Acuson

Cypress™ Ultrasound System

DICOM Conformance Statement

1 Introduction

This document describes the conformance of the Acuson Cypress Ultrasound System to the ACR-NEMA DICOM (Digital Imaging and Communications in Medicine) standard and satisfies the DICOM requirement for a vendor conformance specification.

This conformance statement applies to the Acuson Cypress released software version 9.0 or greater.

1.1 Acronyms and Abbreviations

ACR	American College of Radiology
AE	Application Entity
ANSI	American National Standards Institute
DICOM	Digital Imaging and Communications in Medicine
FSC	File Set Creator
FSR	File Set Reader
IOD	Information Object Definition
MB	Megabyte
MO	Magneto-Optical (disk)
NEMA	National Electrical Manufacturers Association
OSI	Open Systems Interconnections
PDU	Protocol Data Unit
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
UID	Unique Identifier
US	Ultrasound
VR	Value Representation (CS and OB are examples of VR)

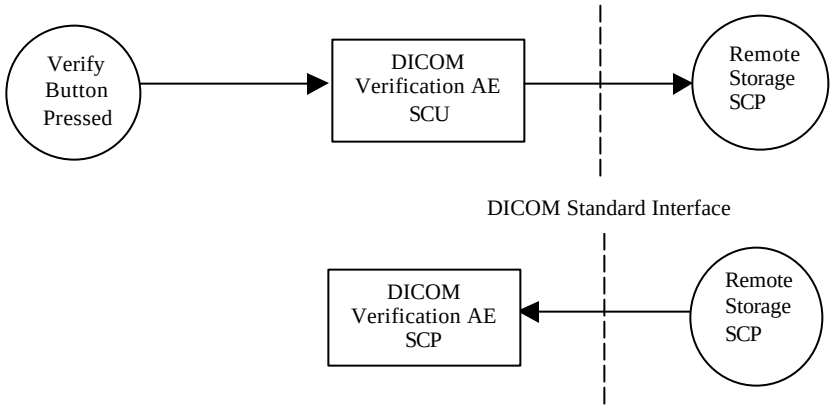
2 Implementation Model

The Acuson Cypress incorporates the DICOM 3.0 standard for networked image storage, network verification services, and media image storage.

2.1 Application Data Flow Diagram

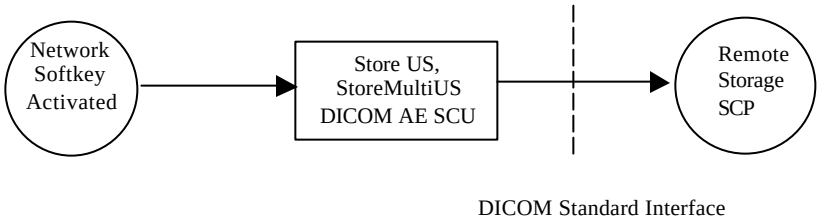
2.1.1 Verification AE

With the optional Network package, the Acuson Cypress has the capability to issue Verification requests to a networked DICOM device. The Acuson Cypress has the capability to respond to a Verification request sent from a networked DICOM device.



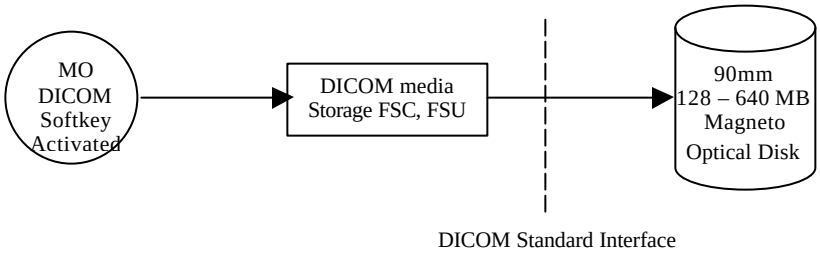
2.1.2 Network Image Storage AE

With the optional Network package, the Acuson Cypress has the capability to store Ultrasound Image and Ultrasound Multi-Frame Image IODs to a networked DICOM server.



2.1.3 Media Image Storage AE

The Acuson Cypress has the capability to store Ultrasound Image and Ultrasound Multi-Frame Image IODs to the local removable Magneto-Optical disk. The Acuson Cypress has the capability to create the Basic Directory IOD on the local Magneto-Optical disk.



2.2 Functional Definitions of Application Entities

The Verification and Networked Image Storage Application Entities are available only with the optional Network package. The Media Image Storage Application entity is standard on the Cypress.

2.2.1 Verification AE

The Verification AE issues a DICOM 3.0 verification request to the remote DICOM server, and receives and reports the result. The response to the verification request indicates success, failure, or timeout.

A networked DICOM device can issue a verification request to the Cypress. Once received, the Cypress will send its response back to the networked device.

2.2.2 Networked Image Storage AE

If the Network option is installed, the Cypress's Network Image Storage AE acts as a DICOM Storage SCU for Ultrasound Image and Multi-Frame Image SOP classes. The Cypress can store images to a networked DICOM server, which supports the SCP role of each Storage service class.

2.2.3 Media Image Storage AE

In its standard configuration, the Cypress can perform DICOM operations to its on-board 90mm (3.5 inch) Magneto-Optical (MO) disk drive. Disk capacities from 128 MB to 640 MB may be used with the system.

The Cypress performs the following DICOM roles for MO disks:

?? File Set Creator (FSC): a DICOM MOD medium is created when the user saves studies in DICOM format to the MO. A DICOM 3.0 conformant dicomdir is created along with the directory structures and the image files.

?? File Set Updater (FSU): the Cypress modifies the dicomdir file and image files when the user saves or deletes studies from the MO disk.

2.3 Sequencing of Real-World Activities

2.3.1 Network Image Storage

In order to store single and multi-frame images over a network, the network option must be installed and valid server information (application entity, network address, port number, and PDU length) must be entered on the DICOM Setup page. The compression type (None, RLE lossless, or JPEG and its compression) must be selected on the DICOM Setup page. The study to be saved must be selected and activated from the Patient screen. This study can then be sent over a network to a DICOM Server when the Network softkey is activated. The Acuson Cypress system will first send a Verification command to the remote server, and if the response received is good, the study will be sent to the remote server. If no response is received, or an error is detected on the Verification

Operation, the save will not be initiated, and an error dialog box will be presented to the user.

2.3.2 Verification Command

With the Network option installed, the Verification AE will open an association to the networked DICOM device when one of the following occurs:

?? When a network store is initiated. If the association fails, an error dialog box will appear and the store operation will be aborted.
?? When the "Server Verify" button on the DICOM Setup page is activated. The result will be displayed in the area of the screen labeled "Verification Result".

In both cases, valid server information must be entered on the DICOM setup page.

2.3.3 Media Image Storage

For storing single and multi-frame images to the local MO disk, a patient and study must be selected from the patient screen. The compression type (None, RLE lossless, or JPEG and its compression value) must be selected on the DICOM page. The save to the MO disk will begin when the softkey labeled "MO Dicom" is activated. The Cypress AE will save the images onto the disk, and either create a dicomdir if one is not present on the disk, or update an existing dicomdir with the new image information.

An error dialog box will be displayed for the following errors:
?? no disk in the system
?? the disk is write protected
?? insufficient space on the disk for the study
?? a disk with an unknown format is detected
?? an unformatted disk is in the drive.

For the final two conditions, the user will be prompted to format the disk, if desired. If the disk is successfully formatted, the save will be performed.

Limitations:
?? Studies from the Cypress and other DICOM FSCs cannot be mixed on a single MO disk. A warning dialog box will be displayed if a save is initiated to an MO disk containing a non-Cypress file set.
?? Saved studies cannot be opened for review on the Cypress system.
?? Saved Cypress studies cannot be opened for review on other Acuson ultrasound systems.

3 Network Storage AE – Specification

The Network Storage Application Entity is available only with the purchase of the optional Network package.

3.1 Supported SOP Classes

3.1.1 Storage SOP Classes

The Acuson Cypress Application Entity provides Standard Conformance to the following DICOM V3.0 SOP classes as an SCU:

Table 1: Storage SOP Classes

SOP Class Name	SOP Class UID	Conformance Level
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	Standard
Ultrasound Multi-frame Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.3.1	Standard

Note that the retired SOP class UIDs for Ultrasound Image Storage and Ultrasound Multi-Frame Image storage are not used in the Cypress implementation.

3.1.2 Verification SOP Class

The Acuson Cypress Application Entity provides Standard Conformance to the following DICOM V3.0 Verification SOP class as an SCU and an SCP:

Table 2: Verification SOP Class

SOP Class Name	SOP Class UID	Conformance Level
Verification SOP Class	1.2.840.10008.1.1	Standard

3.2 Association Establishment Policies

3.2.1 General

The maximum PDU size is configurable. The default PDU size is 4096 bytes.

3.2.2 Number Of Associations

Number of simultaneous associations: 1
A networked DICOM device may open a verification association to the Acuson Cypress at any time.

3.2.3 Asynchronous Nature

There is no asynchronous activity in this implementation.

3.2.4 Implementation Identifying Information

Implementation Class UID: 1.2.840.113680.4.103
Implementation Version: see section 1

3.2.5 Calling and Called AE Titles

The calling and called AE titles are user-configurable through the Cypress's "DICOM" screen.

3.3 Association Initiation by Real-World Activity

3.3.1 Network Storage

See Section 3.3.1

3.3.2 Verification

See Section 3.3.2

3.3.3 Proposed Presentation Contexts

Table 3 shows all possible transfer syntaxes that can be used with each SOP class. In the cases of Image Storage, the actual transfer syntax used will be based upon the compression scheme selected from the DICOM setup page, and the result of the association negotiation.

Note that the retired SOP class UIDs for Ultrasound Image Storage and Ultrasound Multi-Frame Image storage are not used in the Cypress implementation.

Table 3: Possible Presentation Contexts for all supported SOP Classes

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Run Length Encoding	1.2.840.10008.1.2.5	SCU	None
		JPEG Baseline	1.2.840.10008.1.2.4.50	SCU	None
Ultrasound Multi-Frame Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.3.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Run Length Encoding	1.2.840.10008.1.2.5	SCU	None
		JPEG Baseline	1.2.840.10008.1.2.4.50	SCU	None
Verification SOP Class	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.3.4 SOP Specific Conformance of SCU

The Cypress image storage AE presents transfer syntaxes based on the compression type selected from the DICOM setup page. For uncompressed data, only the DICOM default transfer syntax will be proposed. For RLE and JPEG compression, the AE will propose two transfer syntaxes – the first being the selected compression type, and the second is

the DICOM default transfer syntax. Both transfer syntaxes will be proposed to the DICOM server when the association is begun. If the server does not support the compressed transfer syntax, and it accepts the DICOM default transfer syntax, the Cypress will send the study in uncompressed format.

Table 4: Presentation Context Selection Scheme

Abstract Syntax		Selected Compression	Selection order: transfer syntax UID	
Name	UID		Name	UID
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	None	Implicit VR Little Endian	1.2.840.10008.1.2
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	RLE	Run Length Encoding Implicit VR Little Endian	1.2.840.10008.1.2.5 1.2.840.10008.1.2
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	JPEG	JPEG Baseline Implicit VR Little Endian	1.2.840.10008.1.2.4.50 1.2.840.10008.1.2
Ultrasound Multi Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	None	Implicit VR Little Endian	1.2.840.10008.1.2
Ultrasound Multi Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	RLE	Run Length Encoding Implicit VR Little Endian	1.2.840.10008.1.2.5 1.2.840.10008.1.2
Ultrasound Multi Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	JPEG	JPEG Baseline Implicit VR Little Endian	1.2.840.10008.1.2.4.50 1.2.840.10008.1.2

4 Removable Media Specifications

4.1 Supported SOP Classes

The Cypress supports standard conformance to the following DICOM SOP classes:

Table 5: Media Storage SOP Classes

Abstract Syntax		Role
Name	UID	
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	FSC
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	FSC
Directory Storage	1.2.840.10008.1.3.10	FSC, FSU

4.2 Proposed Transfer Syntaxes

The Transfer syntax used with the Ultrasound Image Storage and Multi-Frame Image Storage SOP classes will be the compression type selected on the DICOM setup page. The Directory Storage SOP class will always use Explicit VR, Little Endian.

Table 6: Proposed Transfer Syntaxes for Media Interchange

Abstract Syntax		Selected Compression	Transfer Syntax	
Name	UID		Name	UID List
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	None	Explicit VR, Little Endian	1.2.840.10008.1.2.1
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	RLE	Run Length Encoding	1.2.840.10008.1.2.5
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	JPEG	JPEG baseline	1.2.840.10008.1.2.4.50
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	None	Explicit VR Little Endian	1.2.840.10008.1.2.1
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	RLE	Run Length Encoding	1.2.840.10008.1.2.5
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	JPEG	JPEG baseline	1.2.840.10008.1.2.4.50
Directory Storage	1.2.840.10008.1.3.10	any	Explicit VR Little Endian	1.2.840.10008.1.2.1

4.3 Association Initiation by Real-World Activity

See section 3.3.3

4.4 Physical Description of Storage Media and Media Formats

The physical storage media is 90mm (3.5 inch) Magneto Optical disks in capacities from 128MB to 640MB. The disks are formatted in FAT format, with one partition. A partition table is present, due to operating system requirements.

5 Image Data Format

The native image data format (photometric type) of the Cypress is palette based. Each pixel is represented by one 8 bit value, and three 256 entry palette tables (Red, Green and Blue lookup tables) are sent with the data when required. Using a palette-based scheme, the Cypress reduces uncompressed image size by a factor of 3:1 over a system that exports data in an RGB (24 bit per pixel) format.

5.1 Non-Compressed Image Format

Non-compressed image format is used when the user has selected a compression type of "None" in the "Dicom Compression" area of the DICOM setup page. Images sent to the MO disk or over the network will be saved in a non compressed format. The photometric interpretation of the pixel data is PALETTE_COLOR. Three 256 entry palette lookup tables are exported along with the pixel data. The pixel data is 8 bits wide.

5.2 Run Length Encoded Image Format

Run Length Encoded image format is used when the user has selected a compression type of "RLE Lossless" in the "Dicom Compression" area of the DICOM setup page. Images sent to the MO disk or over the network will be saved in an RLE lossless format. The RLE compression algorithm that compresses image loops approximately 3:1 to 4:1 over the Cypress uncompressed format. The photometric interpretation of the pixel data is PALETTE_COLOR. Three 256 entry palette lookup tables are exported along with the pixel data. The pixel data is 8 bits wide.

Since the images are palette-based, there is one RLE segment per frame. The images are stored without the basic offset table item values encoded into the pixel data element.

5.3 JPEG Baseline Image Format

JPEG Baseline image format is used when the user has selected a compression type of "JPEG Lossy" in the "Compression Type" area of the DICOM setup page.

Associated with JPEG compression is the JPEG Compression slider control. Moving the slider to the right produces compressed images of a higher compression (smaller files), but with more loss. Moving the slider to the left produces images of a lower compression

(larger files), but with less loss. Images that use a lower compression value use more storage space than lower quality images, but even at the lowest compression, the image size is significantly smaller than RLE compressed images.

The photometric interpretation of the JPEG compressed pixel data is YBR_FULL_422. The images are stored without the basic offset table item values encoded into the pixel data element.

6 Data Identification Information

Patient and study information that originated from a Cypress system can be identified by the SOP Instance IOD (0008, 0018), Study Instance UID (0020, 000D), and Series Instance UID (0020, 000E), and in the IOD.

?? The ANSI registered Acuson root UID is 1.2.840.113680.
?? The Cypress root UID is 1.2.840.113680.4.103
?? The SOP Instance UID Is in the following format:
1.2.840.113680.4.103.n.dm
where:
n is the serial number of the Cypress unit
dm is the year, month, day, hour, minute, second, and millisecond that the image save was initiated.

?? The Study Instance UID is composed of the SOP Instance UID:
1.2.840.113680.4.103.n.d.p.s
where:
d is the year, month, day, hour, minute, and second the study was created
p is the patient number on the MO disk (p will be 0 when sending over a network)
s is the study number of the patient on the MO disk (s will be 0 when sending over a network)

?? The Series Instance UID is composed of the Study Instance UID and the Series Number.
1.2.840.113680.4.103.n.d.p.s.r
where
r is the series number within the study

7 Communication Profiles

7.1 Supported Protocol Stacks

This implementation supports the TCP/IP protocol stack. The OSI stack is not supported. The DICOM 50 pin physical connection is not supported.

7.1.1 Physical Network Media Supported

Standard IEEE 802 (Ethernet) 10BaseT (twisted pair) is supported. It requires TCP/IP in the Transport and Network layers.

8 Extensions, Specializations, and Privatizations

8.1 Standard, Extended, Specialized, Private SOPs

None

8.2 Private Transfer Syntaxes

None

8.3 Private Tags

There are no private tags used in the implementation.

9 Configuration

The Acuson Cypress system is configured at the time of installation.

9.1 AE Title/Presentation Address Mapping

The IP address of the system will be assigned by the user's Network Administrator and entered into the system at the time of installation.

9.2 Configurable Parameters

With the Network option installed, the user can configure the following parameters for the remote server and the Acuson Cypress Ultrasound System. These parameters can be accessed through the DICOM screen.

Remote Server Application Entity
Remote Server Network (IP) Address
Remote Server Port Number
Acuson Cypress Application Entity Title
Acuson Cypress Port Number
Network Timeout (seconds)
Protocol Data Unit (PDU) size

If the Network option is not installed, these values cannot be set or changed.

10 Support of Extended Character Sets

The following character set is supported:

ISO-IR 100 Latin Alphabet No. 1