(0018,9004)	1	Content qualification indicator. 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).
Acquisition Duration	(0018,9073)	1	The time in seconds needed for the complete acquisition. See C.7.6.16.2.2.1 for further explanation.
<i>Include 'Digital X-Ray Detector Macro' Table C.8-71b</i>			
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.
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: 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.
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 Value = 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 to 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 Value: 0000H = unsigned integer
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 Value = NO
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 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 C.7.6.1.1.5 for further explanation. May be multi-valued if successive lossy compression steps have been applied. Required if Lossy Image Compression (0028,2110) = 01.
Lossy Image Compression Method	(0028,2114)	1C	A label for the lossy compression method(s) that have been applied to this image. See C.7.6.1.1.5 for further explanation. May be multi-valued if successive lossy compression steps have been applied; the value order shall correspond to the values of Lossy Image Compression (0028,2112). Required if Lossy Image Compression (0028,2110) = 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.
Type of Detector Motion	(0054,0202)	1	Describes the activity of the Detector during acquisition. See C.8.X.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 'Image Pixel Macro' Table C.7-11b			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.
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232

**C.8.X.1.1 Positioner and Detector Motion Attribute Descriptions**

234 Positioner Motion (0018,1500) and Type of Detector Motion (0054,0202) shall have the Defined Terms specified in Table C.8.X.1.1-1:

236

**Table C.8.X.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

238

240 Complex motion is defined as that which is not simply described by linear translation or rotation around an axis.

**C.8.X.2 Breast X-Ray Positioner Macro**

242 Table C.8.X.2-1 specifies the Attributes of the Breast X-Ray Positioner Functional Group macro.

244

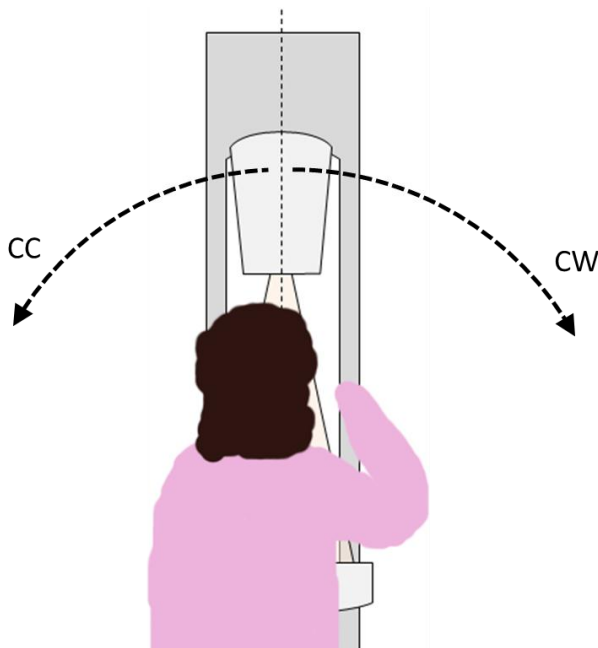
**Table C.8.X.2-1  
BREAST X-RAY POSITIONER MACRO ATTRIBUTES**

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.X.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.

246 **C.8.X.2.1 Breast X-Ray Positioner Attribute Descriptions**

248 Figure C.8.X.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.X.2-1**  
**Illustration of Positioner Primary Angle Direction**

252

**C.8.X.3 Breast X-Ray Detector Macro**

Table C.8.X.3-1 specifies the Attributes of the Breast X-Ray Detector Functional Group macro.

256

**Table C.8.X.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.

258

**C.8.X.4 Breast X-Ray Geometry Macro**

Table C.8.X.4-1 specifies the Attributes of the Breast X-Ray Geometry Functional Group macro.

262

**Table C.8.X.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. Notes: 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. Notes: 1. This value is traditionally referred to as Source Object Distance (SOD). 2. See notes for this attribute in C.8.11.5 DX Positioning Module. 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).

264 **C.8.X.5 Breast X-Ray Acquisition Dose Macro**

Table C.8.X.5-1 specifies the Attributes of the X-Ray Acquisition Dose Functional Group macro.

266

**Table C.8.X.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.

>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. Notes: 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 (IgM). 3. DICOM specifies standard Attributes in Table 10-23 'Exposure Index Macro' 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.

268

### C.8.X.6 Breast X-Ray Isocenter Reference System Macro

270 Table C.8.X.6-1 specifies the Attributes of the Breast X-Ray Isocenter Reference System Functional Group macro.

272

**Table C.8.X.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.X.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.X.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.X.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.X.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.X.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.X.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.X.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.X.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.X.6.1.4 for further explanation.
>Detector X Position to Isocenter	(0018,9552)	1C	X position of the Detector Reference Point with respect to the Isocenter (mm). See C.8.X.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.X.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.X.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.X.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.X.6.1.5 for further explanation. Required if Presentation Intent Type (0008.0068) = FOR PROCESSING. May be present otherwise.

274

### C.8.X.6.1 Isocenter Reference System Attribute Descriptions

276 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.

278 These attributes define four coordinate systems in the 3D space:

- Isocenter coordinate system
- 280 - X-Ray Source coordinate system
- Breast Support coordinate system
- 282 - Detector coordinate system

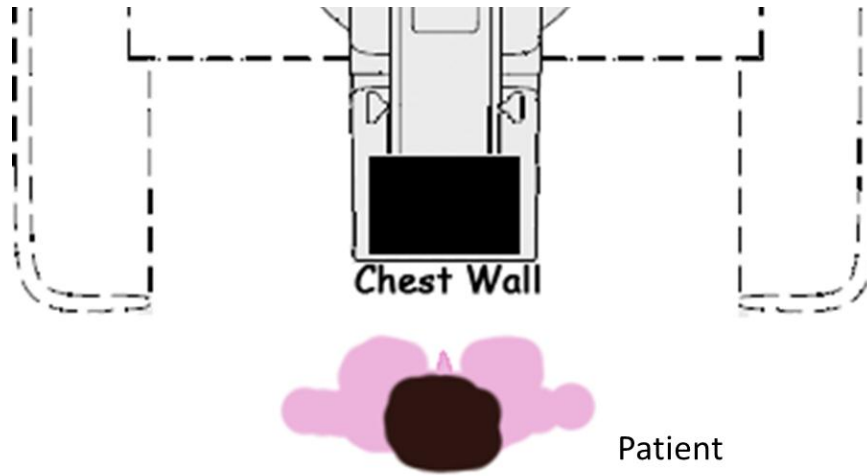
284 The Isocenter Reference System attributes describe the relationship between the 3D coordinates of a point in the Breast Support coordinate system and the 3D coordinates of such point in the X-Ray Source and Detector coordinate systems (which may move in the equipment), by using the Isocenter coordinate system that is fixed in the equipment.

288 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.

292 Note: PS 3.17 Annex X describes the transformations necessary to transpose between coordinate systems.

294

The detector is anterior to the patient standing upright and facing the front of the gantry, as shown in  
 296 Figure C.8.X.6-1.



298 **Figure C.8.X.6-1**  
 300 **Patient/Detector Relationship (Patient Standing)**

302 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:

304

GANTRY FRONT	The side of the equipment closest to the patient when the patient is standing, positioned for breast projection X-Ray imaging	
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	

**Figure C.8.X.6-2**  
**Gantry Sides**

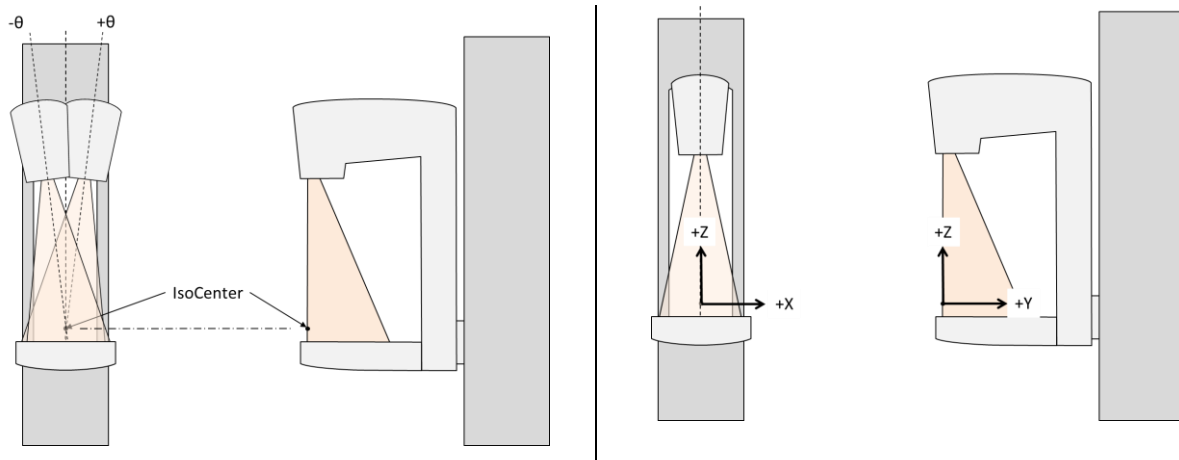
306 **C.8.X.6.1.1 Isocenter Coordinate System**

The Isocenter coordinate system (O,X,Y,Z) of the equipment is defined as follows (see Figure C.8.X.6-3):

- 308 - 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.

- 310 - +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).
- 312 - +Z direction is upward (anti-gravity).
- The isocenter coordinate system does not rotate when the tube head or C-arm rotates.

314



316

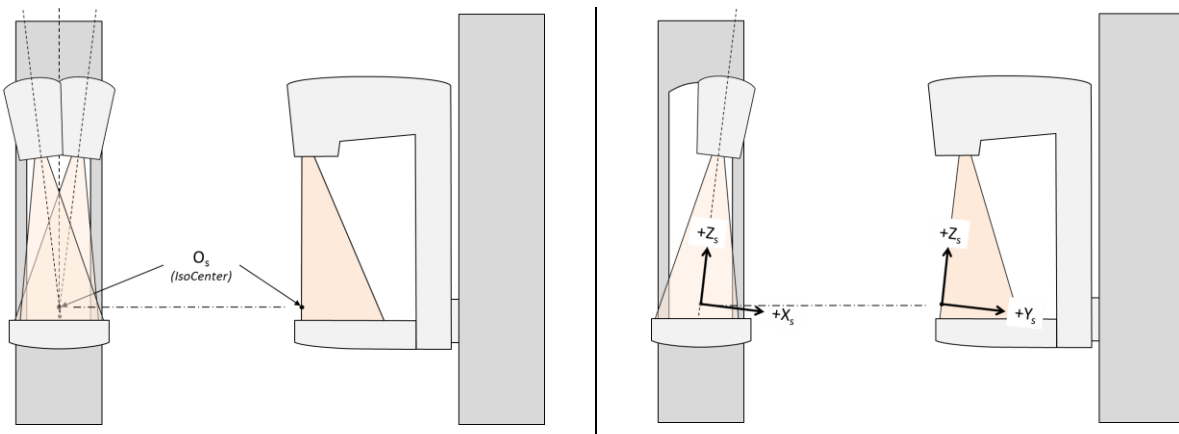
**Figure C.8.X.6-3  
Isocenter Coordinate System**

**318 C.8.X.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.X.6-4):

- 320 - 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  $0^\circ$ ).
- 322 -  $Y_s$  axis is the axis of rotation of the X-ray source. Positive direction is from GANTRY FRONT to GANTRY REAR.
- 324 -  $Z_s$  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  $+Y_s$ .

328



**Figure C.8.X.6-4**  
**X-Ray Source Coordinate System**

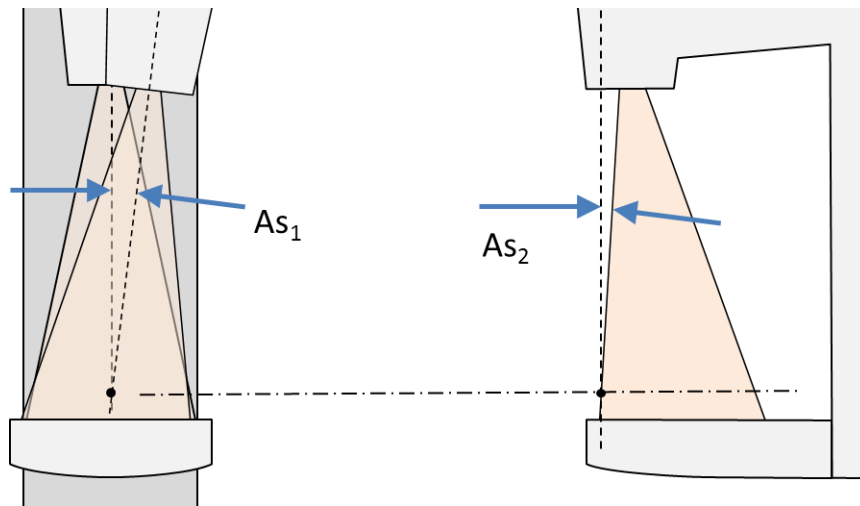
330

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.

334 **X-Ray Source Isocenter Primary Angle (0018,9543)** (so-called  $As_1$  in Figure C.8.X.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.

336 **X-Ray Source Isocenter Secondary Angle (0018,9544)** (so-called  $As_2$  in Figure C.8.X.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.

338

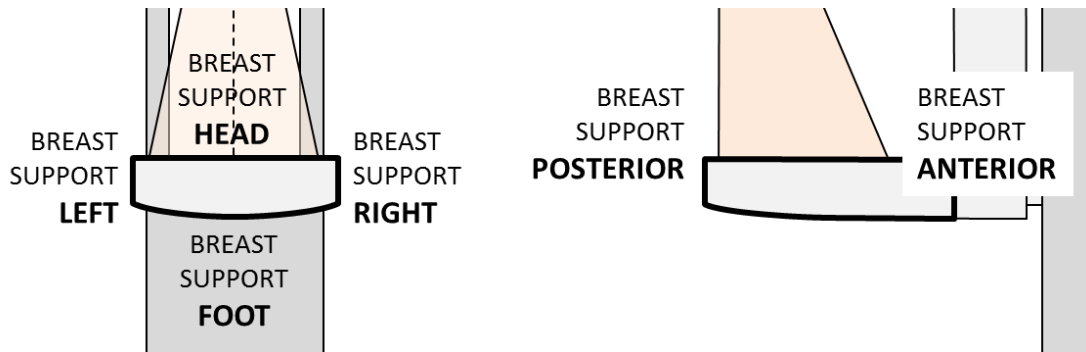


340

**Figure C.8.X.6-5**  
**X-Ray Source Isocenter Angles**

342 **C.8.X.6.1.3 Breast Support Coordinate System**

344 The Breast Support (see Figure C.8.X.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.



346

**Figure C.8.X.6-6**  
**Breast Support Orientation**

348

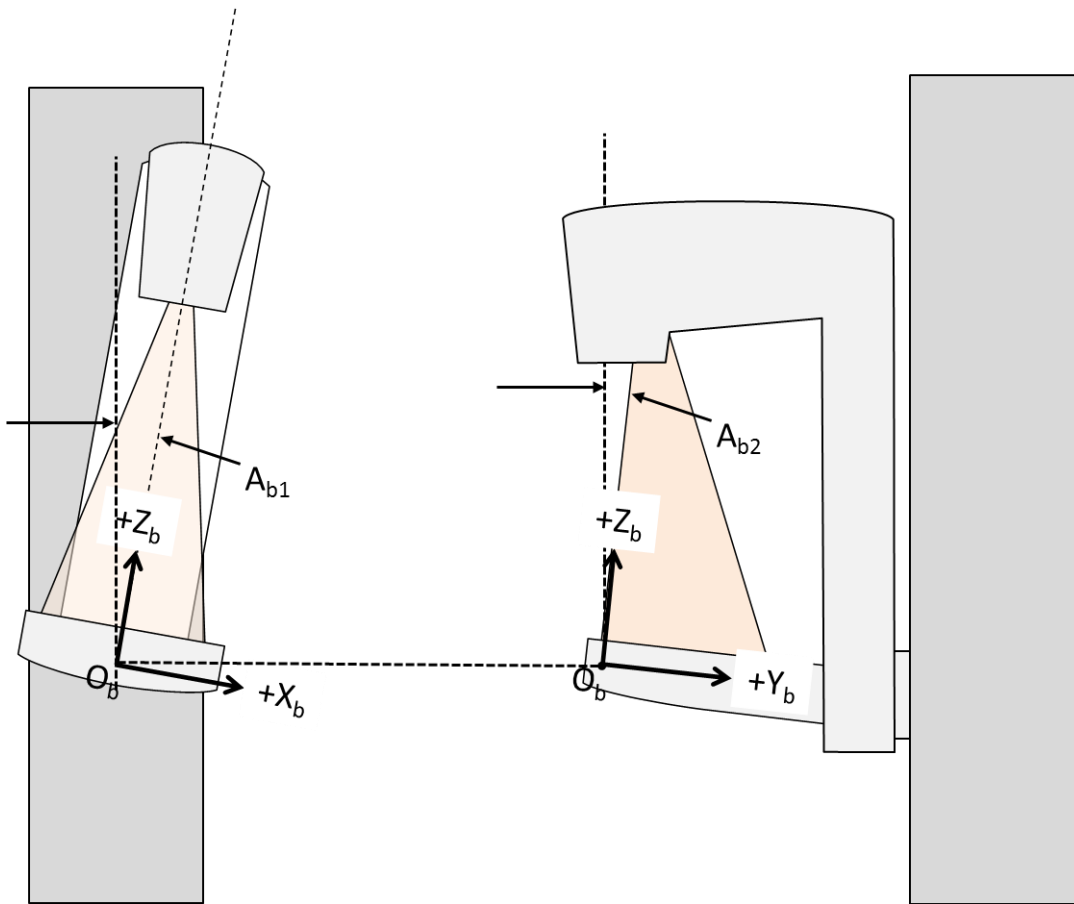
The Breast Support coordinate system ( $O_b, X_b, Y_b, Z_b$ ) is defined as follows (see Figure C.8.X.6-7):

- 350 - Origin  $O_b$ , the so-called Breast Support Reference Point, is an arbitrary point, as defined by the  
equipment manufacturer, on the axis of the center of rotation of the Breast Support.
- 352 -  $X_b$  axis lies parallel to the Breast Support top surface, passes through  $O_b$ , and is parallel to  $X$  when  
354 the Breast Support top surface is normal to gravity. The  $+X_b$  direction is toward BREAST  
SUPPORT RIGHT.
- 356 -  $Y_b$  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.
- 358 -  $Z_b$  axis is normal to the Breast Support top surface and passes through  $O_b$ . The  $+Z_b$  direction is  
toward BREAST SUPPORT HEAD.

360 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.X.6-7). It is the most common convention in breast projection X-Ray system design to  
362 have the Breast Support rotate identically and in synchronization with the system C-arm (they are most  
often rigidly integrated):

364 **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  
366 Support is lower than the Breast Support Left end of the Breast Support, and is  $0^\circ$  when the Breast  
Support surface is normal to the  $+Z$  direction. In digital breast tomosynthesis, because the X-Ray source  
368 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.

370 **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  
372 the Breast Support is lower than the Breast Support Posterior end of the Breast Support, and is  $0^\circ$  when  
the Breast Support surface is normal to the  $+Z$  axis. In most breast projection X-Ray imaging equipment  
374 the value of  $Ab_2$  is  $0^\circ$ .



376

**Figure C.8.X.6-7**  
**Breast Support Angles with respect to the Isocenter Reference System**

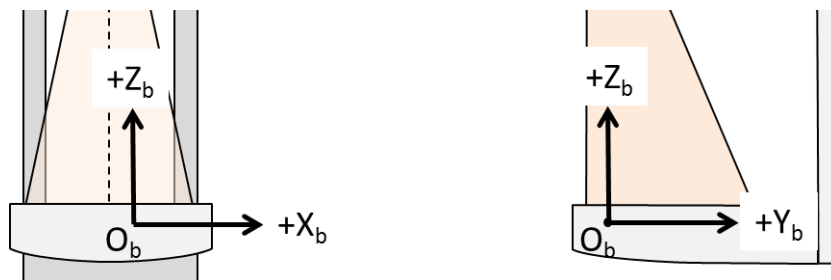
378 **Breast Support X Position to Isocenter (0018,9547)** (so-called  $B_x$ ) is defined as the translation of the  
380 Breast Support Reference Point  $O_b$  with respect to the Isocenter coordinate system in the +X axis  
direction. Breast support translation toward +X is positive.

382 **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.

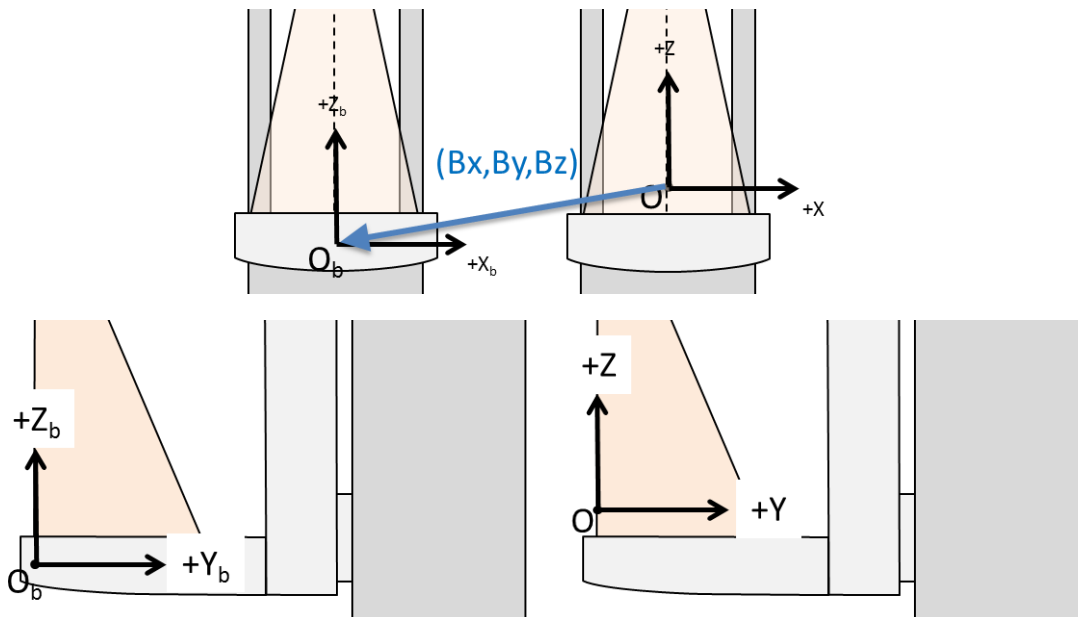
384 **Breast Support Z Position to Isocenter (0018,9459)** (so-called  $B_z$ ) is defined as the translation of the  
Breast Support Reference Point  $O_b$  with respect to the Isocenter coordinate system in the +Z axis  
386 direction. Breast support translation toward +Z is positive.

388 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.

390



392



394

**Figure C.8.X.6-8  
Breast Support Translation with respect to the Isocenter Reference System**

**C.8.X.6.1.4 Detector Coordinate System**

396 A detector coordinate system is defined that allows the detector to be either stationary or in motion. For  
398 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

400

Rotating Detector

Translating Detector

402

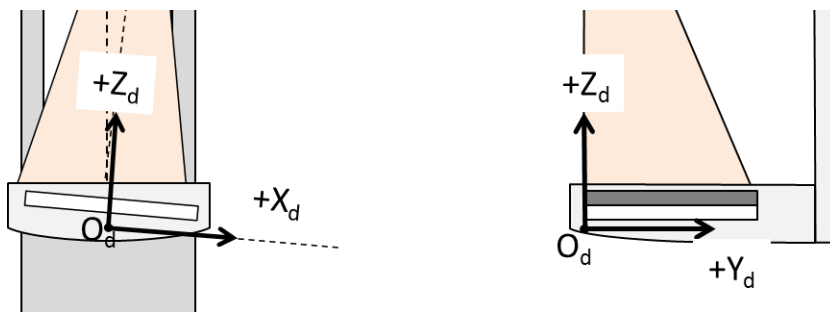
Complex Detector

404 An infinite variation of detector motions is possible through time- and angle- dependent combinations of  
detector rotation and detector translation.

406 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  
408 coordinate system. The detector coordinate system ( $O_d, X_d, Y_d, Z_d$ ) is defined as follows (see Figure  
C.8.X.6-9):

- 410 - 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.
- 412 -  $X_d$  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.
- 414 -  $Y_d$  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.
- 416 -  $Z_d$  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  $+Y_d$ .

418



420

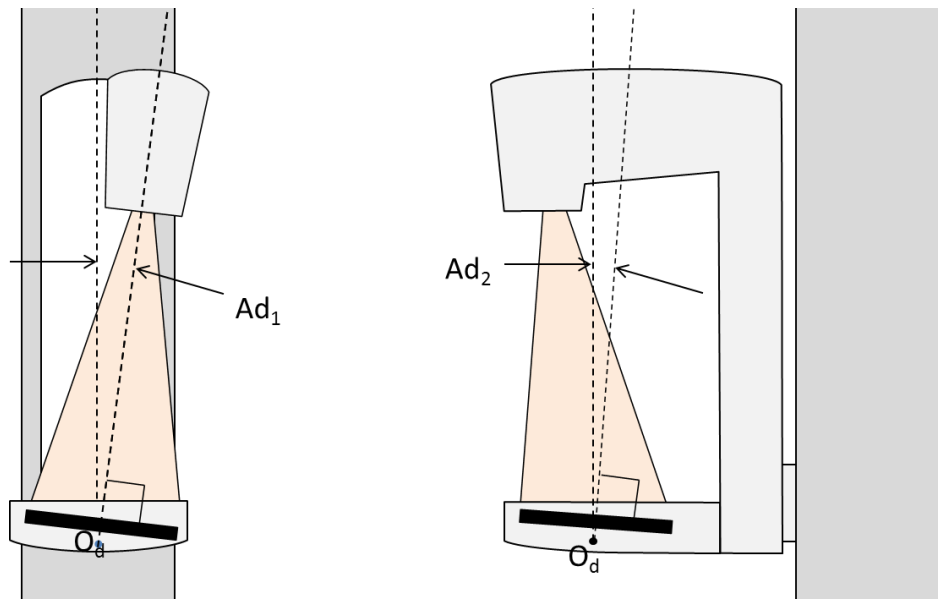
**Figure C.8.X.6-9  
Detector Coordinate System**

422 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  
424 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  $0^\circ$  when the detector surface is normal to the  $+Z$  axis.

428 **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  
430 respect to  $Z$ . In most cases this angle is  $0^\circ$ , inferring that the  $XZ$  plane is parallel to the  $X_dZ_d$  plane.





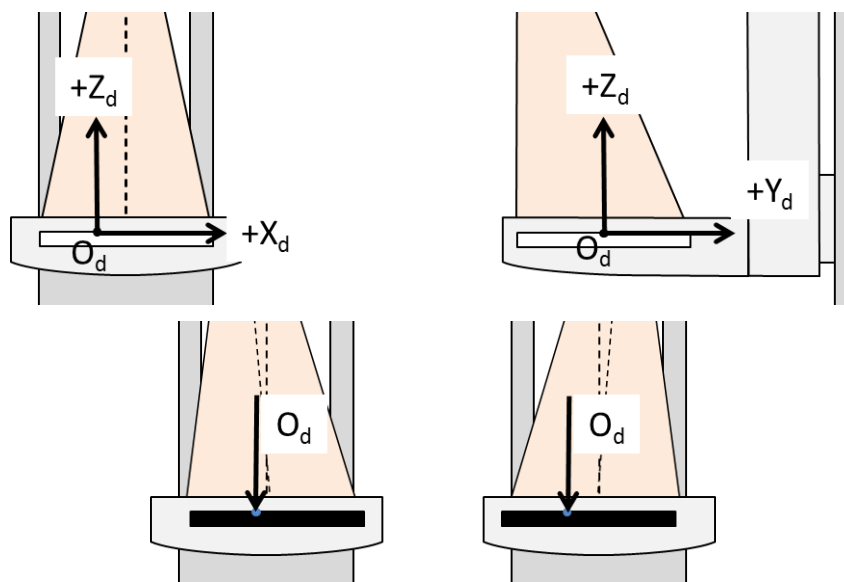
432

**Figure C.8.X.6-10  
Detector Isocenter Angles**

434 **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  $D_x$   
436 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  
438 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.

440 **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  $D_z$   
442 toward Breast Support Head from Detector  $O_d$  is positive.



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**Figure C.8.X.6-11**  
**Translation of the Detector Coordinate System**

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Although not shown in Figure C.8.X.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.

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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.

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The case where the detector is stationary during image acquisition is a degenerate case, but still defined in the same manner.

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Notes: 1. An angulation of  $(Ad_1, Ad_2) = (0, 0)$  means that the Detector is not rotated relative to the System Isocenter coordinate system.

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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.

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**458 C.8.X.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.X.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.X.6.1.4) is defined by two attributes.

466

- Detector Active Area TLHC Position (0018,9557) specifies the x, y and z 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  $X_d Y_d$  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.

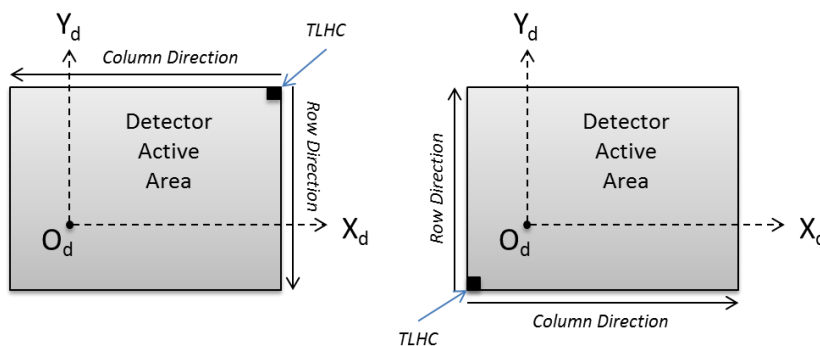
468

- 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.

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**Figure C.8.X.6-12**  
**Examples of Detector Active Area TLHC Position and Orientation**

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In Figure C.8.X.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).

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484 **C.8.X.7 X-Ray Grid Macro**

Table C.8.X.7-1 specifies the Attributes of the X-Ray Grid Functional Group macro.

486

**Table C.8.X.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 are: FIXED FOCUSED RECIPROCATING PARALLEL CROSSED NONE
<i>&gt;Include 'X-Ray Grid Description Macro' Table C.8-36b</i>			

488

**C.8.X.8 X-Ray Filter Macro**

490 Table C.8.X.8-1 specifies the Attributes of the X-Ray Filter Functional Group macro.

492

**Table C.8.X.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.
<i>&gt;Include 'X-Ray Filtration Macro' Table C.8-35a</i>			

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**Changes to NEMA Standards Publication PS 3.4-2011**

**Digital Imaging and Communications in Medicine (DICOM)**

504

**Part 4: Service Class Specifications**

506 **Item #10: Add SOP Classes to Table B.5-1**

**B.5 STANDARD SOP CLASSES**

508 Table B.5-1  
Standard SOP Classes

SOP Class	SOP Class UID	IOD Specification (defined in PS 3.3)
Breast Projection X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.13.1.4	
Breast Projection X-Ray Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.13.1.5	

510

**B.5.1.X Breast Projection X-Ray Image Storage SOP Classes**

512 The Breast Projection X-Ray Image Storage – For Presentation SOP Class shall use the Breast Projection X-Ray Image IOD with an Enumerated Value of FOR PRESENTATION for Presentation Intent Type (0008,0068).  
514

516 The Breast Projection X-Ray Image Storage – For Processing SOP Class shall use the Breast Projection X-Ray Image IOD with an Enumerated Value of FOR PROCESSING for Presentation Intent Type (0008,0068).

518 An SCU or SCP of the Breast Projection X-Ray Image Storage – For Processing SOP Class shall also support the Breast Projection X-Ray Image Storage – For Presentation SOP Class.

520 **Item #11: Add SOP Classes to Table I.4-1**

**I.4 MEDIA STORAGE SOP CLASSES**

522 Table I.4-1  
Media Storage Standard SOP Classes

SOP Class	SOP Class UID	IOD Specification
Breast Projection X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.13.1.4	IOD defined in PS 3.3
Breast Projection X-Ray Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.13.1.5	IOD defined in PS 3.3

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**Changes to NEMA Standards Publication PS 3.6-2011**

**Digital Imaging and Communications in Medicine (DICOM)**

536

**Part 6: Data Dictionary**

538 **Item #12: Add the following rows to Section 6**

Tag	Name	Keyword	VR	VM
(0018,9541)	Detector Position Sequence	DetectorPositionSequence	SQ	1
(0018,9542)	X-Ray Acquisition Dose Sequence	XRayAcquisitionDoseSequence	SQ	1
(0018,9543)	X-Ray Source Isocenter Primary Angle	XRaySourceIsocenterPrimaryAngle	FD	1
(0018,9544)	X-Ray Source Isocenter Secondary Angle	XRaySourceIsocenterSecondaryAngle	FD	1
(0018,9545)	Breast Support Isocenter Primary Angle	BreastSupportIsocenterPrimaryAngle	FD	1
(0018,9546)	Breast Support Isocenter Secondary Angle	BreastSupportIsocenterSecondaryAngle	FD	1
(0018,9547)	Breast Support X Position to Isocenter	BreastSupportXPositionToIsocenter	FD	1
(0018,9548)	Breast Support Y Position to Isocenter	BreastSupportYPositionToIsocenter	FD	1
(0018,9549)	Breast Support Z Position to Isocenter	BreastSupportZPositionToIsocenter	FD	1
(0018,9550)	Detector Isocenter Primary Angle	DetectorIsocenterPrimaryAngle	FD	1
(0018,9551)	Detector Isocenter Secondary Angle	DetectorIsocenterSecondaryAngle	FD	1
(0018,9552)	Detector X Position to Isocenter	DetectorXPositionToIsocenter	FD	1
(0018,9553)	Detector Y Position to Isocenter	DetectorYPositionToIsocenter	FD	1
(0018,9554)	Detector Z Position to Isocenter	DetectorZPositionToIsocenter	FD	1
(0018,9555)	X-Ray Grid Sequence	XRayGridSequence	SQ	1
(0018,9556)	X-Ray Filter Sequence	XRayFilterSequence	SQ	1
(0018,9557)	Detector Active Area TLHC Position	DetectorActiveAreaTLHCPosition	FD	3
(0018,9558)	Detector Active Area Orientation	DetectorActiveAreaOrientation	FD	6
(0018,9559)	Positioner Primary Angle Direction	PositionerPrimaryAngleDirection	CS	1

540 **Item #13: Add the following rows to Table A-1**

UID Value	UID Name	UID Type	Part
1.2.840.10008.5.1.4.1.1.13.1.4	Breast Projection X-Ray Image Storage – For Presentation	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.13.1.5	Breast Projection X-Ray Image Storage – For Processing	SOP Class	PS 3.4

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**Changes to NEMA Standards Publication PS 3.15-2011**

552

**Digital Imaging and Communications in Medicine (DICOM)**

**Part 15: Security and System Management Profiles**

554



**Item #14: Add to Section C2 and C3**

556

**C.2 CREATOR RSA DIGITAL SIGNATURE PROFILE**

558 ...

- x. any Attributes of the Implant Assembly Template module that are present
- y. any Attributes of the Implant Template Group module that are present
- z. **any attributes of the Enhanced Mammography Image module that are present**

562

**C.3 AUTHORIZATION RSA DIGITAL SIGNATURE PROFILE**

564 ...

- w. any attributes of the Implant Assembly Template module that are present
- x. any attributes of the Implant Template Group module that are present
- y. **any attributes of the Enhanced Mammography Image module that are present**

568