

ACUSON CypressTM Ultrasound System Version 12.0

DICOM Conformance Statement

Document History

Rev	Date	Author	Comments
A	02/29/2000	GCK	Created
B	05/23/2000	GCK	Updated for Version 10.0
C	09/20/2001	GCK	Updated for Version 11.1
D	08/20/2002	GCK	Updated for Version 12.0
E	12/2/2002	LAE	Updated to meet company trademark guidelines

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 system software version 12.0. The current version of the Cypress DICOM Conformance Statement can be obtained from the ACUSON website: www.acuson.com

1.1 Sources Of Information

- Digital Imaging and Communication in Medicine (DICOM), NEMA Standard Publication No. PS 3.1-3.13, NEMA, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209, phone (703) 841-3200.
- World Wide Web: <http://www.nema.org/medical/dicom.htm>

1.2 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
FSU	File Set Updater
IOD	Information Object Definition
MB	Megabyte
MOD	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

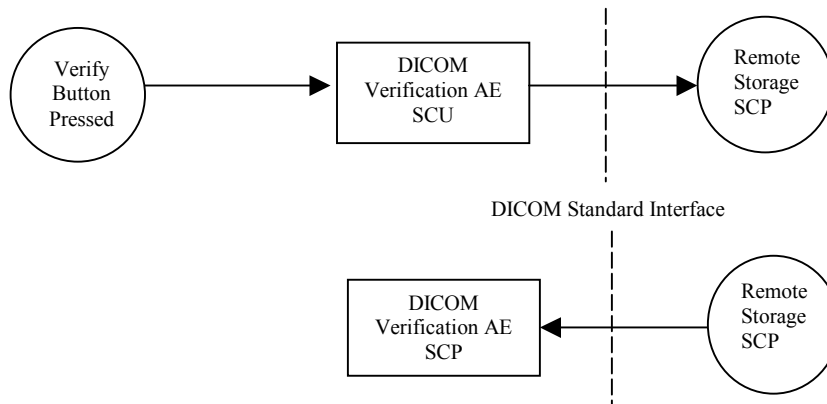
2. Implementation Model

The ACUSON Cypress system incorporates the DICOM 3.0 standard for networked image storage, network verification services, and media image storage. Each DICOM function is an Application Entity (AE).

2.1 Application Data Flow Diagrams

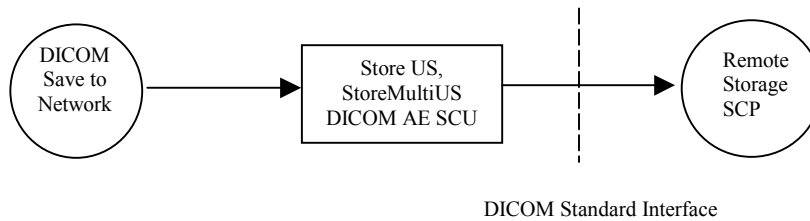
2.1.1 Verification AE

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



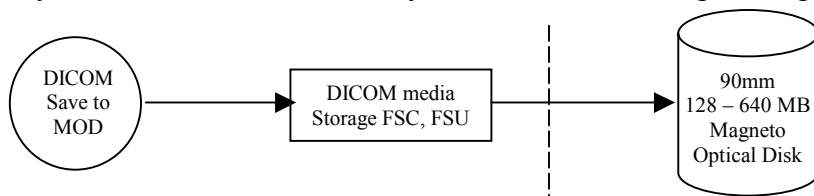
2.1.2 Image Export AE

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



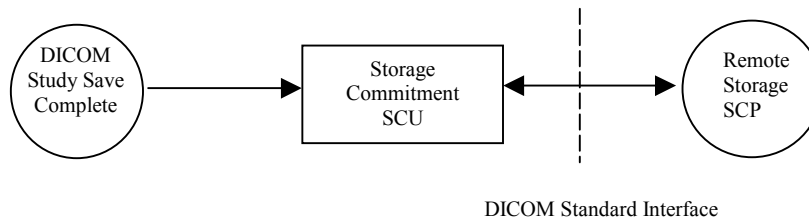
2.1.3 DICOM MO Disk Media Interchange AE

The Cypress system 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.



2.1.4 DICOM Storage Commitment AE

With the optional DICOM Network package and a Storage Commitment SCP, the Cypress system can verify that the Remote Storage SCP has properly received and stored all images for a study.



2.2 Functional Definitions of AE

The Verification, Networked Image Storage and Storage Commitment Application Entities are available only with the purchase of the optional DICOM Network package. The Media Image Storage Application entity is standard on the Cypress system.

2.2.1 Verification AE

The Verification AE SCU 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 Verification AE SCP. Once received, the Cypress system will send its response back to the networked device.

2.2.2 Image Export AE

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

In Cypress system Version 12, studies are exported with one series per study. All images in the study, including the calculation report images, are contained within this single series. Earlier versions of the Cypress system exported studies with multiple images per study.

2.2.3 DICOM MO Disk Media Interchange AE

The Cypress system can perform DICOM operations to its standard 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 system performs the following DICOM roles for MO disks:

- File Set Creator (FSC): a DICOM conformant MOD media is created when the user saves studies in DICOM format to the MO. A DICOM 3.0 conformant DICOMDIR file is created along with the directory structures and the image files.
- File Set Updater (FSU): the Cypress system modifies the DICOMDIR file and image files when the user saves or deletes studies from the MO disk.

In Cypress system Version 12, studies are exported with one series per study. All images in the study, including the calculation report images, are contained within this single series. Earlier versions of the Cypress system exported studies with multiple images per study.

2.2.4 DICOM Storage Commitment AE

DICOM Storage Commitment is sent to the DICOM Store SCP upon successful completion of the study store. It is dynamically negotiated when all images have been successfully sent to the server.

This AE uses the DICOM Storage Commitment Push Model to inform the server when all stores for a study have been completed. The Storage Commitment SCU uses the N_ACTION primitive to make a request to the SCP for safekeeping of a set of ultrasound images.

The Cypress Storage Commitment SCU also performs a role reversal and becomes the SCP for the N-Event-Report primitives from the original SCP (now an SCU).

2.3 Sequencing Of Real World Activities

2.3.1 Network Store

The Cypress system initiates an association to a networked DICOM server when the user selects one or more studies to be saved and initiates the transfer using the Send Dialog. The Cypress AE uses the C-Store command to send the image(s) to the networked server.

Before issuing the first C-Store command in a study, the Cypress system will first issue a Verification (C-Echo) command to the remote server. If the response received is good, the C-Store command(s) for the study will be sent to the remote server. If no response to the C-Echo command is received, or an error is detected on the Verification Operation, the save will not be initiated, and an error will be presented to the user.

The Network Store function is available only with the DICOM Network option.

2.3.2 Store To MOD

The Cypress system initiates a Store to MOD when the user selects one or more studies to be saved and initiates the transfer using the Send Dialog.

2.3.3 Verification

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 will be displayed and the store operation will be aborted.
- When the “Verify” button on the DICOM Server Information screen is activated. The result will be displayed in the area of the screen labeled “Test Result”.

In both cases, valid server information must be entered on the DICOM Server Information screen.

The Verification function is available only with the DICOM Network option.

2.3.4 Storage Commitment

When the study store to the Storage SCP is complete, a Storage Commitment request is sent to the Storage SCP. This request will contain the SOP instance UIDs for all images in the study. The Storage SCP will verify that all image instances are properly stored. The user will be notified if any images are reported to be not properly stored.

If the Storage SCP does not support the Storage Commitment function, the Cypress system can be configured in the DICOM Server Setup screen so it does not issue the Storage Commitment request.

The Storage Commitment function is available only with the DICOM Network option.

3. Network Transfer Specifications

3.1 Supported SOP Classes

This implementation provides standard conformance to the following DICOM 3.0 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	Role	Conformance Level
Ultrasound Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.6.1	SCU	Standard
Ultrasound Multi-frame Image Storage SOP Class	1.2.840.10008.5.1.4.1.1.3.1	SCU	Standard

Note that the retired SOP class UIDs for Ultrasound Image Storage and Ultrasound Multi-Frame Image storage are not used in the Cypress system implementation. The Secondary Capture SOP class is not used in the Cypress system 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	Role	Conformance Level
Verification SOP Class	1.2.840.10008.1.1	SCU, SCP	Standard

3.1.3 Storage Commitment SOP Class

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

Table 3: Storage Commitment SOP Class

SOP Class Name	SOP Class UID	Role	Conformance Level
Storage Commitment Push	1.2.840.10008.1.20.1	SCU	Standard

3.2 Association Establishment Policies

3.2.1 General

The maximum PDU size is configurable. This value must be greater than 1024. 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 system 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: 12.0

3.2.5 Calling and Called AE Titles

The calling AE Title is the AE title of the Cypress Storage, Verification, or Storage Commitment SCU that is presented to a networked SCP. The Calling AE Title is also used by a remote Verification SCU when opening an association to the Cypress Verification SCP.

The Calling AE Title can be easily modified in the Cypress DICOM Information screen. It is recommended that it be set to CYPRESSnnnnn where nnnnn is the serial number of the unit.

The Called AE Title is the AE Title of the Networked Storage or Verification SCP. The Called AE Title is displayed on the DICOM Server Information screen. The Called AE Title may be modified by adding or editing a DICOM server entry.

3.3 Association Initiation Policy

This implementation will initiate the association in the following manner.

- The Verification SCU opens one association. It is closed at the end of the transaction.
- The Storage SCU will open one association per study. This association contains two presentation contexts, for single frame and multi frame images. The number of frames within a particular image is used to determine which presentation context is applicable. When the transmission of all images in the study is complete and acknowledgements from the SCP have been received, the association is closed.
- The Cypress Storage Commitment SCU will open an association to the server when all images for the study have been sent to the Storage SCP. This association will be closed when the Storage Commitment Request has been made, and the acknowledgement from the SCP has been received. The Cypress system will send the Storage Commitment only if the Server has been configured to accept Storage Commitment in the DICOM Server Setup screen.

3.3.1 Proposed Presentation Context

Table 3 shows all possible transfer syntaxes that can be used with each SOP class. For the Image Storage SOP class, the actual transfer syntax used will be based upon the compression scheme selected from the DICOM Send Dialog, 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 system implementation. The Secondary Capture SOP class is also not used in the Cypress system implementation.

Table 4: 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
Storage Commitment SOP Class	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.3.2 SOP Specific Conformance of SCU

3.3.2.1 Storage SOP Classes: Presentation Contexts

The Cypress system image storage AE presents transfer syntaxes based on the compression type selected from the Send Dialog. 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 Storage SCP when the association is initiated. If the Storage SCP does not support the compressed transfer syntax, and it accepts the DICOM default transfer syntax, the Cypress system will send the study in uncompressed format. All images sent in uncompressed format will use a Photometric Interpretation of PALETTE_COLOR.

Table 5: 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	1.2.840.10008.1.2.5
			Implicit VR Little Endian	1.2.840.10008.1.2
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
			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	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	1.2.840.10008.1.2.5
			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	JPEG	JPEG Baseline Implicit VR Little Endian	1.2.840.10008.1.2.4.50 1.2.840.10008.1.2
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3.3.2.2 Storage SOP Classes: Photometric Interpretation

Photometric Interpretation, the color mode of the pixel data, is not a negotiable parameter in DICOM 3.0. Table 5 lists the Photometric Interpretations used with each compression type.

This implementation will export images using a photometric interpretation of PALETTE_COLOR for images sent in Uncompressed or RLE compressed formats.

If the C-Store SCP accepts the JPEG compression transfer syntax, images are exported using a photometric interpretation of YBR_FULL_422.

The Cypress system does not make any Photometric Interpretation selections based on the lack of or the presence of Color data.

Table 6. Photometric Interpretation of Exported Images

Ultrasound Image SOP Class UID	Transfer Syntax and UID	User Compression Selection	Photometric Interpretation
Single Frame 1.2.840.10008.5.1.4.1.1.6.1	Implicit VR Little Endian 1.2.840.10008.1.2	None	PALETTE_COLOR
Single Frame 1.2.840.10008.5.1.4.1.1.6.1	RLE Lossless Compression 1.2.840.10008.1.2.5	RLE	PALETTE_COLOR
Single Frame 1.2.840.10008.5.1.4.1.1.6.1	JPEG Baseline Compression 1.2.840.10008.1.2.4.50	JPEG	YBR_FULL_422
Multi Frame 1.2.840.10008.5.1.4.1.1.3.1	Implicit VR Little Endian 1.2.840.10008.1.2	None	PALETTE_COLOR
Multi Frame 1.2.840.10008.5.1.4.1.1.3.1	RLE Lossless Compression 1.2.840.10008.1.2.5	RLE	PALETTE_COLOR
Multi Frame 1.2.840.10008.5.1.4.1.1.3.1	JPEG Baseline Compression 1.2.840.10008.1.2.4.50	JPEG	YBR_FULL_422

3.3.2.3 Storage SOP Classes: DICOM IOD Specification

This implementation uses DICOM 3.0 Part 3 as the DICOM Image IOD specification.

3.4 Association Acceptance Policy

This implementation accepts an association request from a Verification SCU. The Cypress Verification SCP will accept one association at a time from a Verification SCU.

3.5 Communication Profile

This implementation supports the TCP/IP protocol stack. The OSI stack is not supported.

The DICOM 50 pin physical connection is not supported.

This implementation is indifferent to the underlying physical medium. It only requires TCP/IP in the Transport and Network layers.

4. Removable Interchange Media Specifications

This implementation supports 90mm (3.5 inch) DICOM MOD removable media. It conforms to DICOM 3.0 Parts 10, 11, and 12.

Limitations:

- Studies from the Cypress system and other DICOM FSCs cannot be mixed on a single MO disk. A warning will be displayed if a save is initiated to an MO disk containing a non-Cypress system file set. The save will not occur.
- Saved DICOM studies cannot be opened for review on the Cypress system.
- Saved Cypress system DICOM studies cannot be opened for review from MOD on other Acuson or Siemens ultrasound systems.

4.1 Supported SOP Classes

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

Table 7: 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

4.1.1 Proposed Media Interchange Transfer Syntaxes

The Transfer syntax used with the Ultrasound Image Storage and Multi-Frame Image Storage SOP classes will correspond to the selected compression type, with Explicit VR encoding. The Directory Storage SOP class will always use Explicit VR, Little Endian encoding.

Table 8: 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	Explicit VR, 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	Explicit VR, 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	Explicit VR, 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	Explicit VR, 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

4.1.2 Physical Storage Media and Format

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

At this time, the DICOM committee does not approve the use of the 640 MB MOD. The sector size for the 640 MB disk is 2048 bytes/sector. If a 640 MB MOD is used on the Cypress system, 640 MB MOD hardware must be present on the review station in order to review the studies.

5. Data Identification Information

The SOP Instance IOD, Study Instance UID, and Series Instance UID can identify patient and study information that originated from a Cypress system system. These UIDs correspond to DICOM elements (0008, 0018), (0020, 000D), and (0020, 000E) in the IOD.

- The ANSI registered Acuson root UID is 1.2.840.113680.
- The Cypress system root UID is 1.2.840.113680.4.103
- The SOP Instance UID uses one of the following formats:
For Image Storage SOP Classes: 1.2.840.113680.4.103.n.d.0.t.s
For Directory Storage SOP Class: 1.2.840.113680.4.103.n.e
Where:
 - n is the serial number of the Cypress system unit
 - d is the year, month, day, hour, minute, and second that the study was created.
 - e is the year, month, day, hour, minute, second and millisecond when the directory write was initiated..
 - t is 1 for images, 2 for calc report images
 - s is the image number (1 - n) for images or the page number (1 - n) for the calc report images.
- The Study Instance UID uses the following format:
1.2.840.113680.4.103.n.d
Where:
 - n is the serial number of the Cypress system unit
 - d is the year, month, day, hour, minute, and second the study was created
- The Series Instance UID uses the following format:
1.2.840.113680.4.103.n.d.0
Where:
 - n is the serial number of the Cypress system unit
 - d is the year, month, day, hour, minute, and second the study was created

6. Extensions, Specializations and Privatizations

No private SOP Classes, private Transfer Syntaxes, or private Elements are used in this implementation.

7. Configuration

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

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

8. Support of Extended Character Sets

The following character set is supported:

ISO-IR 100 Latin Alphabet No. 1