Philips Medical Systems
DICOM Conformance Statement

Digital Diagnost
R 1.2

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PHILIPS

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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 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].

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.

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 and PS 3.4.
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 2000
National Electrical Manufacturers Association (NEMA) Publication Sales
1300 N. 17th Street, Suite 1847
Rosslyn, Va. 22209, United States of America

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
- 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 Digital Diagnost R1.2 of Philips Medical Systems is an Computed Radiography (CR) image generating system. It contains an Export function based on the DICOM Image Storage to transfer image data from the Digital Diagnost system to a remote system. This DICOM Export function is described in this document.

2.1 Application Data Flow Diagram

The Digital Diagnost DICOM Export transfers a Digital Diagnost image to a remote DICOM system. This is activated by an operator request or automatically if the system is configured to do so. A remote destination is selected from the user interface, followed by the selection of the image to be transferred.
Post-processed image data can be transferred (pixel value between 0 and 30,000) as an instance of the DICOM Computed Radiography IOD. The images transferred are intended for viewing purpose and VOI LUT transformation (grayscale transformation) only.

The Digital Diagnost DICOM Export behaves as a single Application Entity. The related Implementation Model is shown in Figure 2-1 on page 4.

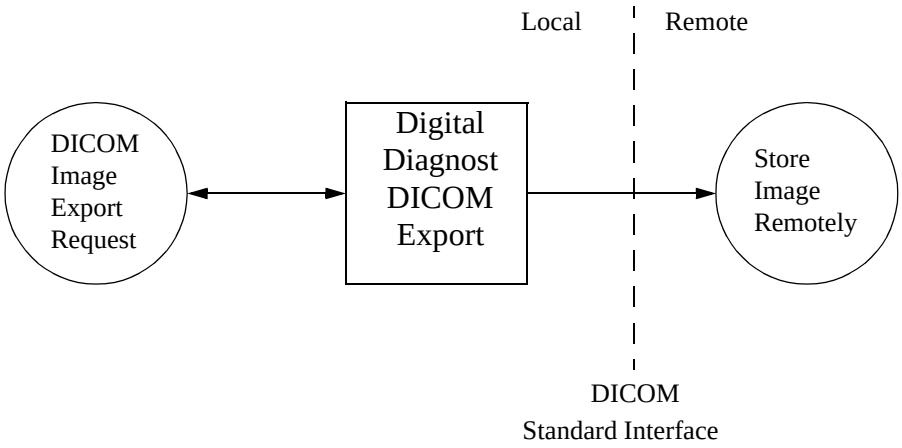

Figure 2-1: Digital Diagnost DICOM Export Implementation Model

2.2 Functional definition of Application Entities

The Digital Diagnost DICOM Export application entity acts as a Service Class User (SCU) of the Storage Service Class. After invoking it will open an association to the remote system. For each image to be transported a retrieve action from the internal Digital Diagnost storage will take place followed by the conversion to a DICOM message to be transferred to the remote system.

2.3 Sequencing of Real World Activities

Not applicable.

3 AE Specifications

Digital Diagnost DICOM Export acts as a single Application Entity.

3.1 AE Digital Diagnost DICOM Export Specification

The Digital Diagnost Export Application Entity provides Standard Extended Conformance to the following DICOM 3.0 SOP class as an SCU:

Table 3-1: Supported SOP class by the Digital Diagnost Export AE as SCU

SOP class Name	*UID*
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1

The Digital Diagnost Export Application Entity does not support DICOM 3.0 SOP Classes as SCP.

3.1.1 Association Establishment Policies

3.1.1.1 General

The Digital Diagnost export will offer a fixed maximum PDU size of 16K = 16384 bytes on the associations initiated by the application itself.

3.1.1.2 Number of Associations

The Digital Diagnost export will attempt to establish one association at a time.

3.1.1.3 Asynchronous Nature

The Digital Diagnost export does not support asynchronous operations and will not perform asynchronous window negotiation.

3.1.1.4 Implementation Identifying Information

The Implementation Class UID is: “1.3.46.670589.26.1.2“.
The implementation version name is: “DigiDiagnost1.2”.

3.1.2 Association Initiation Policy

The Digital Diagnost export initiates associations as a result of only one Real-World activity and is described below.

3.1.2.1 The Digital Diagnost DICOM Image Export Request

3.1.2.1.1 Associated Real-World Activity

The DICOM Image Export Request can be done on the following ways:

- the operator requests via the User Interface the export of the selected Digital Diagnost image to a remote system,
- the generation of a new Digital Diagnost image will result in an automatic export of that image when the system is configured in automatic export mode.

For each export request a new association is set-up, then the transfer of the image is started. The association is released when the transfer is ended. The transferred image will not be deleted from the system.
In case of unsuccessful transfer with special response status conditions (e.g. Store SCP down), a new attempt will be done automatically every 20 seconds. These queued export requests can be aborted by the operator.

3.1.2.1.2 Proposed Presentation Contexts

The Digital Diagnost export will propose the following presentation contexts:

Table 3-2: Proposed Presentation Contexts for the Digital Diagnost Export

Presentation Context table					
Abstract Syntax		*Transfer Syntax*		*Role*	*Extended Negotiation*
Name	*UID*	*Name List*	*UID List*		
Computed Radiography Image Storage	1.2.840.10008.5 .1.4.1.1.1	ILE ELE EBE	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	SCU	None

3.1.2.1.3 SOP Specific Conformance to Storage SOP Classes

The Digital Diagnost provides standard conformance to the Storage Service Class.

The status of the C-STORE Response (Success, Refused, Error, Warning) will be displayed via the user interface.
Extended negotiation is not supported.

Table 3-3 lists the applied optional and extended modules and attributes of the CR IOD. Conditional attributes Patient Orientation (type 2C), Image Date (type 2C), Image Time (type 2C), Specific Character Set (type 1C) are always present.

Table 3-3: Applied optional Modules and Attributes of the applied CR IOD

IE	*Module*	*Optional Attributes*	*Conditional Attributes*
Patient	Patient	Other Patient's ID, Ethnic Group, Patient Comments	-
Study	General Study	Study Description, Physician(s) of Record	-
	Patient Study	Additional Patient's History	-
Series	General Series	Series Date, Series Time, Operator's Name, Protocol Name	Laterality.
	CR Series	Filter Type, Focal Spot(s), Plate Type, Focal Spot(s)	
Equipment	General Equipment	Institution Name, Station Name, Institutional Department Name, Manufacturer's Model name, Device Serial Number, Software Version(s), Date of Last Calibration, Time of Last Calibration	-
Image	General Image	Image Type, Acquisition Number, Image Comments	Image Date, Image Type, Patient Orientation
	Image Pixel	-	-
	X-Ray Acquisition	Image Area Dose Product, Grid, Imager Pixel Spacing	-
	XRF Tomagraphy Acquisition	Tomo Angle, Tomo Time, Scan Options	-
	CR Image	KVP, Distance Source to Detector, Exposure Time, Exposure, Sensitivity, Generator Power, Collimator/Grid Name, Processing Function, Postprocessing Function	-
	VOI LUT	Window Center	Window Width
	SOP Common	-	Specific Character Set

The modules selected from the CR Image IOD module table of DICOM 3.0 and the extended modules are given in the table below.

Table 3-4: Applied Modules in the Extended CR IOD

IE	*Module*		*Reference*
Patient	Patient	M	Table 3-5
Study	General Study	M	Table 3-6
	Patient Study	U	Table 3-7
Series	General Series	M	Table 3-8
	CR Series	M	Table 3-9
Equipment	General Equipment	M	Table 3-10
Image	General Image	M	Table 3-11
	Image Pixel	M	Table 3-12
	CR Image	M	Table 3-13
	Private	M	Table 3-14
	X-Ray Acquisition	M	Table 3-15
	XRF Tomagraphy Acquisition	C	Table 3-16
	VOI LUT	U	Table 3-17
	SOP Common	M	Table 3-18

The details of these applied modules are given in the tables below. The list of possible attribute values are given (if applicable). The situation that an attribute is present conditionally/optionally or that an attribute may contain a zero length value, is indicated too.

The greyed attributes are the attributes from which the contents are received from the RIS via the EasyLink.

Table 3-5: Computed Radiography Image Storage SOP Class - Patient Module

Attribute Name	*Tag*	*Note*
Patient's Name	0010,0010	Received from RIS or filled in by Operator or is empty.
Patient ID	0010,0020	Received from RIS or filled in by Operator or is empty.
Patient's Birth Date	0010,0030	Received from RIS or filled in by Operator or is empty.

Table 3-5: Computed Radiography Image Storage SOP Class - Patient Module (Continued)

Attribute Name	*Tag*	*Note*
Patient's Sex	0010,0040	Received from RIS or filled in by Operator or is empty. Applied value(s): F, M, O
Other Patient IDs	0010,1000	Received from RIS or filled by operator or is empty.
Ethnic Group	0010,2160	Received from RIS or filled by operator or is empty.
Patient Comments	0010,4000	Received from RIS or filled by operator or is empty.

Table 3-6: Computed Radiography Image Storage SOP Class - General Study Module

Attribute Name	*Tag*	*Note*
Physician(s) of Record	0008,1048	Received from RIS or filled by operator or is empty.
Study Date	0008,0020	First Image Date of an acquisition sequence of a Study.
Study Time	0008,0030	First Image Time of an acquisition sequence of a Study.
Accession Number	0008,0050	Received from RIS or filled by operator or is empty.
Referring Physician's Name	0008,0090	Received from RIS or filled by operator or is empty..
Study Description	0008,1030	
Additional Patient’s History	0010,21B0	Received from RIS or filled by operator or is empty.
Study Instance UID	0020,000D	Received from RIS or generated by Digital Diagnost.
Study ID	0020,0010	Digital Diagnost generated.

Table 3-7: Computed Radiography Image Storage SOP Class - General Series Module

Attribute Name	*Tag*	*Note*
Series Date	0008,0021	Identical to Study Date.
Series Time	0008,0031	
Modality	0008,0060	Applied value(s): CR
Operator's name	0008,1070	Filled in by operator or is empty.
Protocol Name	0018,1030	Received from RIS of filled by operator or is empty.
Series Instance UID	0020,000E	Digital Diagnost generated, derived from Series Number.
Series Number	0020,0011	Digital Diagnost generated.
Laterality	0020,0060	Always Empty

Table 3-8: Computed Radiography Image Storage SOP Class - C-STORE-RQ - Patient Study Module

Attribute Name	Tag	Note
Additional Patient History	0010,21B0	

Table 3-9: Computed Radiography Image Storage SOP Class - CR Series Module

Attribute Name	*Tag*	*Note*
Body Part Examined	0018,0015	Applied value(s): ABDOMEN, ANKLE, BREAST, CHEST, CLAVICLE, COCCYX, CSPINE, ELBOW, EXTREMITY, FOOT, HAND, HIP, KNEE, LSPINE, PELVIS, SHOULDER, SKULL, SSPINE, TSPINE
Filter Type	0018,1160	
Focal Spot(s)	0018,1190	
Plate Type	0018,1260	
View Position	0018,5101	Applied value(s): AP, LL, LLD, LLO, PA, RL, RLD, RLO

Table 3-10: Computed Radiography Image Storage SOP Class - General Equipment Module

Attribute Name	*Tag*	*Note*
Manufacturer	0008,0070	Applied value(s): Philips Medical Systems
Institution Name	0008,0080	
Station Name	0008,1010	
Institutional Department Name	0008,1040	
Manufacturer's Model Name	0008,1090	Applied value(s): digital DIAGNOST
Device Serial Number	0018,1000	
Software Version(s)	0018,1020	
Date of Last Calibration	0018,1200	
Time of Last Calibration	0018,1201	

Table 3-11: Computed Radiography Image Storage SOP Class - General Image Module

Attribute Name	*Tag*	*Note*
Image Type	0008,0008	Applied Value(s): DERIVED\ PRIMARY
Content Date	0008,0023	
Content Time	0008,0033	
Acquisition Number	0020,0012	
Instance Number	0020,0013	Is composed of Digital Diagnost acquisition and post number.
Patient Orientation	0020,0020	Applied Value(s): A, F, H, L, P, R
Image Comments	0020,4000	Text from annotationtool included.

Table 3-12: Computed Radiography Image Storage SOP Class - Image Pixel Module

Attribute Name	*Tag*	*Note*
Samples per Pixel	0028,0002	Applied value(s): 1
Photometric Interpretation	0028,0004	Applied value(s): MONOCHROME1, MONOCHROME2. In combination with EV RAD: Applied value(s):MONOCHROME2
Rows	0028,0010	
Columns	0028,0011	
Bits Allocated	0028,0100	Applied Value(s): 16, 8

Table 3-12: Computed Radiography Image Storage SOP Class - Image Pixel Module (Continued)

Attribute Name	*Tag*	*Note*
Pixel Spacing	0028,0030	
Bits Stored	0028,0101	Applied Value(s): 10, 12, 15, 8
High Bit	0028,0102	Applied Value(s): 11, 14, 7, 9
Pixel Representation	0028,0103	Applied value(s): 0000

Table 3-13: Computed Radiography Image Storage SOP Class - CR Image Module

Attribute Name	*Tag*	*Note*
Pixel Data	7FE0,0010	
KVP	0018,0060	
Distance Source to Detector(SID)	0018,1110	
Exposure Time	0018,1150	
Exposure	0018,1152	
Generator Power	0018,1170	
Acquisition Device Processing Description	0018,1400	
Collimator/Grid Name	0018,1180	
Processing Function	0018,5020	
Postprocessing Function	0018,5021	
Sensitivity	0018,6000	

Table 3-14: Computed Radiography Image Storage SOP Class - Private Module

Attribute Name	*Tag*	*Note*
Private Creator Group 0019	0019,0019	Only exported when image is exported for printing Applied Value(s): DIDI TO PCR 1.1
Route AET	0019,1922	
PCR Print Scale	0019,1923	Only exported when image is exported for printing
PCR Print Job End	0019,1924	Only exported when image is exported for printing
PCR No Film Copies	0019,1925	Only exported when image is exported for printing

Table 3-14: Computed Radiography Image Storage SOP Class - Private Module (Continued)

Attribute Name	*Tag*	*Note*
PCR Film Layout Position	0019,1926	Only exported when image is exported for printing
PCR Print Report Name	0019,1927	Only exported when image is exported for printing
RAD Protocol Printer	0019,1970	Only exported when image is exported for printing
RAD Protocol Medium	0019,1971	Only exported when image is exported for printing
Private Creator	0089,0010	Applied Value(s): DIDI TO PCR 1.1
Stamp Image Sequence	0089,1020	
>Samples per Pixel	0028,0002	Applied Value(s): 1
>Photometric Interpretation	0028,0004	Applied Value(s): MONOCHROME1
>Rows	0028,0010	Maximum value 512
>Columns	0028,0011	Maximum value 512
>Bits Allocated	0028,0100	Applied Value(s): 8
>Bits Stored	0028,0101	Applied Value(s): 8
>High Bit	0028,0102	Applied Value(s): 7
>Pixel Representation	0028,0103	Applied Value(s): 0x000
>Pixel Data	7FE0,0010	

Table 3-15: Computed Radiography Image Storage SOP Class - C-STORE-RQ - X-ray Acquisition Module

Attribute Name	Tag	Note
Image Area Dose Product	0018,115E	
Imager Pixel Spacing	0018,1164	
Grid	0018,1166	Applied Value(s): IN, NONE

Table 3-16: Computed Radiography Image Storage SOP Class - C-STORE-RQ - X-ray Tomography Acquisition Module

Attribute Name	Tag	Note
Scan Options	0018,0022	Applied Value(s): TOMO
Tomo Layer Height	0018,1460	Distance in mm between the table surface and the sharp image plane.
Tomo Angle	0018,1470	Angle span in degrees of rotation of X-ray source during X-Ray acquisition.
Tomo Time	0018,1480	Time in seconds the source has taken to rotate the Tomo Angle during X-Ray acquisition.

Table 3-17: Computed Radiography Image Storage SOP Class - VOI LUT Module

Attribute Name	*Tag*	*Note*
Window Center	0028,1050	
Window Width	0028,1051	

Table 3-18: Computed Radiography Image Storage SOP Class - SOP Common Module

Attribute Name	*Tag*	*Note*
Specific Character Set	0008,0005	Applied Value(s): ISO_IR 100
SOP Class UID	0008,0016	Applied value(s): 1.2.840.10008.5.1.4.1.1.1
SOP Instance UID	0008,0018	Generated by Digital Diagnost.

3.1.3 Association Acceptance Policy

The Digital Diagnost does not accept associations.

4 Communication Profiles

4.1 TCP/IP Stack

The Digital Diagnost provides DICOM 3.0 TCP/IP Network Communication Support as defined in Part 8 of the DICOM 3.0 Standard.

4.1.1 Physical Media Support

The Digital Diagnost system supports ISO 8802-3 10BASE-T and 100Base-TX Ethernet.

5 Configuration

The configuration of a Digital Diagnost system is done by means of updating configuration files. This should be done by Philips service engineers only.

5.1 AE Title/Presentation Address mapping

5.1.1 Local AE Titles and Presentation Addresses

The local Application Entity Title and Presentation Address are configurable.

5.1.2 Remote AE Titles and Presentation Addresses

All remote applications to be selected as export destination (SCP) are configurable for the following items:

- The Application Entity Title of the remote application.
- The Presentation Address at which the remote application should accept association requests.
- The Remote Host Name of the system on which the remote application resides.

5.2 Configurable parameters

- The Character Set is ISO-IR 100 which is the Latin alphabet No. 1, supplementary set.
- Whether a RIS is connected to a Digital Diagnost or not (this influences some attribute values of the exported DICOM images; see section 3.1.2.1.3 on page 6)
- Whether automatic transfer of generated images will be done to a configured destination or not (i.e. the automatic export mode which can be switched on or off; see section 3.1.2.1 on page 6)

5.3 Export Filter

The Digital Diagnost system stores images internally with 15 bit depth, MONOCHROME1 format. The pixel values are 10000 times that of the optical density, which this pixel should have on film.

The Export Filter converts the Digital Diagnost pixel data into data fitting the requirements of the receiving station.

To meet the different requirements of different receiving stations, it is possible to create one Configuration for every SCP.

5.4 Configurable Attributes

For every SCP it is possible to configure the following:

Bits stored (0028, 0101)
Photometric Interpretation (0028, 0004)
One of four modes

5.4.1 Bits stored

See also Table 3-12, “Computed Radiography Image Storage SOP Class - Image Pixel Module,” on page 11.

The possible values for Bits stored are:
8, 10, 12, 15.

Giving the following derived values:
Bits allocated: 8, 16, 16, 16
High Bit: 7, 9, 11, 14.

5.4.2 Photometric Interpretation

The possible values for Photometric Interpretation are:
MONOCHROME1 or MONOCHROME2.

5.4.3 Modes

1) Full Range

The source data range is mapped to the full destination range.

Advantage: Uses the maximum precision of the output range.
Disadvantage:There is the possibility, that consecutive images are harder to compare.

It is possible to apply an additional non-linear pixel transformation.

2) Film-like

The number of bits is reduced by the division through a constant factor.

Advantage: Consecutive images are easier to compare
Disadvantage: Reduced precision, compared to that of full range mode.

It is possible to apply an additional non linear pixel transformation.

3) Grayscale Display Function Standard (p-values)

The Digital Diagnost image pixel values represent optical densities on a film according to DICOM PS 3.14.An image is a kind of virtual film, which can be put in front of a virtual light box. The result is, a range of luminescence values. These values are transformed into perceptual linear values using the whole output range which is defined by the "Bits stored" parameter.

These values are exported.

The viewing station should be able to display these values in a perceptual linear manner. This means in most cases a non linear mapping between the input pixel

and the data send to the graphic card.

Advantage: Very good quality, if the viewing station supports the Grayscale Standard Display Function.
Disadvantage: There are many viewing stations not supporting the Grayscale Standard Display Function.

4) Measured

In addition to the processing described before, a second pixel transformation is calculated by using measured luminescence values of the viewing device.

This results in a perceptual linear behaviour of the viewing device.

Advantage: It is possible to achieve results similar to the results of a viewing station supporting the Grayscale Display Function Standard (p-values).
Disadvantage: Changing brightness and contrast at the viewing station, the calibration has to be redone and the Export Filter settings must be adapted. Changing window center/window width at the viewing station can produce results below optimum.

6 Support of Extended Character Sets

The Digital Diagnost export supports Character Sets ISO-IR 100.