Ultrasonic Waveform IOD

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November 18, 2022

1 Abstract

The DICONDE[1] Standard offers a lot for saving result pictures, which are already rendered, but lacks a little bit when it comes to RAW-Data. This Proposal introduces a new IOD, combining the Ultrasonic IOD and the Waveform IOD from the DICOM[2]. It was developed at the Fraunhofer IZFP in Saarbrücken from the named Authores and is currently WORK IN PROGRESS!.
We aim to standardize our proposal at the ASTM, but this is not yet done! So use this at your own risk! This may or may not change, and may or may not be standarized in the future.

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[1] Digital Imaging and Communication in Non Destructive Evaluation
[2] Digital Imaging and Communications in Medicine

2 Ultrasonic Waveform IOD

2.1 Ultrasonic Waveform IOD Description

Ultrasonic Waveform IOD is the specification of digitized Waveforms (A-Scans) taken from the surface of a specimen, which has been acquired by an US modality.

2.2 Ultrasonic Waveform IOD Definition

IE	Module	Reference	Usage
Component	Component	E2339, Section 7	M
	NDE Indication	E2339, Section 7	U
	NDE Geometry	E2339, Section 7	U
Study	General Study	E2339, Section 7	M
Series	General Series	E2339, Section 7	M
Equipment	NDE Equipment	E2339, Section 7	M
	NDE US Equipment	E2339, Section 7.2	U
	NDE Equipment Settings	E2339, Section 7.3	U
Image	NDE US Image	E2663, Section 7.1	M
Ultrasonic Waveform	Ultrasonic Waveform	Section 3	M

2.3 Ultrasonic Waveform IOD Content Constraints

2.3.1 Modality

The value of Modality (0008,0060) shall be US.

3 Ultrasonic Waveform Module

3.1 Ultrasonic Waveform Module Defintion

Attribute Name	Tag	Type	VR	Attribute Description
Scan Type	(4010,1048)	1	SH	Defines which scan type was used to create the stored AScans. Possible values are f.e. SECTORSCAN, LINEARSCAN, SINGLESCAN, MULTISCAN, COMPOUND_BSCAN, PWI
Wave Source Dimensions Sequence	(0019,1012)	1	SQ	Sequence of elements, each representing a physical dimension describing the generation point of the referenced wave.
>Dimension Number	(0019,1011)	1	UL	Number to reference this dimension.

>Dimension Name	(0019,1013)	1	ST	Human readable description of the spatial direction or angle.
>Dimension Code Value	(0019,1014)	1	ST	Dimension Code Value is an identifier that is unambiguous within the Coding Scheme denoted by Dimesnsion Coding Scheme Designator (0019,1015) and Dimesnsion Coding Scheme Version (0019,1016).
>Dimesnsion Coding Scheme Designator	(0019,1015)	1	ST	An identifier of the version of the coding scheme if necessary to resolve ambiguity.
>Dimesnsion Coding Scheme Version	(0019,1016)	1	ST	An identifier of the version of the coding scheme if necessary to resolve ambiguity.
>Dimension Code Meaning	(0019,1017)	1	ST	Dimension Code Meaning is text that has meaning to a human and conveys the meaning of the term defined by the combination of Dimension Code Value (0019,1014) , and Destination Coding Scheme Designator (0019,1015). 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.
>Dimension Coding Scheme Name	(0019,1018)	1	ST	The coding scheme full common name
>Dimension Coding Scheme Responsible Organisation	(0019,1019)	1	ST	Name of the organization responsible for the Coding Scheme. May include organizational contact information.
>Dimension Code Value Type	(0019,1020)	1	ST	Defines the type of the Dimension Value. Defined Terms: NUMERIC, SHORTNUMERIC, FLOATINGPOINT
Waveform Sequence	(5400,0100)	1	SQ	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.
>Wave Source Values Sequence	(0019,0021)	1	SQ	Each item contains a value for the dimension defined by an item of the Wave Source Position Sequence (0019,0012).
>>Referenced Dimension	(0019,0022)	1	UL	Indicates to which item in Wave Source Dimension Sequence (0019,0012) the current item refers.
>>Numeric Value	(0040,a30a)	1C	ST	This is the Value component of a Name/Value pair when the Value Type (0019,0020) implied a set of one or more numeric values. Required if (0019,1020) is set to Numeric.

>>Short Numeric Value	(0019,1024)	1C	DS	Same as Numeric Value (0019,1023), but Encoded as 2 Byte integer (short). Required if (0019,1020) is set to SHORTNUMERIC.
>>Floating Point Value	(0019,1025)	1C	FD	Same as Numeric Value (0019,1023), but Encoded as 8 Byte floatingpoint (double). Required if (0019,1020) is set to FLOATINGPOINT.
>Multiplex Group Time Offset	(0018,1068)	1C	DS	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	DS	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	UL	Sample number whose time corresponds to a synchronization trigger (see Section C.10.9.1.2).
>Waveform Originality	(003A,0004)	1	CS	See Section C.10.9.1.3. Enumerated Values: ORIGINAL, DERIVED
>Number of Waveform Channels	(003A,0005)	1	US	Number of channels for this multiplex group.
>Number of Waveform Samples	(003A,0010)	1	UL	Number of samples per channel in this multiplex group.
>Sampling Frequency	(003A,001A)	1	DS	Frequency in Hz
>Multiplex Group Label	(003A,0020)	3	SH	Label for multiplex group
>Channel Definition Sequence	(003A,0200)	1	SQ	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	IS	Equipment physical channel number used for acquisition.
>>Channel Label	(003A,0203)	3	SH	Text label for channel, which may be used for display purposes
>>Channel Status	(003A,0205)	3	CS	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	SQ	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	SQ	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".				
>> Source Waveform Sequence	(003A,020A)	3	SQ	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"				
>>> 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	SQ	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	DS	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	DS	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	DS	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	DS	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	DS	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	US	Number of significant bits within the waveform samples (see Section C.10.9.1.4.4)
>>Filter Low Frequency	(003A,0220)	3	DS	Nominal 3dB point of lower frequency of pass band; in Hz
>>Filter High Frequency	(003A,0221)	3	DS	Nominal 3dB point of upper frequency of pass band; in Hz
>>Notch Filter Frequency	(003A,0222)	3	DS	Center frequency of notch filter(s); in Hz
>>Notch Filter Bandwidth	(003A,0223)	3	DS	Nominal 3dB bandwidth of notch filter(s); in Hz
>>Channel Minimum Value	(5400,0110)	3	OB	Minimum valid sample value as limited by the acquisition equipment (see Section C.10.9.1.4.5)
>>Channel Maximum Value	(5400,0112)	3	OB	Maximum valid sample value as limited by the acquisition equipment (see Section C.10.9.1.4.5)
>Waveform Bits Allocated	(5400,1004)	1	US	Size of each waveform data sample within the Waveform Data; See Section C.10.9.1.5
>Waveform Sample Interpretation	(5400,1006)	1	CS	Data representation of the waveform data points. See Section C.10.9.1.5.
>Waveform Padding Value	(5400,100A)	1C	OW	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	OW	Encoded data samples - channel multiplexed. See Section C.10.9.1.7

Waveform Data Display Scale	(003A,0230)	3	OW	The recommended time-based waveform data display scale in units of mm/s (see Section C.10.9.1.8).
5>>Referenced Waveform Channels	(0040,A0B0)	1		Identifier of the displayed channel, specified as a pair of values

4 Acronyms

DICONDE Digital Imaging and Communication in Non Destructive Evaluation

DICOM Digital Imaging and Communications in Medicine

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