Designation: E2663 – 14

Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods[1]

This standard is issued under the fixed designation E2663; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice facilitates the interoperability of ultrasonic imaging equipment by specifying image data transfer and archival storage methods in commonly accepted terms. This document is intended to be used in conjunction with Practice E2339 on Digital Imaging and Communication in Nondestructive Evaluation (DICONDE). Practice E2339 defines an industrial adaptation of the NEMA Standards Publication titled Digital Imaging and Communications in Medicine (DICOM, see http://medical.nema.org), an international standard for image data acquisition, review, transfer and archival storage. The goal of Practice E2339, commonly referred to as DICONDE, is to provide a standard that facilitates the display and analysis of NDE test results on any system conforming to the DICONDE standard. Toward that end, Practice E2339 provides a data dictionary and set of information modules that are applicable to all NDE modalities. This practice supplements Practice E2339 by providing information object definitions, information modules and data dictionary that are specific to ultrasonic test methods.

1.2 This practice has been developed to overcome the issues that arise when analyzing or archiving data from ultrasonic test equipment using proprietary data transfer and storage methods. As digital technologies evolve, data must remain decipherable through the use of open, industry-wide methods for data transfer and archival storage. This practice defines a method where all the ultrasonic technique parameters and test results are communicated and stored in a standard format regardless of changes in digital technology.

1.3 This practice does not specify:

1.3.1 A testing or validation procedure to assess an implementation's conformance to the standard.

1.3.2 The implementation details of any features of the standard on a device claiming conformance.

1.3.3 The overall set of features and functions to be expected from a system implemented by integrating a group of devices each claiming DICONDE conformance.

1.4 Although this practice contains no values that require units, it does describe methods to store and communicate data that do require units to be properly interpreted. The SI units required by this practice are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1316 Terminology for Nondestructive Examinations

E1454 Guide for Data Fields for Computerized Transfer of Digital Ultrasonic Testing Data (Withdrawn 2013)[3]

E2339 Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)

2.2 *Other Documentation:*

National Electrical Manufacturers Association Standard for Digital Imaging and Communications in Medicine (DICOM), 2014[4]

3. Terminology

3.1 *Definitions:*

3.1.1 Nondestructive evaluation terms used in this practice can be found in Terminology E1316.

3.1.2 DICONDE terms used in this practice are defined in Practice E2339.

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.11 on Digital Imaging and Communication in Nondestructive Evaluation (DICONDE).

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, http://www.nema.org.

***A Summary of Changes section appears at the end of this standard**

4. Summary of Practice

4.1 A fundamental principle of DICONDE is the use of standard definitions and formats for data communication and storage. This means all systems that are DICONDE compliant use a common data dictionary and common communication protocols. To further standardization, the elements in the data dictionary are organized into common groups referred to as information modules. The data dictionary and information modules common to all NDE modalities are defined in Practice E2339.

4.2 The data dictionary and information modules specified in Practice E2339 do not cover the information storage requirements for each individual modality (CT, DR, CR, UT, etc.). Additions to the data dictionary and information modules are required to support the individual modalities. This practice contains the additions to the DICONDE data dictionary and information modules necessary for ultrasonic inspection.

4.3 The highest organizational level in the DICONDE information model is the information object definition (IOD). An information object definition is a collection of the information modules necessary to represent a set of test results from a specific modality. This practice contains the information object definitions for ultrasonic inspection.

5. Significance and Use

5.1 Personnel that are responsible for the creation, transfer, and storage of ultrasonic test results will use this standard. This practice defines a set of information modules that along with Practice E2339 and the DICOM standard provide a standard means to organize ultrasonic test parameters and results. The ultrasonic test results may be displayed and analyzed on any device that conforms to this standard. Personnel wishing to view any ultrasonic inspection data stored in DICONDE format may use this document to help them decode and display the data contained in the DICONDE compliant inspection record.

6. Information Object Definitions

6.1 *Ultrasound Image IOD Description:*

6.1.1 The Ultrasound (US) Image Information Object Definition specifies an image that has been created by an ultrasound imaging device for NDE purposes. The IOD definition will follow that for US Images found in Part 3, Section A.6 of the DICOM standard except as noted in Table 1. Table 1 is not stand-alone and must be used in conjunction with Part 3, Section A.6 of the DICOM standard to have a complete definition of the DICONDE US information object.

6.1.2 This IOD will use the Service-Object Pair (SOP) Classes for the US IOD as defined in Part 4, Section B.5 of the DICOM standard.

6.2 *Ultrasound Multi-Frame Image:*

6.2.1 The Ultrasound Multi-Frame (US-MF) Image Information Object Definition specifies a multi-frame image that has been created by an ultrasound imaging device for NDE purposes. The IOD definition will follow that for US-MF Images found in Part 3, Section A.7 of the DICOM standard except as noted in Table 2. Table 2 is not stand-alone and must be used in conjunction with Part 3, Section A.7 of the DICOM standard to have a complete definition of the DICONDE US-MF information object.

6.2.2 This IOD will use the Service-Object Pair (SOP) Classes for the US-MF IOD as defined in Part 4, Section B.5 of the DICOM standard.

TABLE 1 US Image Information Object Definition

DICOM Module	DICONDE Module	Reference	Usage
Patient	Component	E2339, Section 7	M
Clinical Trial Subject	Not Applicable		
General Study	Component Study	E2339, Section 7	M
Patient Study	Not Applicable		
Clinical Trial Study	Not Applicable		
General Series	Component Series	E2339, Section 7	M
Clinical Trial Series	Not Applicable		
General Equipment	NDE Equipment	E2339, Section 7	M
Contrast/bolous	Not Applicable		
Specimen	Not Applicable		
US Image	NDE US Image	Section 7.1	M
US Region Calibration	Not Applicable		
	NDE US Equipment	Section 7.2	U
	NDE US Equipment Settings	Section 7.3	U
	NDE Indication	E2339, Section 7	U
	NDE Geometry	E2339, Section 7	U

TABLE 2 US-MF Image Information Object Definition

DICOM Module	DICONDE Module	Reference	Usage
Patient	Component	E2339, Section 7	M
Clinical Trial Subject	Not Applicable		
General Study	Component Study	E2339, Section 7	M
Patient Study	Not Applicable		
Clinical Trial Study	Not Applicable		
General Series	Component Series	E2339, Section 7	M
Clinical Trial Series	Not Applicable		
General Equipment	NDE Equipment	E2339, Section 7	M
Contrast/bolous	Not Applicable		
Specimen	Not Applicable		
US Image	NDE US Image	Section 7.1	M
US Region Calibration	Not Applicable		
	NDE US Equipment	Section 7.2	U
	NDE US Equipment Settings	Section 7.3	U
	NDE Indication	E2339, Section 7	U
	NDE Geometry	E2339, Section 7	U

TABLE 3 NDE US Image Module Attributes

Attribute Name	Tag	VR	VM	Type	Description
Samples Per Pixel	(0028,0002)	US	1	1	Number of samples per pixel (planes) in this image. See 7.1.1.1.
Photometric Interpretation	(0028,0004)	CS	1	1	Specifies the intended interpretation of the pixel data. See 7.1.1.2.
Bits Allocated	(0028,0100)	US	1	1	Number of bits allocated for each pixel data. See 7.1.1.3.
Bits Stored	(0028,0101)	US	1	1	Number of bits stored for each pixel data. See 7.1.1.4.
High Bit	(0028,0102)	US	1	1	Most significant bit for pixel data.
Planar Configuration	(0028,0006)	US	1	1C	Indicates whether the pixel data is sent color by plane or color by pixel. Required if Samples Per Pixel (0028, 0002) has a value greater than 1. See 7.1.1.5.
Pixel Representation	(0028,0103)	US	1	1	Representation of pixel data. See 7.1.1.6.
Frame Increment Pointer	(0028,0009)	AT	1-n	1C	Contains the Data Element Tag of the attribute that is used as the frame increment in multi-frame pixel data. Required if number of frames is sent. See 7.1.1.7.
Image Type	(0008,0008)	CS	1-n	1	Image identification characteristics. See 7.1.1.8.
Lossy Image Compression	(0028,2110)	CS	1	1C	Specifies whether an image has undergone lossy compression. Enumerated Values 00 = NO lossy compression 01 = Lossy compression Required if lossy compression has been performed on the image.
Number of Surfaces	(0008,2124)	IS	1	3	Number of distinct scan surfaces on the inspection specimen.
Number of Gates in Surface	(0008,212A)	IS	1	3	Number of inspection gates associated in this scan surface.
Surface Name	(0008,2120)	SH	1	3	Name of this scan surface.
Surface Number	(0008,2122)	IS	1	3	Number of this scan surface.
Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
Acquisition Date / Time	(0008,002A)	DT	1	3	The date and time that the acquisition of data that resulted in this image started.
Physical Units X Direction	(0018,6024)	US	1	1	The physical units of the dimension of the region. See 7.1.1.10 for valid values.
Physical Units Y Direction	(0018,6026)	US	1	1	The physical units of the dimension of the region. See 7.1.1.10 for valid values.
Physical Delta X	(0018,602C)	FD	1	1	The physical value per positive X pixel increment. The units are as specified in the Physical Units X Direction (0018,6024). See 7.1.1.11.
Physical Delta Y	(0018,602E)	FD	1	1	The physical value per positive Y pixel increment. The units are as specified in the Physical Units Y Direction (0018,6024). See 7.1.1.11.

7. Information Modules

7.1 *NDE US Image Module:*

7.1.1 Table 3 specifies the Attributes that describe NDE ultrasound images.

7.1.1.1 For NDE US Images, Samples per Pixel (0028, 0002) is specified to use the following values for specified Photometric Interpretations.

NDE US Image Samples Per Pixel

Photometric Interpretation	Samples Per Pixel Value
MONOCHROME2	1
RGB	3
PALETTE COLOR	1

7.1.1.2 For NDE US Images, Photometric Interpretation (0028,0004) is specified to use the following defined terms. See Part 3 Section C.7.6 of the DICOM standard for definitions of the terms.

MONOCHROME2	PALETTE COLOR	RGB

7.1.1.3 For NDE US Images, Bits Allocated (0028,0100) is specified to use the following values for specified Photometric Interpretations.

NDE US Image Bits Allocated

Photometric Interpretation	Bits Allocated Value
MONOCHROME2	8
RGB	8
PALETTE COLOR	8 – 8 bit palette, or 16 – 16 bit palette

7.1.1.4 For NDE US Images, Bits Stored (0028,0101) is specified to use the following values for specified Photometric Interpretations.

NDE US Image Bits Stored

Photometric Interpretation	Bits Stored Value
MONOCHROME2	8
RGB	8
PALETTE COLOR	8 – 8 bit palette, or 16 – 16 bit palette

7.1.1.5 For NDE US Images, Planar Configuration (0028, 0006) is specified to use the following values for specified Photometric Interpretations.

NDE US Planar Configuration

Photometric Interpretation	Planar Configuration Value
RGB	0 – color by pixel, or 1 – color by plane

7.1.1.6 For NDE US Images, Pixel Representation (0028, 0103) is specified to use the following Enumerated Value:

0000H = unsigned integer

0001H = signed integer

7.1.1.7 For NDE US multi-frame images, the Attribute Frame Increment Pointer (0028,0009) of the Multi-frame Module (see DICOM Part 3 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)

7.1.1.8 For NDE US Images and NDE US-MF Images, Image Type (0008,0008) is specified to be Type 2. The defined terms for value 3 are:

C_SCAN	B_SCAN	TOF C_SCAN
VOLUME SCAN		

Value 4 contains information about the ultrasonic inspection mode. The defined terms for value 4 are:

LONGITUDINAL	SHEAR	SURFACE WAVE
TOFD	THRU TRANS	LAMB
SHEAR HORIZ	SHEAR VERT	

7.1.1.9 For Gate Name (0008,2127) and Gate Number (0008,2128), the term 'Gate' refers to a period of time over which ultrasonic data is collected. Gates are typically associated with regions within the test specimen, the front surface echo or the back surface echo.

7.1.1.10 Physical Units X Direction (0018,6024) and Physical Units Y Direction (0018,6026) provide Enumerated Values indicating the physical units of the dimensions of the image.

Value	Meaning	Value	Meaning
0000H =	None or not applicable	0001H=	percent
0002H=	dB	0003H=	cm
0004H=	seconds	0005H=	hertz ($seconds^{-1}$)
0006H=	dB/sec	0007H=	cm/sec
0008H=	cm^2	0009H=	cm^2/sec
000AH	cm^3	0000BH=	cm^3/sec
000CH	degrees		

7.1.1.11 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.

7.2 *NDE US Equipment Module:*

7.2.1 Table 4 specifies the Attributes that describe NDE ultrasound equipment.

7.2.1.1 For NDE US Images, Pulser Type (0014,4004) is specified is specified to use the following defined terms.

POSITIVE SPIKE	SQUARE WAVE	SINUSOIDAL
NEGATIVE SPIKE	TONE BURST	

7.2.1.2 For NDE US Images, Amplifier Type (0014,400A) is specified is specified to use the following defined terms.

LINEAR	LOGARITHMIC

7.2.1.3 For NDE US Images, Transducer Type (0018,6031) is specified is specified to use the following defined terms.

SINGLE CRYSTAL	SPLIT CRYSTAL	LINEAR ARRAY
CURVED LIN ARRAY	SECTOR ARRAY	SECTOR ANN ARRAY
MATRIX ARRAY		

7.2.1.4 For NDE US Images, Element Shape (0014,4013) is specified is specified to use the following defined terms.

CIRCLE	ELLIPSE
RECTANGLE	RING

7.2.1.5 For NDE US Images, Connector Type (0014,5105) is specified to use the following defined terms.

MICRO DOT	LEMO 00	LEMO 01
BNC	RCA	OTHER

7.2.1.6 For NDE US Images, Wedge Type (300A,00D3) is specified to use the following defined terms.

LONGITUDINAL	SHEAR

7.2.1.7 For NDE US Images, Wedge Curve (0014,511E) is specified to use the following terms.

FLAT	OD INSPECTION	ID INSPECTION

7.2.1.8 For NDE US Images, Element 1 Position (0014, 5109) is specified to use the following defined terms where the Element 1 position in Fig. 1 is defined as LOW with HIGH having the probe oriented with Element 1 at the opposite end.

HIGH	LOW

7.3 *NDE US Equipment Settings Module:*

7.3.1 Table 5 specifies the Attributes that describe NDE ultrasound equipment settings.

7.3.1.1 For NDE US Images, Modulation Type (0014,4026) is specified to use the following defined terms.

HANNING

7.3.1.2 For NDE US Images, Rectification Type (003A, 0302) is specified to use the following defined terms.

FULL	HALF
HALF POSITIVE	HALF NEGATIVE
NONE	

7.3.1.3 For NDE US Images, Transducer Mode (0018, 9178 is specified to use the following defined terms.

LONG	SHEAR
REFRACT LONG	SURFACE

7.3.1.4 For NDE US Images, Trigger Source (0018,1061) is specified to use the following defined terms.

MAIN BANG	FRONT INTERFACE
BACK INTERFACE	INTERFACE

7.3.1.5 For NDE US Images, Gate Type (0018,106A) is specified to use the following defined terms.

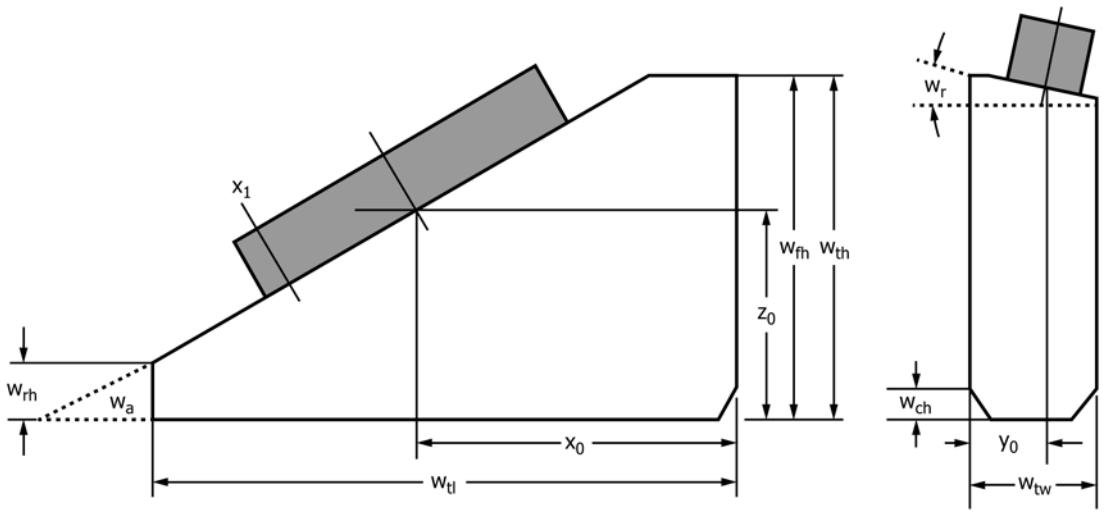
FLAW	BACK ECHO
TRANS AMP	PE AMP

7.3.1.6 For NDE US Images, DAC Type (0014,4036) is specified to use the following defined terms.

LINEAR	QUADRATIC
SPLINE	

7.3.1.7 For NDE US Images, Acquisition Compression Type (0014,4032) is specified to use the following defined terms.

SMOOTHING	PAIRING



x_0 Offset X
z_0 Offset Z
w_{tl} Wedge Total Length
w_{th} Wedge Total Height
w_{fh} Wedge Front Height
w_{rh} Wedge Rear Height
w_a Wedge Angle
x_1 Element 1 Position

y_0 Offset Y
w_{tw} Wedge Total Width
w_r Wedge Roof Angle
w_{ch} Wedge Chamfer Height

FIG. 1 Definition of Terms for Wedge Sequence

TABLE 4 NDE US Equipment Module Attributes

Attribute Name	Tag	VR	VM	Type	Description
Pulser Equipment Sequence	(0014,4002)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Manufacturer	(0008,0070)	LO	1	3	Manufacturer of the equipment used to pulse the transducer.
>Model Number	(0008,1090)	LO	1	3	Manufacturer's model number for the equipment used to pulse the transducer.
>Serial Number	(0018,1000)	LO	1	3	Manufacturer's serial number for the equipment used to pulse the transducer.
>Pulser Type	(0014,4004)	CS	1	3	Type of pulser used in data collection. See 7.2.1.1.
>Time of Last Calibration	(0018,1201)	TM	1-n	3	Time of the last calibration for the equipment used to pulse the transducer.
>Date of Last Calibration	(0018,1200)	DA	1-n	3	Date of the last calibration for the equipment used to pulse the transducer.
>Pulser Notes	(0014,4006)	LT	1	3	User-defined comments on the pulser equipment.
Receiver Equipment Sequence	(0014,4008)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate See 7.1.1.9 for definition of Gate.
>Manufacturer	(0008,0070)	LO	1	3	Manufacturer of the equipment used to receive the ultrasound signal.
>Model Number	(0008,1090)	LO	1	3	Manufacturer's model number for the equipment used to receive the ultrasonic signal.
>Serial Number	(0018,1000)	LO	1	3	Manufacturer's serial number for the equipment used to receive the ultrasonic signal.
>Amplifier Type	(0014,400A)	CS	1	3	Type of amplifier used in data collection. See 7.2.1.2.
>Time of Last Calibration	(0018,1201)	TM	1-n	3	Time of the last calibration for the equipment used to receive the ultrasonic signal.
>Date of Last Calibration	(0018,1200)	DA	1-n	3	Date of the last calibration for the equipment used to receive the ultrasonic signal.
>Receiver Notes	(0014,400C)	LT	1	3	User-defined notes on the receiver equipment.
Pre-Amplifier Equipment Sequence	(0014,400E)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Manufacturer	(0008,0070)	LO	1	3	Manufacturer of the equipment used to pre-amplify the ultrasound signal.
>Model Number	(0008,1090)	LO	1	3	Manufacturer's model number for the equipment used to pre-amplify the ultrasonic signal.
>Serial Number	(0018,1000)	LO	1	3	Manufacturer's serial number for the equipment used to pre-amplify the ultrasonic signal.
>Time of Last Calibration	(0018,1201)	TM	1-n	3	Time of the last calibration for the equipment used pre-amplify the ultrasonic signal.
>Date of Last Calibration	(0018,1200)	DA	1-n	3	Date of the last calibration for the equipment used pre-amplify the ultrasonic signal.
>Pre-Amplifier Notes	(0014,400F)	LT	1	3	User-defined notes on the pre-amp equipment.
Transmit Transducer Sequence	(0014,4010)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Manufacturer	(0008,0070)	LO	1	3	Manufacturer of the transducer used to transmit the ultrasonic signal.
>Model Number	(0008,1090)	LO	1	3	Manufacturer's model number for transducer used to transmit the ultrasonic signal.
>Serial Number	(0018,1000)	LO	1	3	Manufacturer's serial number for transducer used to transmit the ultrasonic signal.
>Transducer Type	(0018,6031)	CS	1	3	Type of transducer used in data collection. See 7.2.1.3.
>Manufacturer Data	(0018,5010)	LO	1	3	Manufacturer defined code or description.
>Number of Elements	(0014,4012)	US	1	3	Number of individual elements that make up the transducer.
>Element Shape	(0014,4013)	CS	1	3	Primary shape of transducer used in data collection. See 7.2.1.4.
>Element Dim A	(0014,4014)	DS	1	3	Dimension of the major axis of the transducer element in cm.
>Element Dim B	(0014,4015)	DS	1	3	Dimension of the minor axis of the transducer element in cm.
>Element Pitch A	(0014,4016)	DS	1	3	Spacing between major axis elements in a phased array transducer in cm.
>Element Pitch B	(0014,401D)	DS	1	3	Spacing between minor axis elements in a phased array transducer in cm.
>Measured Beam Dim A	(0014,4017)	DS	1	3	Dimension of the major axis of the transducer beam in cm.
>Measured Beam Dim B	(0014,4018)	DS	1	3	Dimension of the minor axis of the transducer beam in cm.
>Location of Measured Beam Diameter	(0014,4019)	DS	1	3	Distance from the element surface where the beam diameter measurements were taken in cm.
>Focal Length	(0018,5012)	DS	1	3	Distance from the transducer face of the manufactures defined beam focus in water in cm.
>Nominal Frequency	(0014,401A)	DS	1	3	Nominal center frequency of the transducer in Hz.
>Measured Center Frequency	(0014,401B)	DS	1	3	Measured center frequency of the transducer in Hz.
>Measured Bandwidth	(0014,401C)	DS	1	3	Measured –3dB bandwidth of the transducer in KHz.

TABLE 4 *Continued*

Attribute Name	Tag	VR	VM	Type	Description
>Active Aperture	(0014,5100)	US	1	3	Number of elements used to generate a single beam.
>Total Aperture	(0014,5101)	DS	1	3	Total length of the aperture, along major axis: equal to Pitch x Number of Elements, or probe diameter for conventional circular probe.
>Aperture Elevation	(0014,5102)	DS	1	3	Total length of the aperture, along the minor axis.
>Main Lobe Angle	(0014,5103)	DS	1	3	This is the angle main lobe of an unsteered beam. It is 0 when the emission is orthogonal to the transducer plane. If it is directed towards the first element, it will be <0 and >0 if facing in the opposite direction.
>Main Roof Angle	(0014,5104)	DS	1	3	The roof angle is used for probes with two transducer halves. It is half of the angle between the normals to the transducer faces. It is 0 for all probes where the transducers are on one plane.
>Connector Type	(0014,5105)	CS	1	3	See 7.2.1.5.
Receive Transducer Sequence	(0014,4011)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Manufacturer	(0008,0070)	LO	1	3	Manufacturer of the transducer used to receive the ultrasonic signal.
>Model Number	(0008,1090)	LO	1	3	Manufacturer's model number for transducer used to receive the ultrasonic signal.
>Serial Number	(0018,1000)	LO	1	3	Manufacturer's serial number for transducer used to receive the ultrasonic signal.
>Transducer Type	(0018,6031)	CS	1	3	Type of transducer used in data collection. See 7.2.1.3.
>Manufacturer Data	(0018,5010)	LO	1	3	Manufacturer defined code or description.
>Number of Elements	(0014,4012)	US	1	3	Number of individual elements that make up the transducer.
>Element Shape	(0014,4013)	CS	1	3	Primary shape of transducer used in data collection. See 7.2.1.4.
>Element Dim A	(0014,4014)	DS	1	3	Dimension of the major axis of the transducer element in cm.
>Element Dim B	(0014,4015)	DS	1	3	Dimension of the minor axis of the transducer element in cm.
>Element Pitch A	(0014,4016)	DS	1	3	Spacing between major axis elements in a phased array transducer in cm.
>Element Pitch B	(0014,401D)	DS	1	3	Spacing between minor axis elements in a phased array transducer in cm.
>Measured Beam Dim A	(0014,4017)	DS	1	3	Dimension of the major axis of the transducer beam in cm.
>Measured Beam Dim B	(0014,4018)	DS	1	3	Dimension of the minor axis of the transducer beam in cm.
>Location of Measured Beam Diameter	(0014,4019)	DS	1	3	Distance from the transducer face where the beam diameter measurements were taken in cm.
>Focal Length	(0018,5012)	DS	1	3	Distance from the transducer face of the manufactures defined beam focus in water in cm.
>Nominal Frequency	(0014,401A)	DS	1	3	Nominal center frequency of the transducer in Hz.
>Measured Center Frequency	(0014,401B)	DS	1	3	Measured center frequency of the transducer in Hz.
>Measured Bandwidth	(0014,401C)	DS	1	3	Measured –3dB bandwidth of the transducer in KHz.
>Active Aperture	(0014,5100)	US	1	3	Number of elements used to generate a single beam.
>Total Aperture	(0014,5101)	DS	1	3	Total Length of the aperture, along major axis: equal to Pitch x Number of Elements, or probe diameter for conventional circular probe.
>Aperture Elevation	(0014,5102)	DS	1	3	Total length of the aperture, along the minor axis.
>Main Lobe Angle	(0014,5103)	DS	1	3	This is the angle main lobe of an unsteered beam. it is 0 when the emission is orthogonal to the transducer plane. If it is directed towards the first element, it will be <0 and >0 if facing in the opposite direction.
>Main Roof Angle	(0014,5104)	DS	1	3	The roof angle is used for probes with two transducer halves. It is half of the angle between the normals to the transducer faces. It is 0 for all probes where the transducers are on one plane.
>Connector Type	(0014,5105)	CS	1	3	See 7.2.1.5.
Wedge Sequence	(300A,00D1)	SQ	1	3	
>Wedge Model Number	(0014,5106)	SH	1	3	Model number of the wedge.
>Wedge Serial Number	(300A,00D4)	SH	1	3	Serial number of the wedge.
>Wedge Angle	(0014,5107)	DS	1	3	Native angle between probe and surface that is introduced by the wedge along the major axis. See Fig. 1.
>Wedge Roof Angle	(0014,5108)	DS	1	3	Native angle between probe and surface that is introduced by the wedge along the minor axis. See Fig. 1.
>Wedge Element 1 Position	(0014,5109)	CS	1	3	Position of the first element of the probe on the wedge. See 7.2.1.8.
>Wedge Material Velocity	(0014,510A)	DS	1	3	Sound velocity of the wedge material.
>Wedge Material	(0014,510B)	SH	1	3	Description of the wedge material.
>Wedge Offset Z	(0014,510C)	DS	1	3	The distance between the probe center element and the wedge plane on the surface. See Fig. 1.
>Wedge Origin Offset X	(0014,510D)	DS	1	3	Distance to move the resulting image as defined by the probe and wedge.
>Wedge Time Delay	(0014,510E)	DS	1	3	Defines the time the sound needs to travel through the wedge at center probe element in µs.
>Wedge Name	(0014,510F)	SH	1	3	The name of the wedge.
>Wedge Manufacturer Name	(0014,5110)	SH	1	3	The name of the manufacturer of the wedge.
>Wedge Description	(0014,5111)	LO	1	3	Manufacturer defined code or description.
>Wedge Type	(300A,00D3)	CS	1	3	See 7.2.1.6.
>Nominal Beam Angle	(0014,5112)	DS	1	3	Beam angle given by the wedge according to a material. In case of phased array, the nominal angle is defined according to flat law.
>Wedge Offset X	(0014,5113)	DS	1	3	Distance from the probe center to the wedge front, according to the major axis. See Fig. 1.
>Wedge Offset Y	(0014,5114)	DS	1	3	Distance from the probe center to the wedge front, according to the minor axis. See Fig. 1.
>Wedge Total Length	(0014,5115)	DS	1	3	Overall length of the wedge along the major axis. See Fig. 1.

TABLE 4 *Continued*

Attribute Name	Tag	VR	VM	Type	Description
>Wedge in Contact Length	(0014,5116)	DS	1	3	The length of the part of the wedge that is in contact with the material along the major axis.
>Wedge Front Gap	(0014,5117)	DS	1	3	Horizontal distance between the wedge front and the first point in contact with the wedge.
>Wedge Total Height	(0014,5118)	DS	1	3	Total height of the wedge. See Fig. 1.
>Wedge Front Height	(0014,5119)	DS	1	3	Height of the wedge at the front. See Fig. 1.
>Wedge Rear Height	(0014,511A)	DS	1	3	Height of the wedge at the rear, i.e., opposite to the front. See Fig. 1.
>Wedge Total Width	(0014,511B)	DS	1	3	Total width of the wedge, defines the length along the minor axis. See Fig. 1.
>Wedge in Contact Width	(0014,511C)	DS	1	3	Total width of the wedge that is in contact with the material along the minor axis.
>Wedge Chamfer Height	(0014,511D)	DS	1	3	Height of the chamfer in front of the wedge. See Fig. 1.
>Wedge Curve	(0014,511E)	CS	1	3	See 7.2.1.7.
>Radius Along the Wedge	(0014,511F)	DS	1	3	Defines the radius that the wedge has to the surface.

TABLE 5 NDE US Equipment Settings Module Attributes

Attribute Name	Tag	VR	VM	Type	Description
Pulser Settings Sequence	(0014,4020)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Pulse Repetition Frequency	(0018,6032)	UL	1	3	The ultrasound pulse repetition frequency used to collect the ultrasonic data. The units are in Hertz.
>Pulse Height	(0018,5000)	SH	1-n	3	Character string description of the ultrasound output levels used in generating a given image. Data may be expressed in dB, %, W/cm^2, etc.
>Pulse Width	(0014,4022)	DS	1	3	Width in msec of the ultrasonic pulse used to generate a given image.
>Excitation Frequency	(0014,4024)	DS	1	3	Frequency of the excitation waveform in Hz for Tone Burst type pulsers.
>Modulation Type	(0014,4026)	CS	1	3	Type of modulation window used for Tone Burst type pulsers. See 7.3.1.1 for details.
>High Pass Filter	(003A,0221)	DS	1	3	Nominal 3dB point of upper frequency of pass band; in Hz.
>Low Pass Filter	(003A,0220)	DS	1	3	Nominal 3dB point of lower frequency of pass band; in Hz.
>Damping	(0014,4028)	DS	1	3	Damping resistance applied to collect the ultrasonic data; in Ohms.
Receiver Settings Sequence	(0014,4030)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Center Frequency	(003A,0222)	DS	1	3	Center point of the 3dB pass band; in Hz.
>Bandwidth	(003A,0223)	DS	1	3	Width of the 3dB pass band; in Hz.
>High Pass Filter	(003A,0221)	DS	1	3	Nominal 3dB point of upper frequency of pass band; in Hz.
>Low Pass Filter	(003A,0220)	DS	1	3	Nominal 3dB point of lower frequency of pass band; in Hz.
>Fixed Gain	(003A,0218)	DS	1	3	Amount of fixed signal amplification applied to ultrasonic image data; in dB.
>User Selected Gain	(003A,0210)	DS	1	3	Amount of variable signal amplification applied to ultrasonic image data; in dB.
>Rectification Type	(003A,0302)	CS	1	3	Type of rectification applied to the RF-signal for the ultrasonic image data. See 7.3.1.2 for details.
>Acquired Soundpath Length	(0014,4031)	DS	1	3	Length of time in milliseconds of the acquired data.
>Acquisition Compression Type	(0014,4032)	CS	1	3	Type of compression applied to a-scan data acquisition. See 7.3.1.7 for details.
>Acquisition Sample Size	(0014,4033)	IS	1	3	Number of samples acquired in a-scan data acquisition.
>Rectifier Smoothing	(0014,4034)	DS	1	3	msec.
>DAC Sequence	(0014,4035)	SQ	1	3	Sequence of data describing the Distance Amplitude Correction (DAC) used in collecting the ultrasonic image data.
>>DAC Type	(0014,4036)	CS	1	1C	Type of interpolation applied to the DAC points for the ultrasonic image data. See 7.3.1.6 for details.
>>Trigger Source	(0018,1061)	LO	1	1C	The source of the timing synchronization trigger used for the start of DAC. See 7.3.1.4.
>>DAC Gain Points	(0014,4038)	DS	1-n	1C	Set of gain values that make up the DAC curve for this ultrasonic image in dB.
>>DAC Time Points	(0014,403A)	DS	1-n	1C	The time points relative to the reference in (0018,1061) that correspond to the gain points in (0009,XX36) in msec.
>>DAC Amplitude	(0014,403C)	DS	1-n	3	Amplitude of the UT calibration target at that DAC point.
Pre-Amplifier Settings Sequence	(0014,4040)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.

TABLE 5 *Continued*

Attribute Name	Tag	VR	VM	Type	Description
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Center Frequency	(003A,0222)	DS	1	3	Center point of the 3dB pass band; in Hz.
>Bandwidth	(003A,0223)	DS	1	3	Width of the 3dB pass band; in Hz.
>High Pass Filter	(003A,0221)	DS	1	3	Nominal 3dB point of upper frequency of pass band; in Hz.
>Low Pass Filter	(003A,0220)	DS	1	3	Nominal 3dB point of lower frequency of pass band; in Hz.
>Fixed Gain	(003A,0218)	DS	1	3	Amount of fixed signal amplification applied to ultrasonic image data; in dB.
>User Selected Gain	(003A,0210)	DS	1	3	Amount of variable signal amplification applied to ultrasonic image data; in dB.
Transmit Transducer Sequence	(0014,4050)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Mode	(0018,9178)	CS	1	3	Ultrasonic inspection wave mode used to collect the data. See 7.3.1.3.
>Incident Angle	(0014,4052)	DS	1	3	Angle formed from the intersection of the direction of sound propagation in the coupling material and the sound entry surface on the test specimen in degrees.
>Coupling Technique	(0014,4054)	ST	1	3	Technique used to couple the transducer to the test piece.
>Coupling Medium	(0014,4056)	ST	1	3	Description of the medium used to couple the transducer to the test piece.
>Coupling Velocity	(0014,4057)	DS	1	3	Velocity of sound of the coupling medium in mm/sec.
>Probe Center Location X	(0014,4058)	DS	1	3	Location of the probe center from the sound entry point parallel to the surface of the test specimen in cm.
>Probe Center Location Z	(0014,4059)	DS	1	3	Location of the probe center from the sound entry point perpendicular to the surface of the test specimen in cm.
>Sound Path Length	(0014,405A)	DS	1	3	Distance of the crystal center from the sound entry point in cm.
>Delay Law Identifier	(0014,405C)	ST	1	3	For phased array transducers, a description of the delay law used to generate the data in this ultrasonic image.
Receive Transducer Sequence	(0014,4051)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Mode	(0018,9178)	CS	1	3	Ultrasonic inspection wave mode used to collect the data. See 7.3.1.3.
>Incident Angle	(0014,4052)	DS	1	3	Angle of formed from the intersection of the direction of sound propagation in the coupling material and the sound entry surface on the test specimen in degrees.
>Coupling Technique	(0014,4054)	ST	1	3	Technique used to couple the transducer to the test piece.
>Coupling Medium	(0014,4056)	ST	1	3	Description of the medium used to couple the transducer to the test piece.
>Coupling Velocity	(0014,4057)	DS	1	3	Velocity of sound of the coupling medium in mm/sec.
>Probe Center Location X	(0014,4058)	DS	1	3	Location of the probe center from the sound entry point parallel to the surface of the test specimen in cm.
>Probe Center Location Z	(0014,4059)	DS	1	3	Location of the probe center from the sound entry point perpendicular to the surface of the test specimen in cm.
>Sound Path Length	(0014,405A)	DS	1	3	Distance of the crystal center from the sound entry point in cm.
>Delay Law Identifier	(0014,405C)	ST	1	3	For phased array transducers, a description of the delay law used to generate the data in this ultrasonic image.
Gate Settings Sequence	(0014,4060)	SQ	1	3	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Trigger Source	(0018,1061)	LO	1		The source of the timing synchronization trigger used to collect the ultrasonic data. See 7.3.1.4.
>Gate Type	(0018,106A)	CS	1	3	The type of gate used to collect the ultrasonic data. See 7.3.1.5.
>Gate Delay	(0018,1081)	IS	1	3	The amount of time that passes after the trigger before data collection begins in msec.
>Gate Width	(0018,1082)	IS	1	3	The duration of data collection in msec.
>Gate Threshold	(0014,4062)	DS	1	3	The minimum value above which data is collected.
>Velocity of Sound	(0014,4064)	DS	1	3	Velocity of sound in the test specimen in mm/sec.
Calibration Settings Sequence	(0014,4070)	SQ	1	2	
>Gate Name	(0008,2127)	SH	1	3	User defined name of this inspection gate. See 7.1.1.9 for definition of Gate.
>Gate Number	(0008,2128)	IS	1	3	User defined number of this inspection gate. See 7.1.1.9 for definition of Gate.
>Calibration Procedure	(0014,4072)	ST	1	3	Description of the calibration procedure used in collecting the data.
>Procedure Version	(0014,4074)	SH	1	3	Version of the calibration procedure used in collecting the data.
>Procedure Creation Date	(0014,4076)	DA	1	3	Creation date of the calibration procedure used in collecting the data.
>Procedure Expiration Date	(0014,4078)	DA	1	3	Expiration date of the calibration procedure used in collecting the ultrasonic data.
>Procedure Last Modified Date	(0014,407A)	DA	1	3	Date of last modification for the calibration procedure used in collecting the ultrasonic data.

TABLE 5 *Continued*

Attribute Name	Tag	VR	VM	Type	Description
>Calibration Time	(0014,407C)	TM	1-n	3	The time the ultrasonic data collection system was calibrated for this image.
>Calibration Date	(0014,407E)	DA	1-n	3	The date the ultrasonic data collection system was calibrated for this image.

8. Keywords

8.1 database; DICOM; DICONDE; digital data storage; digital data transmission; file format; ultrasound; UT

SUMMARY OF CHANGES

Committee E07 has identified the location of selected changes to this standard since the last issue (E2663 - 11) that may impact the use of this standard. (November 1, 2014)

(1) Updated DICOM Standard reference in 2.2.
(2) Added the DICOM Specimen Information Module as "Not Applicable" for DICONDE US and US-MF IODs in Table 1 and Table 2.
(3) Updated Table 4 with additional attributes to support phased array inspection.
(4) Added 7.2.1.5 through 7.2.1.8 to support additional attributes for phased array inspection.
(5) Added Fig. 1 to support additional attributes for phased array inspection.