Philips Medical Systems
DICOM Conformance Statement

Inturis Cardio View Station R 1.1

Document Number 4522 982 71921
27 October 1999

Philips
Medical
Systems

PHILIPS

Issued by:
Philips Medical Systems Nederland B.V.
Integrated Clinical Solutions, Marketing & Communications
Building QV-280
P.O. Box 10.000
5680 DA Best
The Netherlands
Tel.: +31 40 2762456
Fax.: +31 40 2762673
email: dicom@philips.com
Internet (with the latest versions of Conformance Statements and other DICOM information):
http://www.philips.com/ms/solution/connect
ftp://ftp.philips.com/pub/ms/dicom/Conformance_Stmnts

1 Introduction

This chapter provides general information about the purpose, scope and contents of this Conformance Statement.

1.1 Scope and field of application

The scope of this DICOM Conformance Statement is to facilitate data exchange with equipment of Philips Medical Systems. This document specifies the compliance to the DICOM standard (formally called the NEMA PS 3.X-1996 standards). It contains a short description of the applications involved and provides technical information about the data exchange capabilities of the equipment. The main elements describing these capabilities are: the supported DICOM Service Object Pair (SOP) Classes, Roles, Information Object Definitions (IOD) and Transfer Syntaxes.

The field of application is the integration of the Philips Medical Systems equipment into an environment of medical devices.
This Conformance Statement should be read in conjunction with the DICOM standard and its addenda [DICOM]. The conformance to the DICOM standard is a key element of the Inturis Program (see [INTURIS]).

1.2 Intended audience

This Conformance Statement is intended for:
- (potential) customers,
- system integrators of medical equipment,
- marketing staff interested in system functionality,
- software designers implementing DICOM interfaces.

It is assumed that the reader is familiar with the DICOM standard.

1.3 Contents and structure

The DICOM Conformance Statement is contained in chapter 2 through 7 and follows the contents and structuring requirements of DICOM PS 3.2-1996.

1.4 Used definitions, terms and abbreviations

DICOM definitions, terms and abbreviations are used throughout this Conformance Statement. For a description of these, see NEMA PS 3.3-1996 and PS 3.4-1996.
The word Philips in this document refers to Philips Medical Systems.

1.5 References

[DICOM] The Digital Imaging and Communications in Medicine (DICOM) standard:
NEMA PS 3.X 1996
National Electrical Manufacturers Association (NEMA) Publication Sales
1300 N. 17th Street, Suite 1847
Rosslyn, Va. 22209, United States of America

[INTURIS] Inturis for Cardiology

On-Line Image Access
Doc. nr. 4522 982 69681
Philips Medical Systems Ned. BV

1.6 Important note to the reader

This Conformance Statement by itself does not guarantee successful interoperability of Philips equipment with non-Philips equipment. The user (or user's agent) should be aware of the following issues:

- **Interoperability**
  Interoperability refers to the ability of application functions, distributed over two or more systems, to work successfully together. The integration of medical devices into a networked environment may require application functions that are not specified within the scope of DICOM. Consequently, using only the information provided by this Conformance Statement does not guarantee interoperability of Philips equipment with non-Philips equipment.
  It is the user's responsibility to analyse thoroughly the application requirements and to specify a solution that integrates Philips equipment with non-Philips equipment.

- **Validation**
  Philips equipment has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with this Conformance Statement.
  Where Philips equipment is linked to non-Philips equipment, the first step is to compare the relevant Conformance Statements. If the Conformance Statements indicate that successful information exchange should be possible, additional validation tests will be necessary to ensure the functionality, performance, accuracy and stability of image and image related data. It is the responsibility of the user (or user's agent) to specify the appropriate test suite and to carry out the additional validation tests.

- **New versions of the DICOM Standard**
  The DICOM Standard will evolve in future to meet the user's growing requirements and to incorporate new features and technologies. Philips is actively involved in this evolution and plans to adapt its equipment to future versions of the DICOM Standard. In order to do so, Philips reserves the right to make changes to its products or to discontinue its delivery.
  The user should ensure that any non-Philips provider linking to Philips equipment, also adapts to future versions of the DICOM Standard. If not, the incorporation of DICOM enhancements into Philips equipment may lead to loss of connectivity (in case of networking) and incompatibility (in case of media).

1.7 General Acronyms and Abbreviations.

The following acronyms and abbreviations are used in the document.

- ACC American College of Cardiology
- AE Application Entity
- ACR American College of Radiology
- ANSI American National Standard Institute
- BOT Basic Offset Table
- CD-R CD Recordable
- CD-M CD Medical
- CIVP Cardio Image Viewing Package
- DCI Digital Cardio Imaging
- DCR Dynamic Cardio Review
- DICOM Digital Imaging and Communication in Medicine
- DIMSE DICOM Message Service Element
- DIMSE-C DICOM Message Service Element-Composite
- DIMSE-N DICOM Message Service Element-Normalized
- ELE Explicit VR Little Endian
- EBE Explicit VR Big Endian
- FSC File Set Creator
- GUI Graphic User Interface
- HIS Hospital Information System
- HL7 Health Level Seven
- ILE Implicit VR Little Endian
- IOD Information Object Definition
- ISIS Information System - Imaging System
- NEMA National Electrical Manufacturers Association
- PDU Protocol Data Unit
- RIS Radiology Information System
- RWA Real World Activity
- SC Secondary Capture
- SCM Study Component Management
- SCP Service Class Provider
- SCU Service Class User
- SOP Service Object Pair
- TCP/IP Transmission Control Protocol/Internet protocol
- UID Unique Identifier
- WLM Worklist Management

2 Implementation model

The Implementation Model identifies all of the DICOM *Application Entities (AEs)* and relates these Application Entities to the *Real World Activities (RWAs)*.

The DICOM interface for the CD-Medical product range of Philips Medical Systems is a Media Storage implementation of the 120mm *Compact Disc Recordable (CD-R)* medium, as described in the NEMA standard PS3.12-Annex F.

2.1 Application Data Flow Diagram

The Philips Inturis Cardio Image Viewing Package (Philips Inturis CIVP) application domain can be represented by a single Application Entity, describing the reading process (see Figure 2-2 on page 6).

The Philips Inturis CIVP will be the PC-NT based counterpart of the current CD-Medical Viewer. In addition to the CD-Medical viewer, it shall offer the following functionality:

- Local Archive for multiple patients.
- Point to Point printer
- Enhanced zoom and loupe.
- Adapted video mode for video copies
- On-line help for all functions
- Export current frame to other applications

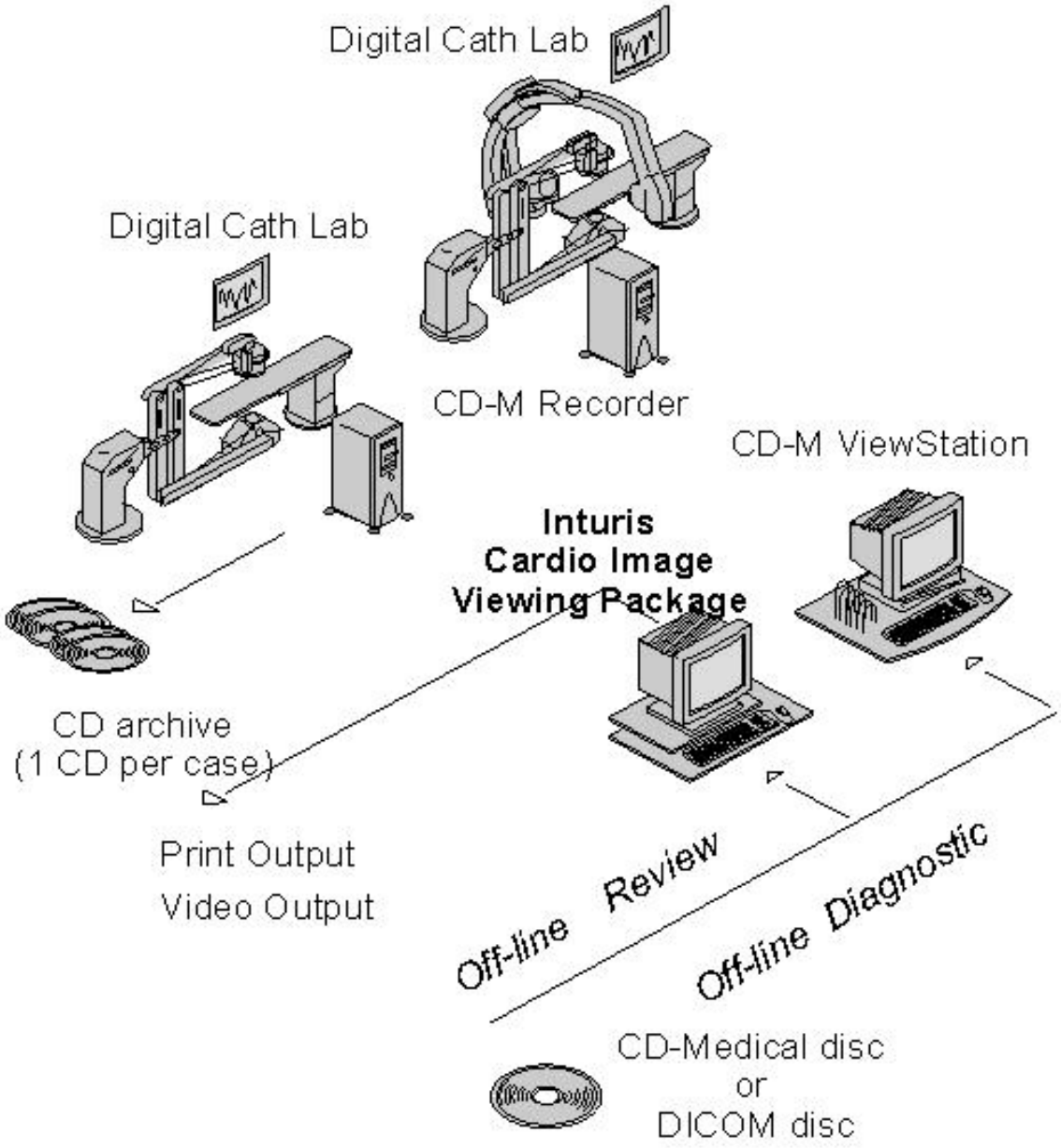

Figure 2-1: Topology Image

The “DICOM Reader” AE provides Standard Conformance to the DICOM Media Storage Service and File Format Class (PS 3.10) and the Media Storage Application Profile (PS 3.11). And Standard Conformance to the SC IOD

The CD-Medical “DICOM Reader” AE is able to read the multi-frame images stored in two-types of data-streams on the CD-R media.

- The first stream type is according to the DICOM format of the ACC-ACR-NEMA; i.e. each (cardiac) frame is stored as a 512 x 512, 8 bit deep, pixel matrix using a **lossless** JPEG com-

pression algorithm; i.e. with a compression factor of about 2.
- The second stream support the SC Image IOD.

.

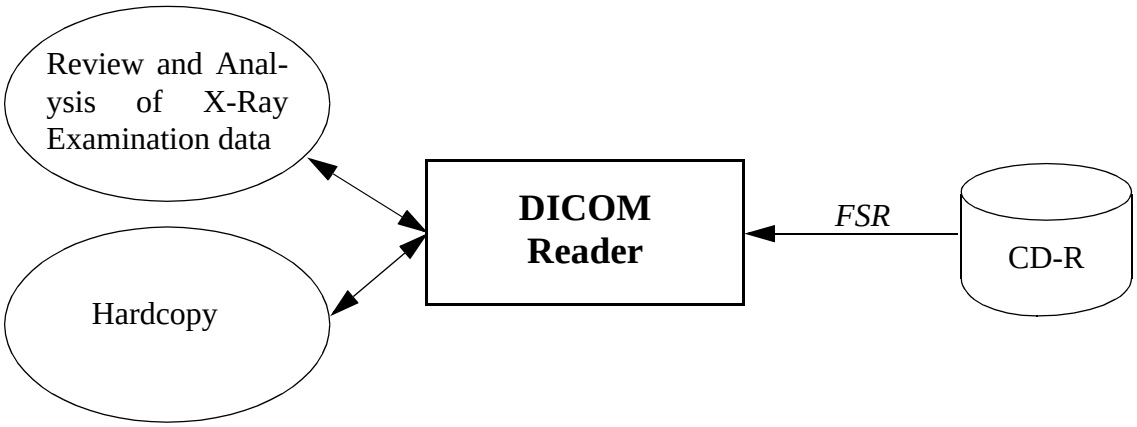

Figure 2-2: Application Data Flow diagram of the Philips Inturis CIVP

2.2 Functional definition of Application Entities

Referring to Figure 2-1, the local RWA “Review of X-Ray Examination” (i.e. putting a CD-R disc into the Philips Inturis CIVP) will cause the AE “DICOM Reader” to read the File-set on the CD-R medium. The term *File-set Reader (FSR)* means that the Philips Inturis CIVP device will read the DICOMDIR file and one or more DICOM files, covering all X-ray images, patient data, study parameters, etc.

2.2.1 Application Entity: DICOM Reader

The AE “DICOM Reader” supports the following functions;
- Read the DICOMDIR file that represents the contents of the (image) data as recorded.
  This information is displayed as an ordered list of icon images together with pertinent identifying information (patient name, etc.).
- Read the selected image *SOP (Service Object Pair)* instance from CD-R device and/or local archive and display it on the monitor of the Philips Inturis CIVP.
  This information is displayed as an ordered list of frames of the selected image or as a dynamic review of the selected image.
- The Philips Inturis CIVP application shall not provide functions yet to create patient folders into the local archive manually. Patient folders are only created from data that have been imported from local CD into the local archive. In this release the relation patient vs. procedure is considered 1:1. Multiple procedures are not married up into one patient folder.

2.3 Sequencing of Real World Activities

The Reader process is activated by request from the user.
In case of multiple discs for a single examination, these discs are considered as self-contained. Multiple CD’s which originate from **one** image-transmission digital cat-lab -> CD -medical Recorder (this means with a Disc.inf on the CD’s to recognize multiple CD’s) are married up to one patient/procedure folder in the local archive.

Multiple CD’s which originate from two or more image-transmissions digital cath-lab -> CD-Medical recorder can not be handled in this release.

2.4 Implementation Identifying Information

The Implementation Class UID is:

Implementation Class UID = *“1.3.46.670589.7.7.1.1”*

The Implementation Version Name is not relevant because this release of the Philips Inturis CIVP only reads CD-R Media and has no network capabilities.

3 AE Specifications

This chapter describes in more detail the DICOM context of each individual Application Entity.
Since the Philips Inturis CIVP encompasses a single Application Entity, only one section is necessary to describe the AE specification.

3.1 AE Specification: DICOM Reader

The “DICOM Reader” AE provides Standard Conformance to the DICOM Media Storage Service and File Format Class (PS 3.10) and the Media Storage Application Profile (PS 3.11) as far as the reading of lossless compressed images is concerned.

Table 3-1: Application Profile, Activities and Roles of the CD-Medical DICOM Reader

Application Profile	*Identifier*	*Real World Activity*	*Role*	*SC Option*
Basic Cardiac Media Application Profile (1)	STD-XABC-CD	Review of X-ray Examination.	FSR	Interchange.
SC Image Storage (2)	STD-????	review of Secondary capture Examination	FSR	Interchange

(1) The application profile only accepts 8 bit deep pixel depth.

(2) This application profile also supports the 1024*1024 SC Image IOD, with the exception that it can also read a 1280*1024 pixel matrix which are generated by Cardio applications.

3.1.1 Application Entity Title

The Application Entity Title is not relevant because this release of the Philips Inturis CIVP only reads CD-R Media and has no network capabilities.

3.1.2 RWA Review and Analysis of X-ray Examination

The “DICOM Reader” AE will act as a FSR using the Interchange option when reading the directory of the medium and when reading the requested images.

3.1.2.1 Application Profile(s) for this RWA

Refer to Table 3-1 for the list of Application Profiles that invoke this AE.

3.1.2.2 Required and optionally applied Attributes and DICOMDIR Keys

The Modules and Attributes needed for the correct review of lossless compressed images (Basic Cardiac Media Application Profile) are specified in detail in section 7.1 on page 12. These Modules and Attributes are Mandatory (type 1 or 2) in the DICOM 3.0 standard.
The optionally applied Modules and Attributes (if present on the disc) are also specified in that section.

The Keys needed for the correct review of the contents of a CD-R disc are specified in detail in section 7.1 on page 12. These Keys are Mandatory (type 1 or 2) in the DICOM 3.0 standard.
The optionally applied Keys (if present on the disc) are also specified in that section.

3.1.3 RWA hardcopy

The “DICOM Reader” AE will act as a FSR using the Interchange option when the operator requests for a hardcopy of (a selected part of) the information on CD-R.

3.1.3.1 Application Profile(s) for this RWA

Refer to Table 3-1 for the list of Application Profiles that invoke this AE.

3.1.3.2 Required and optionally applied Attributes and DICOMDIR Keys

See section 3.1.2.2 on page 8.
Attribute Institution Name and Hospital Name on the CD-R disc (if present) are printed on the Hardcopy.

4 Extensions/Specializations/Privatizations

The Standard Extended Attributes (if present on the CD-R disc) applied by Philips Inturis CIVP for the review applications are specified in the sections below.
Due to these extensions, the Philips Inturis CIVP will recognise private attributes identified with Private Creator string "**CARDIO-D.R. 1.0**".

4.1 Edge Enhancement Sequence

Each frame within a lossless compressed image may be Edge Enhanced by applying the formula and the values specified in the Edge Enhancement Sequence (see Table 4-1). Whether the Edge Enhancement is performed or not, depends on the values of the Edge Enhancement Attributes.

Table 4-1 : Edge Enhancement Sequence

Attribute Name	*Tag*	*Type*	*Attribute Description*
Edge Enhancement Sequence	(0029,xx00)	3	Edge Enhancement Sequence describing the Edge Enhancement Filter to be applied to the image. *Formula: E=F+((F-C)*G)* *E: Pixel value of enhanced frame* *F: pixel value of source frame* *C: pixel value of convoluted region* *G: edge enhancement gain*
> Convolution Kernel Size	(0029,xx01)	1C	Number of rows and columns in the convolution kernel. The first value specifies the number of rows; the second value specifies the number of columns. Values shall be equal or greater than 3. Required if Edge Enhancement Sequence (0029,xx00) is present. A fixed kernel size of 5 x 5 is applied; kernel sizes other than 5 x 5 are ignored.
> Convolution Kernel Coefficients	(0029,xx02)	1C	The coefficients of the convolution kernel organized by row from left to right starting with the top row. The number of values shall be equal to the number of rows times the number of columns specified in the Convolution Kernel Size. Required if Edge Enhancement Sequence (0029,xx00) is present. The Philips Inturis CIVP supports only coefficients of 1; other coefficients are ignored.
> Edge Enhancement Gain	(0029,xx03)	1C	Edge Enhancement Gain to be used. Required if Edge Enhancement Sequence (0029,xx00) is present. The Philips Inturis CIVP supports a gain between 0 and 12.4. If another gain is specified, the Edge Enhancement Gain 0 is taken.

5 Configuration

not applicable.

6 Support of Extended Character Sets

The Philips Inturis CIVP supports the following Extended Character Set(s) on the medium:

ISO_IR 100: Latin Alphabet No. 1

7 Specification of the applied IODs

The Attributes required or applied (if present on the disc) by the review functions of the Philips Inturis CIVP are specified in detail for the Basic Cardiac Media Application Profile.

7.1 Basic Cardiac Media Application Profile

7.1.1 Applied XA and SC Image IOD

The Attributes that are required by the review functions of the Philips Inturis CIVP are specified for the SOP Classes in this Application Profile in Table 7-1.
i

Table 7-1: Required Attributes in the standard XA Image IOD

Required Module	*Reference*	*Comments*[a]
Transfer Syntax UID	0002:0010	for lossless compression
Image Type	0008:0008	-
Instance Creation Date	0008:0012	-
Patient's Name	0010:0010	-
Frame Time	0018:1063	-
Samples per Pixel	0028:0002	-
Photometric Interpretation	0028:0004	-
Planar Configuration	0028:0006	-
Rows	0028:0010	-
Columns	0028:0011	-

a. All the not mentioned attributes are optional and will be read but are not required for the viewing functionality.

7.1.2 Applied Basic Cardiac Directory IOD

Table 7-2 specifies the Attributes/Keys in the Basic Cardiac Directory IOD required by the review functions of the Philips Inturis CIVP.

Table 7-2: The Review and Archive parameters in the DICOMDIR File

Applied optional Module	*Review*	*Archive*
Patient	-	Patient ID, Patient Name, Patient Birth Date,
Study	-	Study ID, Study Date, Study Time

Applied optional Module	*Review*	*Archive*
Series	-	Series Number
Image	Referenced File ID	Image Number
Icon	Rows, Columns	

7.1.3 Applied Patient Management IOD

None of the Modules (so none of the Attributes) in the Detached Patient Management IOD are required by the review functions of the Philips Inturis CIVP.

7.2 Applied SC Image IOD.

This paragraph will provide an overview of all the used attributes in the SC Image IOD.

Table 7-3: Applied Modules in the SC Image IOD

Module	*Usage*	*Reference*
SOP Common	M	Table 7-4
Patient	M	Table 7-5
General Study	M	Table 7-6
General Series	M	Table 7-7
General Equipment	U	Table 7-8
SC Equipment	M	Table 7-9
General Image	M	Table 7-10
Image Pixel	M	Table 7-11
Modality LUT	U	Table 7-12
VOI LUT	U	Table 7-13

Table 7-4: SC Image Storage SOP Class - SOP Common Module

Attribute Name	*Tag*	*Note*
Specific Character Set	(0008,0005)	Character Set that expands or replaces the Basic Graphic Set. Defined terms: ISO_IR 100: Latin alphabet No. 1, supplementary set. Required if an extended or replacement character set is used.

Table 7-4: SC Image Storage SOP Class - (Continued)SOP Common Module

Attribute Name	*Tag*	*Note*
Instance Creation Date	(0008,0012)	Date the SOP Instance was created.
Instance Creation Time	(0008,0013)	Time the SOP Instance was created.
Instance Creator UID	(0008,0014)	Uniquely identifies the device which created the SOP Instance.
SOP Class UID	(0008,0016)	1.2.840.10008.5.1.4.1.1.7
SOP Instance UID	(0008,0018)	Uniquely identifies the SOP Instance.

Table 7-5: SC Image Storage SOP Class - Patient Module

Attribute Name	*Tag*	*Note*
Referenced Patient Sequence	(0008,1120)	A sequence which provides reference to a Patient SOP Class/Instance pair. Only a single reference is allowed.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class. Required if Referenced Patient Sequence (0008,1120) is sent.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance. Required if Referenced Patient Sequence (0008,1120) is sent.
Patient’s Name	(0010,0010)	Patient’s full legal name.
Patient ID	(0010,0020)	Primary hospital identification number or code for the patient.
Patient’s Birth Date	(0010,0030)	Birth date of the patient.
Patient’s Sex	(0010,0040)	Sex of the named patient. Enumerated Values: M: Male. F: Female. O: Other.

Table 7-6: SC Image Storage SOP Class - General Study Module

Attribute Name	*Tag*	*Note*
Study Date	(0008,0020)	Date the Study started.
Study Time	(0008,0030)	Time the Study started.
Accession Number	(0008,0050)	A RIS generated number which identifies the order for the Study.
Referring Physicians' Name	(0008,0090)	Patient's referring physician.
Study Description	(0008,1030)	Institution-generated description or classification of the Study component performed.
Referenced Study Sequence	(0008,1110)	A sequence which provides reference to a Study SOP Class/Instance pair. Only a single reference is allowed.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class. Required if Referenced Study Sequence (0008,1110) is sent.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Sequence (0008,1110) is sent.
Study Instance UID	(0020,000D)	Unique identifier for the Study.
Study ID	(0020,0010)	User or equipment generated Study identifier.

Table 7-7: SC Image Storage SOP Class -General Series Module

Attribute Name	*Tag*	*Note*
Series Date	(0008,0021)	Date the Series started.
Series Time	(0008,0031)	Time the Series started.
Modality	(0008,0060)	XA
Performing Physicians' Name	(0008,1050)	Name of the physicians administering the Series.
Referenced Study Component Sequence	(0008,1111)	Uniquely identifies the Study Component SOP Instances to which the Series is related.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class. Required if Referenced Study Component Sequence (0008,1111) is sent.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance. Required if Referenced Study Component Sequence (0008,1111) is sent.

Table 7-7: SC Image Storage SOP Class -General Series Module

Attribute Name	*Tag*	*Note*
Series Instance UID	(0020,000E)	Unique identifier of the Series.
Series Number	(0020,0011)	A number that identifies this Series.

Table 7-8: SC Image Storage SOP Class - General Equipment Module

Attribute Name	*Tag*	*Note*
Manufacturer	(0008,0070)	Manufacturer of the equipment that produced the digital images.
Institution Name	(0008,0080)	Institution where the equipment is located that produced the digital images.
Manufacturer’s Model Name	(0008,1090)	Manufacturer’s model number of the equipment that produced the digital images.
Software Versions	(0018,1020)	Manufacturer’s designation of software version of the equipment that produced the digital images.

Table 7-9: SC Image Storage SOP Class - SC Equipment Module

Attribute Name	*Tag*	*Note*
Conversion Type	(0008,0064)	WSD

Table 7-10: SC Image Storage SOP Class -General Image Module

Attribute Name	*Tag*	*Note*
Image Number	(0020,0013)	A number that identifies this Image.
Patient Orientation	(0020,0020)	Patient direction of the rows and columns of the Image.
Image Comments	(0020,4000)	User-defined comments about the Image.

Table 7-11: SC Image Storage SOP Class - Image Pixel Module

Attribute Name	*Tag*	*Note*
Samples per Pixel	(0028,0002)	1
Photometric Interpretation	(0028,0004)	MONOCHROME2
Rows	(0028,0010)	Number of rows in the image.
Columns	(0028,0011)	Number of columns in the image.
Pixel Aspect Ratio	(0028,0034)	Ratio of the real world spacing of the pixels in the Image, specified by a numeric pair: row value (delimiter) column value. Required if the aspect ratio is not 1\1.
Bits Allocated	(0028,0100)	8
Bits Stored	(0028,0101)	8
High Bit	(0028,0102)	7
Pixel Representation	(0028,0103)	0000H (unsigned integer)
Pixel Data	(7FE0,0010)	A data stream of the pixel samples which comprise the Image.

Table 7-12: SC Image Storage SOP Class - Modality LUT Module

Attribute Name	*Tag*	*Note*
Modality LUT Sequence	(0028,3000)	Defines as sequence of Modality LUTs.
>LUT Descriptor	(0028,3002)	Specifies the format of the LUT Data in this Sequence. Required if the Modality LUT Sequence (0028,3000) is sent.

Table 7-12: SC Image Storage SOP Class - Modality LUT Module

Attribute Name	*Tag*	*Note*
>Modality LUT Type	(0028,3004)	Specifies the output values of this Modality LUT. Defined Terms: OD: The number in the LUT represents thousandths of optical density. That is, a value of 2140 represents an optical density of 2.140. US: Unspecified. Other values are permitted but not defined by DICOM. Required if the Modality LUT Sequence (0028,3000) is sent.
>LUT Data	(0028,3006)	LUT Data in this Sequence. Required if the Modality LUT Sequence (0028,3000) is sent.

Table 7-13: SC Image Storage SOP Class -VOI LUT Module

Attribute Name	*Tag*	*Note*
Window Center	(0028,1050)	Window Center for display.
Window Width	(0028,1051)	Window Width for display. Required if Window Center (0028,1050) is sent.

8 Implementation restrictions and choices

A number of implementation restrictions/choices exist in this release of the Philips Inturis CIVP which may limit the use of the review functions:

- Multi Patient /Multi Study is supported.
- No restriction in max. no. of images
- No restriction in max. no. of frames, however is no. of frames exceeds PCs memory, playbackspeed may reduce dramatically.
- Edge Enhancement reacts only on the gain factor, see also Table 4-1 on page 10.
- The ECG data is displayed (if present) as far as image frames are present.
- The ISO 9660 file naming is less strictly implemented; file names without '.' and ';1' at the end of the name are accepted.
- A negative Window Width is not supported.
- Edge-enhancements, Zoom, Loupe and presentation of ECG curve may limit the display speed.
- Multiframe Images without basic offset table can not be displayed.
- The contents of a Detached Patient Management file do not overrule the Patient Demographics DICOMDIR and Image files.