

Acuson CypressTM Ultrasound System Version 11.1

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 |
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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 software version 11.1. 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 |

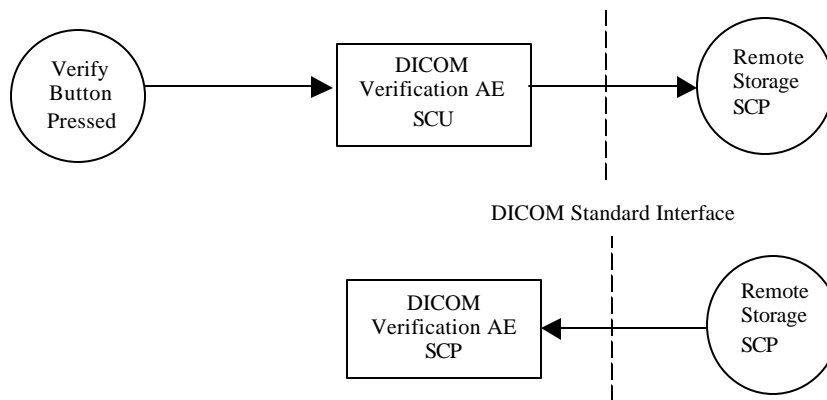
2. Implementation Model

The Acuson Cypress 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

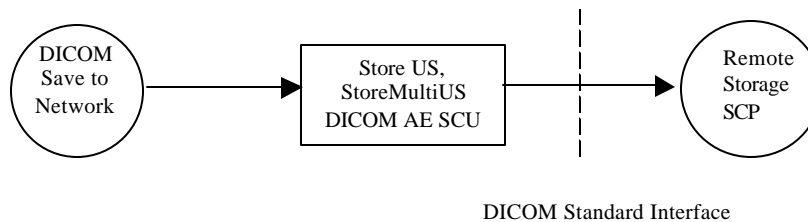
2.1.1 Verification AE

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



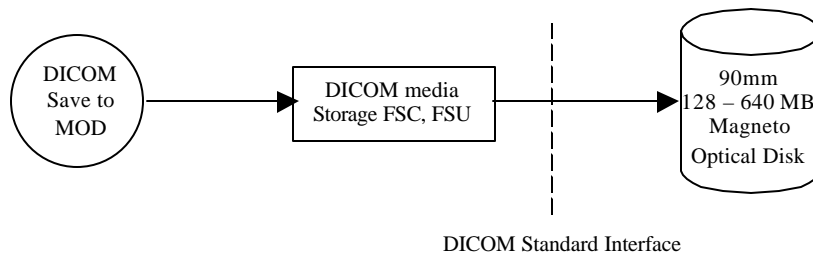
2.1.2 Image Export AE

With the optional DICOM Network package, the Cypress 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 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 AE

The Verification and Networked Image Storage 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.

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 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 can store images to a networked DICOM server, which supports the SCP role of each Storage service class.

The Cypress exports studies with multiple series per study. With the exception of the calculation report, each image in a study is contained in a separate series. All pages of the calculation report are contained within one calculation report series.

2.2.3 DICOM MO Disk Media Interchange AE

The Cypress 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 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 modifies the DICOMDIR file and image files when the user saves or deletes studies from the MO disk.

The Cypress exports studies to MOD with multiple series per study. With the exception of the calculation report, each image in a study is contained in a separate series. All pages of the calculation report are contained within one calculation report series.

2.3 Sequencing Of Real World Activities

2.3.1 Network Store

The Cypress 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 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.

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 implementation. The Secondary Capture SOP class is 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 | Role | Conformance Level |
|------------------------|-------------------|----------|-------------------|
| Verification SOP Class | 1.2.840.10008.1.1 | SCU, SCP | 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 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: 11.1

3.2.5 Calling and Called AE Titles

The calling AE Title is the AE title of the Cypress Storage or Verification SCU that is presented to a networked Storage or Verification 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 is factory pre-configured to be: CYPRESS_AE. This 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. It is initially set to DICOM_SERVER_AE. 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 multiple associations (not simultaneously) for a study. One association will be established for each single or multiframe image in the study. The association is established when transmission for the image begins. When transmission is complete for the image, the association is closed. A new association is established for the next image and it is transmitted. This process continues serially until all images for the study have been transmitted.

3.3.1 Proposed Presentation Context

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. The Secondary Capture SOP class is also 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 |

3.3.2 SOP Specific Conformance of SCU

3.3.2.1 Storage SOP Classes: Presentation Contexts

The Cypress 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 will send the study in uncompressed format. All images sent in uncompressed format will use a Photometric Interpretation of PALETTE_COLOR.

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 |

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

Table 5. 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 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 file set. The save will not occur.
- Saved DICOM studies cannot be opened for review on the Cypress system.
- Saved Cypress DICOM studies cannot be opened for review from MOD on other Acuson or Siemens ultrasound systems.

4.1 Supported SOP Classes

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

Table 6: 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.

Table 7: 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, 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, 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. 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 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.s
For Directory Storage SOP Class: 1.2.840.113680.4.103.n.e
Where:
 - n is the serial number of the Cypress 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..
 - s is the series number (1-based) in the study.
- 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 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.x.r
Where:
 - n is the serial number of the Cypress unit
 - d is the year, month, day, hour, minute, and second the study was created
 - x is the series number (1-based) of the current image in the study, plus 10000
 - r is 1 for an image series, or 2 for a calculation report series

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