

DICOM Correction Item

Correction Number	CP-762
Log Summary:	Add Waveform Presentation attributes
Type of Modification	Name of Standard
Addition	PS 3.3-2007, PS 3.6-2007
<p>Rationale for Correction:</p> <p>There is no DICOM presentation state information object defined for waveforms, and it is not clear that a consensus could be formed at this time for defining such an object. However, there is agreement from the several vendors of electrophysiology lab equipment (through the WG1 EP editorial subgroup) that a basic set of display control attributes should be added to the waveform object to convey the principal parameters of display. It is not necessary that the original display be replicated exactly; however, the grouping, relative position, and color of the waveforms is critical to clinical usability of waveform data.</p> <p>The added attributes are not sufficient to define all aspects of waveform presentation. Scrolling / paging / sweeping styles and speeds, scales and aspect ratios, and reference grids are still implementation dependent. It is presumed that the display application has fundamental knowledge about waveform display and clinical use, and it uses that knowledge with the supplied display parameters to achieve a minimal measure of display consistency between the acquisition and subsequent review. The display application may, of course, disregard the display control attributes.</p> <p>This proposal adds the necessary attributes to the Waveform Module.</p>	
<p>Sections of documents affected</p> <p>PS 3.3 Section C.10.9</p> <p>PS 3.6 Section 6</p>	
Correction Wording:	

Add the following to PS3.3 Section C.10.9

**Table C.10-9
 Waveform Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Waveform Sequence	(5400,0100)	1	Sequence of one or more Items, each representing one waveform multiplex group. Ordering of Items in this Sequence is significant for external reference to specific multiplex groups.
...			
> Waveform Data	(5400,1010)	1	Encoded data samples - channel multiplexed See section C.10.9.1.7
<u>Waveform Data Display Scale</u>	<u>(003A,0230)</u>	<u>3</u>	<u>The recommended time-based waveform data display scale in units of mm/s (see C.10.9.1.8).</u>
<u>Waveform Display Background CIE Lab Value</u>	<u>(003A,0231)</u>	<u>3</u>	<u>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 CIE Lab. See C.10.7.1.1.</u>

<u>Waveform Presentation Group Sequence</u>	<u>(003A,0240)</u>	<u>3</u>	<p><u>Sequence of Items, each Item describing a Presentation Group of one or more waveform channels to be displayed together.</u></p> <p><u>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.</u></p> <p><u>One or more Items may be present.</u></p>
<u>>Presentation Group Number</u>	<u>(003A,0241)</u>	<u>1</u>	<u>A number that identifies the Presentation Group.</u>
<u>>Channel Display Sequence</u>	<u>(003A,0242)</u>	<u>1</u>	<p><u>Sequence of Items, each Item describing a channel to be displayed in the Presentation Group.</u></p> <p><u>One or more Items shall be present.</u></p>
<u>>>Referenced Waveform Channels</u>	<u>(0040,A0B0)</u>	<u>1</u>	<p><u>Identifier of the displayed channel, specified as a pair of values (M,C) where the first value is the ordinal of the sequence item of the Waveform Sequence (5400,0100) attribute (i.e., the Multiplex Group Number), 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.</u></p> <p><u>Note: In the context of a Channel Display Sequence (003A,0242) Item, only a single channel shall be referenced.</u></p>
<u>>>Channel Offset</u>	<u>(003A,0218)</u>	<u>3</u>	<u>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.</u>
<u>>>Channel Recommended Display CIELab Value</u>	<u>(003A,0244)</u>	<u>1</u>	<u>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 C.10.7.1.1.</u>
<u>>>Channel Position</u>	<u>(003A,0245)</u>	<u>1</u>	<u>Position of the Channel within the Presentation Group display area (see C.10.9.1.9).</u>

<u>>>Display Shading Flag</u>	<u>(003A,0246)</u>	<u>3</u>	<p><u>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.</u></p> <p><u>Enumerated Values:</u></p> <p><u>NONE – no shading</u></p> <p><u>BASELINE– shading between the waveform and the channel display baseline (sample value 0 equivalent location)</u></p> <p><u>ABSOLUTE – shading between the waveform and the channel real world actual value 0 (i.e., taking into account the Channel Baseline (003A,0213) value)</u></p> <p><u>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.</u></p>
<u>>>Fractional Channel Display Scale</u>	<u>(003A,0247)</u>	<u>1C</u>	<p><u>Fraction of the Presentation Group vertical display dimension assigned to the unit quantity (least significant bit) of the Channel samples (see C.10.9.1.10). Required if Absolute Channel Display Scale (003A,0248) is not present, may be present otherwise.</u></p>
<u>>>Absolute Channel Display Scale</u>	<u>(003A,0248)</u>	<u>1C</u>	<p><u>Nominal vertical display height in mm assigned to the unit quantity (least significant bit) of the Channel samples (see C.10.9.1.10). Required if Fractional Channel Display Scale (003A,0247) is not present, may be present otherwise.</u></p>

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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. The Waveform Data Display Scale, divided by the Sampling Frequency (003A,001A), times the display scaling in pixels/mm gives the number of horizontal pixels between subsequent samples.

- Notes:
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 is 25 mm/s, and which is being displayed on a monitor at 4.1 pixels/mm, the horizontal interval between samples is

$$25 / 400 * 4.1 = 0.25625 \text{ pixels}$$

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).

Notes: 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 Graphic Annotation Module.

Channel sample value 0 maps to the Channel Position 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.

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 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 value is 0.004, and whose Channel Position 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 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. 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 value, gives the real-world scaling of the intended display.

Notes: 1. This attribute is useful for size consistency between softcopy display and classical hardcopy waveform printed charts. E.g., a channel whose Channel Sensitivity value is 44 uV (per least significant bit), and whose Absolute Channel Display Scale 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 value is 0.44 mm, and which 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 baseline.

Display for waveform samples that would lie outside the Presentation Group display area is unspecified.

Negative values of Fractional Channel Display Scale and Absolute Channel Display Scale are allowed.

Add the following to PS3.6 Section 6

<u>Tag</u>	<u>Name</u>	<u>VR</u>	<u>VM</u>
<u>(003A,0230)</u>	<u>Waveform Data Display Scale</u>	<u>FL</u>	<u>1</u>
<u>(003A,0231)</u>	<u>Waveform Display Background CIELab Value</u>	<u>US</u>	<u>3</u>
<u>(003A,0240)</u>	<u>Channel Presentation Group Sequence</u>	<u>SQ</u>	<u>1</u>

<u>Tag</u>	<u>Name</u>	<u>VR</u>	<u>VM</u>
<u>(003A,0241)</u>	<u>Presentation Group Number</u>	<u>US</u>	<u>1</u>
<u>(003A,0242)</u>	<u>Channel Display Sequence</u>	<u>SQ</u>	<u>1</u>
<u>(003A,0244)</u>	<u>Channel Recommended Display CIELab Value</u>	<u>US</u>	<u>3</u>
<u>(003A,0245)</u>	<u>Channel Position</u>	<u>FL</u>	<u>1</u>
<u>(003A,0246)</u>	<u>Display Shading Flag</u>	<u>CS</u>	<u>1</u>
<u>(003A,0247)</u>	<u>Fractional Channel Display Scale</u>	<u>FL</u>	<u>1</u>
<u>(003A,0248)</u>	<u>Absolute Channel Display Scale</u>	<u>FL</u>	<u>1</u>