

CODONICS

Horizon[®] Imager

DICOM[®] Connectivity Framework

Print Server (Print SCP)

DICOM 3.0 Conformance Statement



LAUREL BRIDGE

Providing DICOM Connectivity for the Medical Community

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TABLE OF CONTENTS

TABLE OF CONTENTS	3
TABLE OF TABLES	5
DCF PRINT SERVER—DICOM 3.0 CONFORMANCE STATEMENT	6
DCF PRINT SERVER—DICOM 3.0 CONFORMANCE STATEMENT	6
0. INTRODUCTION	6
0.1 Scope and Intended Audience.....	6
0.2 Laurel Bridge Software DCF Print Server (Provider).....	6
0.3 References	6
0.4 Important Considerations for the Reader	6
0.5 Revision History.....	7
0.6 Symbols, Abbreviations and Definitions	9
1. IMPLEMENTATION MODELS	13
1.1 Application Data Flow Diagram—DCF Print Server	13
1.2 Functional Definitions of Application Entities (AEs).....	13
1.3 Sequencing of Real World Activities—DCF Print Server.....	14
2. AE SPECIFICATIONS	15
2.1 DCF PrintSCP AE Specification	15
2.1.1 Association Establishment Policies	15
2.1.1.1 General	15
2.1.1.2 Number of Associations.....	16
2.1.1.3 Asynchronous Nature	16
2.1.1.4 Implementation Identifying Information.....	16
2.1.1.5 Called Titles	16
2.1.2 Association Initiation by Real-World Activity.....	17
2.1.3 Association Acceptance Policy	17
2.1.3.1 Real-World Activity—Verification	17
2.1.3.1.1 Associated Real World Activity—Verification.....	17
2.1.3.1.2 Presentation Context Table—Verification	17
2.1.3.1.3 SOP Specific Conformance—Verification.....	17
2.1.3.1.3.1 SOP Specific Conformance to Verification SOP Class.....	17
2.1.3.1.3.2 Presentation Context Acceptance Criterion	18
2.1.3.1.3.5 Transfer Syntax Selection Policies.....	18
2.1.3.2 Real-World Activity—Printing.....	18
2.1.3.2.1 Associated Real World Activity—Printing.....	18
2.1.3.2.2 Presentation Context Table—Printing.....	18
2.1.3.2.3 SOP Specific Conformance—Printing	19
2.1.3.2.3.1 Supported Attributes—Possible Values Specifications	20
2.1.3.2.3.2 Supported Attributes—Attribute Usage Specifications.....	20
2.1.3.2.3.1 SOP Specific Conformance to Basic Film Session SOP Class	21

2.1.3.2.3.2	SOP Specific Conformance to Basic Film Box SOP Class.....	23
2.1.3.2.3.3	SOP Specific Conformance to Basic Grayscale Image Box SOP Class	30
2.1.3.2.3.4	SOP Specific Conformance to Basic Color Image Box SOP Class	34
2.1.3.2.3.5	SOP Specific Conformance to Printer SOP Class	37
2.1.3.2.3.7	SOP Specific Conformance to Basic Annotation Box SOP Class	40
2.1.3.2.4	Presentation Context Acceptance Criterion	40
2.1.3.2.5	Transfer Syntax Selection Policies.....	40
3.	COMMUNICATION PROFILES.....	41
3.1	TCP/IP Stack	41
3.2	Physical Media Support	41
4.	EXTENSIONS/SPECIALIZATIONS/PRIVATIZATIONS.....	41
5.	CONFIGURATION	41
5.1	AE Title Presentation Address Mapping.....	41
5.2	DCF Print Server Configurable Parameters—Global	41
5.3	DCF Print Server Configurable Parameters—Per Association.....	42
5.4	Called AE Titles and Codonics Job Settings	44
5.5	Media Selection Algorithm	44
5.6	Feature Selection Using System Job Settings.....	47
5.7	Printable Area Configuration.....	47
6.	SUPPORT OF EXTENDED CHARACTER SETS.....	49
7.	CODES AND CONTROLLED TERMINOLOGY	49
8.	REFERENCES	49
8.1	DICOM PS 3.2-1999, Annex A (Normative) DICOM Conformance Statement Template.....	49
8.2	DICOM PS 3.2-1999, Annex B (Informative) DICOM Conformance Statement Sample	49
8.3	DICOM PS 3.4-1999, Annex H.3.4 Print Management Service Class Conformance Statement	49
8.4	DICOM Correction Proposals Incorporated	50

TABLE OF TABLES

TABLE 2.1.1 - SUPPORTED SOP CLASSES	15
TABLE 2.1.2 - MANDATORY SOP CLASSES IN GRAYSCALE PRINT META SOP CLASS	15
TABLE 2.1.3 - MANDATORY SOP CLASSES IN COLOR PRINT META SOP CLASS	15
TABLE 2.1.4 - SUPPORTED OPTIONAL PRINT SOP CLASSES	15
TABLE 2.1.3.1.2.1 - TRANSFER SYNTAXES	17
TABLE 2.1.3.1.2.2 - PRESENTATION CONTEXTS	17
TABLE 2.1.3.2.2.1 - TRANSFER SYNTAXES	18
TABLE 2.1.3.2.2.2 - SUPPORTED PRINT PRESENTATION CONTEXTS	19
TABLE 2.1.3.2.3.1.1 - BASIC FILM SESSION SOP CLASS—SUPPORTED DIMSE SERVICES.....	21
TABLE 2.1.3.2.3.1.2 - BASIC FILM SESSION SOP CLASS—SUPPORTED ATTRIBUTES.....	22
TABLE 2.1.3.2.3.1.3— BFS MEDIUM TYPE MAPPING FOR STANDARD VALUES	22
TABLE 2.1.3.2.3.2.1 - BASIC FILM BOX SOP CLASS—SUPPORTED DIMSE SERVICES	23
TABLE 2.1.3.2.3.2.2 - BASIC FILM BOX SOP CLASS—SUPPORTED ATTRIBUTES	23
TABLE 2.1.3.2.3.2.3 – BFB IMAGE DISPLAY FORMATS	25
TABLE 2.1.3.2.3.2.4 – BFB CONFIGURATION INFORMATION PARAMETERS.....	26
TABLE 2.1.3.2.3.2.5 – BFB ANNOTATION DISPLAY FORMAT ID PARAMETERS.....	27
TABLE 2.1.3.2.3.2.6 – ANNOTATION TEXT SIZES	29
TABLE 2.1.3.2.3.3.1 - GRAYSCALE IMAGE BOX SOP CLASS—SUPPORTED DIMSE SERVICES.....	30
TABLE 2.1.3.2.3.3.2 - BASIC GRAYSCALE IMAGE BOX SOP CLASS—SUPPORTED ATTRIBUTES.....	30
TABLE 2.1.3.2.3.3.4.1 - COLOR IMAGE BOX SOP CLASS—SUPPORTED DIMSE SERVICES	34
TABLE 2.1.3.2.3.3.4.2 - BASIC COLOR IMAGE BOX SOP CLASS—SUPPORTED ATTRIBUTES	34
TABLE 2.1.3.2.3.5.1 - PRINTER SOP CLASS—SUPPORTED DIMSE SERVICES.....	37
TABLE 2.1.3.2.3.5.2 - PRINTER SOP CLASS—SUPPORTED ATTRIBUTES.....	37
TABLE 2.1.3.2.3.5.3 - STATUS INFO SUMMARY FOR PRINTER STATUS	38
TABLE 2.1.3.2.3.7.1 - BASIC ANNOTATION BOX SOP CLASS—SUPPORTED DIMSE SERVICES	40
TABLE 2.1.3.2.3.7.2 - BASIC ANNOTATION BOX SOP CLASS—SUPPORTED ATTRIBUTES	40
TABLE 5.2.1 - GLOBAL CONFIGURATION PARAMETERS.....	41
TABLE 5.3.1 - PER ASSOCIATION CONFIGURATION PARAMETERS—SUPPORTED SOP CLASSES.....	42
TABLE 5.3.2 - PER ASSOCIATION CONFIGURATION PARAMETERS—SUPPORTED TRANSFER SYNTAXES	42
TABLE 5.3.3 - PER ASSOCIATION CONFIGURATION PARAMETERS—DCF COMPONENTS.....	43
TABLE 5.4.1 – JOB SETTINGS PARAMETER TO DICOM ATTRIBUTE MAPPING.....	44
TABLE 5.6.1 – SYSTEM JOB SETTINGS NAMES (FOR CALLED AE TITLES)	47
TABLE 5.7.1 – PRINTABLE AREA PER MEDIA TYPE AND SIZE	48

DCF PRINT SERVER—DICOM 3.0 CONFORMANCE STATEMENT

0. INTRODUCTION

The Codonics Horizon imager supports hardcopy medical output via the DICOM 3.0 protocol, using the DICOM Connectivity Framework (DCF) Print Server software. The DCF Print Server is a modular software component system used for storage, processing, printing or otherwise communicating medical image data, in this case, primarily for the purpose of printing on film-based imagers.

0.1 Scope and Intended Audience

Conformance of the DCF Print Server to the DICOM 3.0 Standard is discussed in this document. It specifies the Service Classes, Information Objects, and Communication Protocols supported by the implementation. This statement is intended to aid the system integrator in connecting the Codonics imager to other components which make use of the DICOM 3.0 Standard for inter-network communication. The reader of this document should be familiar with the DICOM 3.0 Standard, the components being interconnected, and other references listed in Section 0.3 and Section 8 of this document.

0.2 Laurel Bridge Software DCF Print Server (Provider)

The Laurel Bridge Software DCF Print Server is a software function of the Codonics imager product. It typically interfaces a modality or other device on a TCP/IP network with the Codonics imager via the DCF Print Server (Provider) software, allowing the imager to accept medical images and related data from the modality or other device—a DICOM Print Client (User)—for printing. This conformance statement represents the functionality of Codonics' DCF-based system.

Because the DCF is highly configurable, the OEM conformance claim for a particular realization of the DCF should not be construed to completely represent the functions or limitations of the complete DCF software package. *Once customized, the OEM conformance claim only applies to the specific OEM implementation described within, in this case, that of the Codonics Horizon imager products.*

For further information on the complete DCF package, one should contact Laurel Bridge Software, Inc., 409 White Clay Center Drive, Newark, DE 19711, Telephone: 302-453-0222, <http://www.laurelbridge.com>. Under the terms of the DCF Software License Agreement, this notice is required to be present in all DICOM conformance claims covering the DCF software functionality.

0.3 References

ACR-NEMA DICOM 3.0 Standard, Parts 1 through 14 (PS 3.1–PS 3.14); ©1999.

See Section 8 of this document for additional reference information.

0.4 Important Considerations for the Reader

There is no concept in DICOM of a singular “monolithic” compliance with the Standard. The DICOM Conformance Statement, is a document whose organization and content are mandated by the Standard (PS 3.2-1999, Annex A & B) and which allows users to communicate how they comply with the Standard in their implementations. The presence of specific DICOM functionality in a Conformance Statement is not sufficient to guarantee inter-operability between components. When evaluating network inter-operability between the DCF and some other DICOM component, the following should be considered:

- The DCF Conformance Claim is an appropriate starting point for ascertaining whether the DCF software can communicate with a particular component on a protocol level.

- The only way to know for certain whether the DCF can inter-operate with other DICOM components is to perform a connectivity test. This test must be completed before a field installation can occur. The OEM normally does such testing in cooperation with the suppliers of other DICOM components.
- The DCF Conformance Claim represents a best effort at documenting the DICOM functionality of commercial versions of the Codonics imager, but is not a functional specification of any DCF component or product. Laurel Bridge Software reserves the right to make changes at any time to the functionality of DCF components described herein. Both Laurel Bridge Software and Codonics are committed to following the evolution of the DICOM Standard with either modifications or additions to the Codonics imager's DICOM functionality provided by the DCF.

Note: The section numbering in this document is fixed and conforms to the numbering scheme prescribed in DICOM PS 3.2-1999, Annex A and Annex B.

0.5 Revision History

Revision	Date	Author	Description of Changes
0.5	20 Jan 2001	Rich Edwards	Adapted from the DCF Conformance Statement Template as first pre-release version.
1.0	28 Jun 2001	Rich Edwards	Cleaned up for first release of document
1.4.0-rc2	3 Jan 2002	Rich Edwards	Modified Annotation Position ID numbering scheme to simplify standard use of them; added Printable Area table;
1.4.0-rc5	28 January, 2002	Rich Edwards	Added list of pre-configured JobSettings for use in media selection; Corrected Dmin/Dmax ranges, based on current system specifications; Formatted document for release with v1.4.0 Horizon;
1.4.0	5 February, 2002	Rich Edwards	Added specification of dot size to Printable Area section; updated document version for release;
1.5.0	9 May, 2002	Rich Edwards	Updated printable area info for A & A4 paper sizes to reflect latest software release; added values 1..8 to Config Info 'LUT' parameter for specifying custom LUTs;
1.5.0a	17 May, 2002	Rich Edwards	Added a note regarding printing images that are of the maximum printable area size, based on a bug discovered after the 1.5.0 software had been frozen.
1.6.0	21 Oct, 2002	Rich Edwards	Clarified description of media selection logic (#1218, #1253); Corrected custom Medium Type tags to match implementation (#1208); Added description of Magnification Type NONE (#1224); removed note added in v1.5.0a, since bug is now fixed;
1.7.0-rc1	22 April, 2003	Rich Edwards	Corrected pixel size spec (#1555); Added printable area definition for 14x17 paper (#1581); Added 11x14 media references for JobSettings and printable area definitions (#1791); Updated printable area widths for CV paper (#1601); Added description of DICOM Lite key (#1884); Corrected list of supported values for the 'Requested Decimate/Crop Behavior' tag;
1.7.0	10 June, 2003	Rich Edwards	Updated for release (version and part number changes only)

Revision	Date	Author	Description of Changes
1.7.2	1 March 2004	Rich Edwards	Corrected MCM value range (#2060); Added distinction between DICOM Lite 1 and 2 keys (#2163); Corrected and clarified description of Requested Decimate/Crop Behavior tag values (#2242); Added information for use in calculating image cell pixel matrices on multi-format prints (#2258); Corrected Codonics-specific medium type tag values for film (#2286);

0.6 Symbols, Abbreviations and Definitions

Abstract Syntax: A DICOM term which is identical to a DICOM SOP Class; it identifies a set of SOPs which, when taken together, represent a logical grouping. An Abstract Syntax identifies one SOP Class or Meta SOP Class.

ACR: American College of Radiology.

Annotation Box: A DICOM name for annotation text printed on the film or other media.

ANSI: American National Standards Institute.

Application Entity (AE): A DICOM term for defining a particular user at an IP address.

Association: A DICOM term for a communication context which is used by two Application Entities that communicate to one another.

Association Negotiation: The software handshaking that occurs between two DICOM Application Entities to set up an Association.

Attribute: Each DICOM information object has its own set of characteristics or attributes. Each attribute has a name and may have a value (see IOD), depending on its category.

Big Endian: A term for encoding data where the most-significant byte appears first and remaining bytes follow in descending order of significance; sometimes known as "Motorola" format (see Little Endian). (The term is used because of an analogy with the story Gulliver's Travels, in which Jonathan Swift imagined a never-ending fight between the kingdoms of the Big-Endians and the Little-Endians, whose only difference is in where they crack open a hard-boiled egg.)

Calling (Requesting) AE Title: The name used by the receiver in a DICOM Association to indicate which Application Entity it received the data from. It is the AE Title of the AE that is initiating the transfer.

Called (Receiving) AE Title: The name used by the sender in a DICOM Association to indicate which Application Entity it wants to transmit its data to. It is the AE Title of the AE that is receiving the transfer.

Command Element: An encoding of a parameter of a command which conveys this parameter's value.

Command Stream: The result of encoding a set of DICOM Command Elements using the DICOM encoding scheme.

Composite Information Object: A DICOM information object (see IOD) whose attributes contain multiple real world objects.

Conformance: Conformance in the DICOM sense means to be in compliance with the parts of the DICOM Standard.

Conformance Statement: A document whose organization and content are mandated by the DICOM Standard, which allows users to communicate how they have chosen to comply with the Standard in their implementations (see Section 8).

Combined Print Image: a pixel matrix created by superimposing an image and an overlay, the size of which is defined by the smallest rectangle enclosing the superimposed image and overlay.

Data Dictionary: A registry of DICOM Data Elements which assigns a unique tag, a name, value characteristics, and semantics to each Data Element (see the DICOM Data Element Dictionary in DICOM PS 3.6-1999).

Data Element: A unit of information as defined by a single entry in the data dictionary. An encoded Information Object Definition (IOD) Attribute that is composed of, at a minimum, three fields: a

Data Element Tag, a Value Length, and a Value Field. For some specific Transfer Syntaxes, a Data Element also contains a VR Field where the Value Representation of that Data Element is specified explicitly.

Data Set: Exchanged information consisting of a structured set of Attribute values directly or indirectly related to Information Objects. The value of each Attribute in a Data Set is expressed as a Data Element.

Data Stream: The result of encoding a Data Set using the DICOM encoding scheme (Data Element Numbers and representations as specified by the Data Dictionary).

DICOM: Digital Imaging and Communications in Medicine.

DICOM File: A DICOM File is a file with a content formatted according to the requirements of DICOM PS 3.10-1999.

DICOM File Format: The DICOM File Format provides a means to encapsulate in a File the Data Set representing a SOP Instance related to a DICOM Information Object.

DIMSE: DICOM Message Service Element. This represents an abstraction of a common set of things that a user would do to a data element, would likely use over and over, and would appear in various different contexts.

DIMSE-C: DICOM Message Service Element—Composite.

DIMSE-C services: A subset of the DIMSE services which supports operations on Composite SOP Instances related to composite Information Object Definitions with peer DIMSE-service-users.

DIMSE-N: DICOM Message Service Element—Normalized.

DIMSE-N services: A subset of the DIMSE services which supports operations and notifications on Normalized SOP Instances related to Normalized Information Object Definitions with peer DIMSE-service-users.

Film Box: A Normalized Information Object which is the DICOM name for the equivalent of a sheet of physical film.

Film Session: A Normalized Information Object which is the DICOM name for the equivalent of a typical “study” or “series”.

Image Box: A Normalized Information Object which is the DICOM name for the equivalent of a typical “frame” or “image”.

Imager: A term synonymous with printer, meaning a hardcopy output device.

Information Object Class or

Information Object [Definition] (IOD): A software representation of a real object (e.g., CT Image, Study, etc.). An Information Object is generally a list of characteristics (Attributes) which completely describe the object as far as the software is concerned. The formal description of an Information Object generally includes a description of its purpose and the Attributes it possesses.

Information Object Instance or

Instance (of an IOD): A software representation of a specific occurrence of a real object or entity, including values for the Attributes of the Information Object Class to which the entity belongs..

Little Endian: A term for encoding data where the least-significant byte appears first and remaining bytes follow in ascending order of significance; sometimes known as “Intel” format (see Big Endian).

LUT: Lookup Table.

Message: A data unit of the Message Exchange Protocol exchanged between two cooperating DICOM Application Entities. A Message is composed of a Command Stream followed by an optional Data Stream.

Meta SOP Class: A collection or group of related SOP Classes identified by a single Abstract Syntax UID, which, when taken together, represent a logical grouping and which are used together to provide a high-level functionality, e.g., for the purpose of negotiating the use of the set with a single item.

Module: A logical group of the valid attributes of DICOM information objects.

NEMA: National Electrical Manufacturers Association.

Normalized Information Object: A DICOM Information Object (see IOD) whose attributes contain a single real world object. *Note: the differentiation of normalized versus composite information object definitions is not strongly enforced in DICOM 3.0.*

Presentation Context: A Presentation Context consists of an Abstract Syntax plus a list of acceptable Transfer Syntaxes. The Presentation Context defines both what data will be sent (Abstract Syntax) and how the data are encoded to be sent (Transfer Syntax).

Print Job SOP Class: A DICOM representation of a Print Job which consists of a set of IODs which describe a Print Job and a set of services which can be performed on those IODs.

Print Management Service Class or

Print Service Class (PSC): A DICOM term for a logical grouping of Service Classes which all involve printing, also referred to as Print Management Service Class (an example of a Meta SOP Class).

Printer SOP Class: A DICOM representation of a Printer which consists of a set of IODs which describe a Printer and a set of services which can be performed on those IODs.

Protocol Data Unit (PDU): A data object which is exchanged by software protocol devices (entities, machines) within a given layer of the protocol stack.

Real-World Activity: Something which exists in the real world and which pertains to specific area of information processing within the area of interest of the DICOM Standard. A Real-World Activity may be represented by one or more SOP Classes.

Real-World Object: Something which exists in the real world and upon which operations may be performed which are within the area of interest of the DICOM Standard. A Real-World Object may be represented through a SOP Instance.

Service Class: A group of operations that a user might want to perform on particular Information Objects. Formally, a structured description of a service which is supported by cooperating DICOM Application Entities using specific DICOM Commands acting on a specific class of Information Object.

Service Class Provider (SCP, Provider, Server): A device which provides the services of a DICOM Service Class or Classes which are utilized by another device (SCU) and which performs operations and invokes notifications on a specific Association.

Service Class User (SCU, User, Client): A device which utilizes the DICOM Service Class or Classes which are provided by another device (SCP) and which invokes operations and performs notifications on a specific Association.

Service-Object Pair (SOP): The combination of a DICOM Information Object and the Service Class which operates upon that object.

SOP Class: A DICOM term which is identical to an Abstract Syntax; it identifies a set of SOPs which, when taken together, represent a logical grouping (see Meta SOP Class).

Storage Service Class (SSC): A DICOM term for a logical grouping of Service Classes which all involve storage of images.

Tag: A unique identifier for an element of information composed of an ordered pair of numbers (a Group Number followed by an Element Number), which is used to identify Attributes and corresponding Data Elements.

TCP/IP: Transmission Control Protocol / Internet Protocol.

Transfer Syntax: A part of the DICOM Presentation Context which specifies a set of encoding rules that allow Application Entities to unambiguously negotiate the encoding techniques (e.g., Data Element structure, byte ordering, compression) they are able to support, thereby allowing these Application Entities to communicate.

Unique Identifier (UID): A globally unique identifier (based on the structure defined by ISO 8824 for OSI Object Identifiers) which is assigned to every DICOM information object as specified by the DICOM Standard (see Section 2.1.1.4) and which guarantees global unique identification for objects across multiple countries, sites, vendors and equipment.

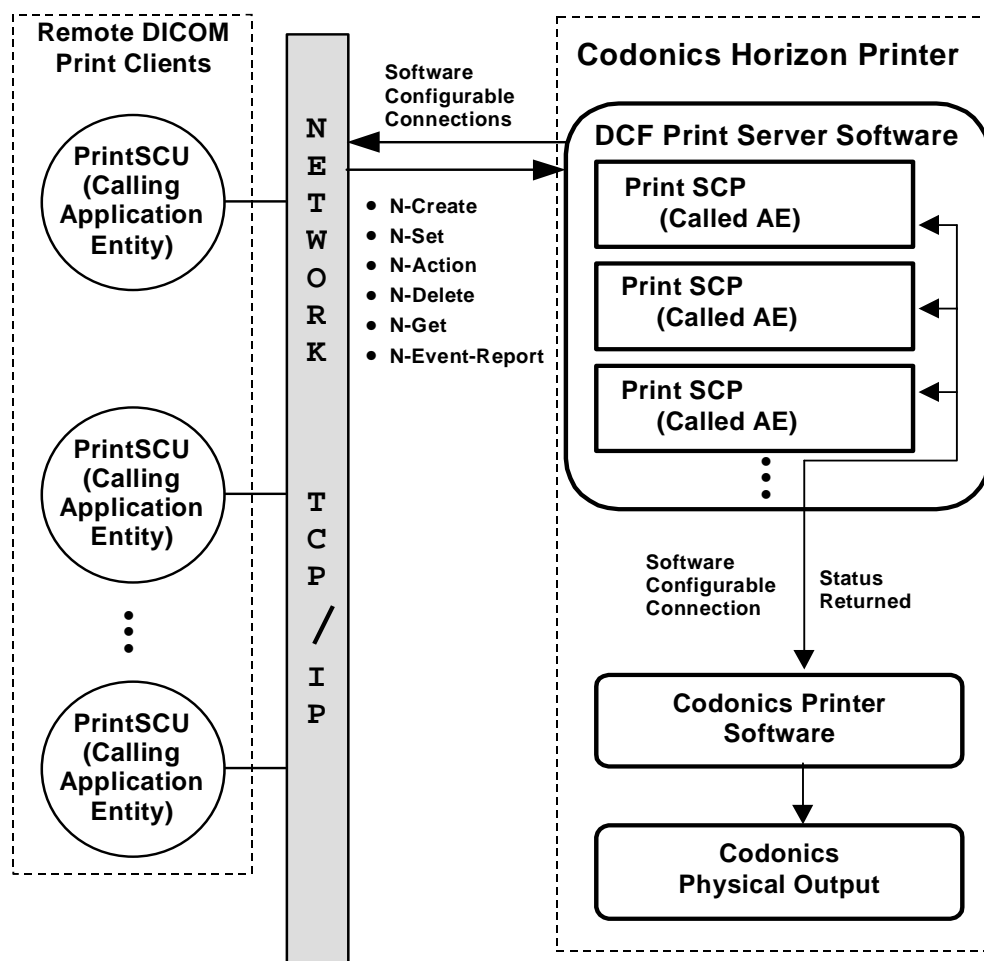
Value Representation (VR): A VR is the defined format of a particular data element.

1. IMPLEMENTATION MODELS

The DCF Print Server is implemented as independent, functional, and configurable components. The DCF Print Server supports multiple Application Entities. Multiple DICOM Print Clients may concurrently initiate and/or maintain associations to the DCF Print Server. The number of associations to the DCF Print Server that can be simultaneously active is configurable, up to a maximum (see Section 2.1.1.2). After the maximum number of associations are established, the DCF Print Server will reject any further client association requests that are received until an association is released.

1.1 Application Data Flow Diagram—DCF Print Server

The implementation model of the DCF Print Server is depicted in the following figure:



1.2 Functional Definitions of Application Entities (AEs)

The DCF Print Server creates a PrintSCP (Application Entity or AE) to handle each requested association (unless the configurable maximum associations is exceeded). Each PrintSCP can be configured independently, based on a flexible policy that takes both Called and Calling AE Titles into account.

Once the configuration for the PrintSCP is selected and the PrintSCP is created, the PrintSCP continues with the association negotiation, independent of the DCF Print Server. The PrintSCP's configuration specifies which SOP classes are to be supported, which transfer syntaxes are to be supported, as well as many other parameters, such as whether the client is to receive asynchronous notification (N-EVENT-REPORT) messages or what type of validation is to be performed on incoming messages.

If the PrintSCP accepts the association, then it will service requests from the client SCU until the association is ended. As the PrintSCPs receive print requests from their corresponding SCUs they submit print jobs to a single queue which is serviced by the Codonics imager software. Multiple SCUs may submit requests concurrently, however, the Codonics imager device processes jobs in a FIFO manner, taking available media and print priority into account. Once the SCU has submitted a print job, it can close the association, or keep the association open for subsequent print requests and/or queries on the Printer object.

Changes in status to the Codonics imager itself are communicated to every active PrintSCP and to each of their associated SCUs, either asynchronously (N-EVENT-REPORT) or synchronously (N-GET), as configured.

The association ends when either the SCU releases the association or there is an unrecoverable error. Optionally, if the SCU does not send a request for a period in excess of the PrintSCP configurable timeout, then the PrintSCP will terminate the association.

1.3 Sequencing of Real World Activities—DCF Print Server

The sequence of events for a typical print transaction are listed below:

Print Client (modality, workstation, or other device) requests association with Print Server (printer).

Film session, Film, Image, and/or Annotation information is sent to Print Server.

Print Client requests film(s) to be printed.

Print Server submits print job information to Codonics imager software (internal, software interface).

Films are printed on the physical device, and status is communicated back to the Print Client.

Print Client terminates the association.

Print Server releases any resources allocated during association.

2. AE SPECIFICATIONS

The DCF Print Server supports multiple Application Entities or AEs. Each AE in this case is an instance of PrintSCP using a particular configuration.

2.1 DCF PrintSCP AE Specification

The DCF Print Server provides standard conformance to the following DICOM 3.0 SOP Classes as an SCP. The SOP classes that are supported by a particular installation are configurable, as described in Section 5. (For example, for a given AE Title, a configuration might be selected that does not support the color printing SOP classes.)

Table 2.1.1 - Supported SOP Classes

SOP Class Name	UID
Verification SOP	1.2.840.10008.1.1
Basic Grayscale Print Management Meta SOP	1.2.840.10008.5.1.1. 9
Basic Color Print Management Meta SOP	1.2.840.10008.5.1.1.18

The following tables contain lists of the mandatory SOP Classes implied by the Print Meta SOP Classes.

Table 2.1.2 - Mandatory SOP Classes in Grayscale Print Meta SOP Class

SOP Class Name	UID
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4
Basic Printer SOP Class	1.2.840.10008.5.1.1.16

Table 2.1.3 - Mandatory SOP Classes in Color Print Meta SOP Class

SOP Class Name	UID
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Color Image Box SOP Class	1.2.840.10008.5.1.1.4.1
Basic Printer SOP Class	1.2.840.10008.5.1.1.16

The DCF Print Server, as configured for the Codonics Horizon imager, supports the following optional SOP classes:

Table 2.1.4 - Supported Optional Print SOP Classes

SOP Class Name	UID
Basic Annotation Box SOP Class	1.2.840.10008.5.1.1.15

2.1.1 Association Establishment Policies

2.1.1.1 General

The DCF Print Server (SCP) listens to the transport (TCP) port which has been configured and accepts associations from DICOM Print Clients (SCUs). If the maximum number of allowed concurrent

associations are already in use then the association is refused and the A-ASSOCIATE-RJ PDU will specify result = rejected-transient, reason = temporary-congestion. An accepted association remains connected until the client disconnects by sending either an A-RELEASE-RQ or A-ABORT PDU, or there is an unrecoverable error detected by the Print Server. If the association remains idle for a configurable period of time, the association will be broken by the DCF Print Server. In the event of an idle timeout, the Print Server will close the transport connection, but will not send any notification (e.g., P-ABORT PDU).

The maximum PDU size which can be received by the DCF Print Server is configurable, with a default value of 16,384 (16K) bytes (see Table 5.3.3).

2.1.1.2 Number of Associations

The DCF Print Server can support multiple associations. The number of independent concurrent associations is determined by the type of DICOM Feature Key installed on the Horizon Imager (see Table 5.2.1). A standard DICOM Feature Key allows up to 12 concurrent associations, a DICOM Lite 2 Feature Key allows 2 concurrent associations, and a DICOM Lite 1 Feature Key allows only a single association at a time. If the maximum number of associations are already open, then an SCU attempting to establish an additional association will be rejected, as described above in Section 2.1.1.1.

2.1.1.3 Asynchronous Nature

With the exception of sending N-EVENT-REPORT DIMSE messages to a DICOM Print Client, the DCF Print Server does not support asynchronous operations. If between the receipt of a request DIMSE message from an SCU and the sending of the response DIMSE message by the Print Server, an event occurs which generates an N-EVENT-REPORT message, then the N-EVENT-REPORT message is queued and sent after the response to the client's original request. The generation of N-EVENT-REPORT messages by the DCF Print Server is a configurable option, which is off by default (see Table 5.3.3).

2.1.1.4 Implementation Identifying Information

The implementation UID for the DCF Print Server is returned in the A-ASSOCIATE-AC PDU. The value for that UID will be "1.2.840.114089.1.1.0.X.Y.Z", where X.Y.Z is the version number (for example, 1.5.0). The implementation version name is also returned and has the form "DCF X.Y.Zz" where X.Y.Zz is the full version identifier (for example, 1.4.0b for beta version 1.4.0).

All internally generated UID's will be prefixed 1.2.840.xxxxxx, where the identification code "xxxxxx"="114089.1.1" is Laurel Bridge Software's ANSI registered organization identification code for the DCF software. See DICOM PS 3.5-1999, Section 9 for further information.

2.1.1.5 Called Titles

The DCF PrintServer operates in a "promiscuous" mode, accepting any valid called title (as defined by the AE VR type). If the called title matches the name of a Codonics Job Settings parameter set, then those parameters are used to determine the manner in which prints within that association are handled. See Section 5.4 for more details on this aspect of system configuration.

Otherwise, if the called title matches one of the special values in the following table, then the behavior of the PrintServer is altered as described:

Table 2.1.1.5 Special Called AE Titles

Called Title	Behavior
specialSlide	Forces an Image Display Format of SLIDE, resulting in 35mm slide output (Codonics logical device 135). This behavior must further be enabled by specifying an Image Display Format (2010,0010) of STANDARD\4,5 or STANDARD\4,6.
specialBracket DoBracketing	Forces an Image Display Format of CUSTOM\9, resulting in a bracketing print for each image printed as part of the association (Codonics logical device 9).

If no special behavior is required through the use of the called title, then it is customary to use the title "PRINT_SCP", although this is arbitrary, and holds no special meaning to the PrintServer.

2.1.2 Association Initiation by Real-World Activity

The DCF Print Server does not initiate associations.

2.1.3 Association Acceptance Policy

2.1.3.1 Real-World Activity—Verification

2.1.3.1.1 Associated Real World Activity—Verification

The Verification Service Class is a feature used for network diagnostic purposes to verify application level communication between peer DICOM AEs. The DCF Print Server responds to Verification requests to provide an SCU with the ability to determine if the DCF Print Server is receiving DICOM requests. This verification is accomplished on an established Association using the C-ECHO DIMSE-C service.

An example of a typical real world activity to initiate a Verification association is a service person invoking a DICOM-Echo client on a remote host, specifying the transport address and AE Title of an instance of the DCF Print Server as the target.

2.1.3.1.2 Presentation Context Table—Verification

Table 2.1.3.1.2.1 - Transfer Syntaxes

Transfer Syntax	UID
DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2

Table 2.1.3.1.2.2 - Presentation Contexts

Abstract Syntax		Transfer Syntax	Role	Extended Negotiation
SOP Class	SOP Class UID			
Verification	1.2.840.10008.1.1	See Table 2.1.3.1.2.1	SCP	None

2.1.3.1.3 SOP Specific Conformance—Verification

2.1.3.1.3.1 SOP Specific Conformance to Verification SOP Class

The DCF Print Server provides standard conformance to the DICOM Verification Service Class.

The Verification SOP Class consists of the C-ECHO DIMSE-C service. No associated Information Object Definition is defined. No Specialized SOP Classes and/or Meta SOP Classes are defined for the Verification SOP Class.

2.1.3.1.4 Presentation Context Acceptance Criterion

The Verification SOP class can be requested on its own, or in combination with other supported SOP classes.

2.1.3.1.5 Transfer Syntax Selection Policies

The transfer syntax for each DICOM presentation context is negotiated independently. The DCF Print Server can be configured to support any or all of the transfer syntaxes listed in Table 2.1.3.1.2.1. The order of preference for selecting a transfer syntax is also configurable. This configuration may vary between associations; however, for a given association, it is shared between all SOP classes or presentation contexts.

2.1.3.2 Real-World Activity—Printing

2.1.3.2.1 Associated Real World Activity—Printing

After an association is established, the DCF Print Server will accept print jobs from the DICOM Print Client. The following steps are representative of a typical print job:

- The client (SCU) may request the status of the printer by sending N-GET (Printer SOP instance) and the server returns the current instance of the Printer SOP.
- The client requests that the server (SCP) N-CREATE a Film Session SOP instance. The server returns the Film Session SOP instance UID.
- For each film to be printed as part of the Film Session, the client requests that the server N-CREATE a Film Box SOP instance containing the appropriate number of Image Box SOP instances and, optionally, Annotation Box SOP instances. The server returns the appropriate SOP instance UIDs to the client.
- For each image to be printed as part of a Film Box, the client requests the server to N-SET (update) the appropriate Image Box with image information. This causes the transfer of the image and pixel data from the client to the server. For each Annotation Box to be printed as part of a Film Box, the client requests the server to N-SET (update) the appropriate Annotation Box with text information.
- Once all the images have been transferred, the client requests the server to N-ACTION (print) the Film Box. This causes the film to be printed in an uncollated fashion. The DCF Print Server may also be configured to support an N-ACTION (print) on the Film Session (printing of collated sheets).
- The DCF Print Server will send the instance of the Printer SOP in response to client requests using the N-GET DIMSE as long as the association is active. The DCF Print Server will send N-EVENT-REPORTs from these objects to the DICOM Print Client if configured to do so.

2.1.3.2.2 Presentation Context Table—Printing

The DCF Print Server will accept association establishment, using one of the presentation contexts listed below:

Table 2.1.3.2.2.1 - Transfer Syntaxes

Transfer Syntax	UID
DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2

Table 2.1.3.2.2.2 - Supported Print Presentation Contexts

Abstract Syntax		Transfer Syntax	Role	Extended Negotiation
Name	UID			
Basic Grayscale Print Management MetaSOP	1.2.840.10008.5.1.9	Table 2.1.3.2.2.1	SCP	None
Basic Color Print Management MetaSOP	1.2.840.10008.5.1.18	Table 2.1.3.2.2.1	SCP	None
Basic Film Session SOP Class	1.2.840.10008.5.1.1	Table 2.1.3.2.2.1	SCP*	None
Basic Film Box SOP Class	1.2.840.10008.5.1.2	Table 2.1.3.2.2.1	SCP*	None
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.4	Table 2.1.3.2.2.1	SCP*	None
Basic Color Image Box SOP Class	1.2.840.10008.5.1.4.1	Table 2.1.3.2.2.1	SCP*	None
Printer SOP Class	1.2.840.10008.5.1.16	Table 2.1.3.2.2.1	SCP [†]	None
Basic Annotation Box SOP Class	1.2.840.10008.5.1.15	Table 2.1.3.2.2.1	SCP [‡]	None

* The Basic Film Session, Basic Film Box, Basic Grayscale Image Box, and Basic Color Image Box SOP Classes cannot be negotiated explicitly, but must be implicitly negotiated via the appropriate Meta-SOP-Class (see Section 2.1).

[†] It is possible to negotiate only the Printer SOP class. Printer status can be queried or monitored in this mode.

[‡] These SOP classes can be negotiated explicitly, but are not useful unless one of the Print Meta-SOP-Classes is also negotiated.

2.1.3.2.3 SOP Specific Conformance—Printing

The DCF Print Server incorporates a configurable validation service. It utilizes reasonable default values for any attribute which is not valid for a given destination and will, in general, always try to complete a print job rather than failing it. Section 5 lists attributes which are imager dependent and configurable.

For every operation requested on a SOP class of the Print Management Service Class, a status code is returned. They are grouped into success, warning or failure categories (see DICOM PS 3.7-1999):

Success - Indicates that the SCP performed the requested operation as requested.

Warning - Indicates that the SCP has received the request and will process it. However, immediate processing of the request, or processing in the way specified by the SCU, may not be possible. The SCP expects to be able to complete the request without further action by the SCU across the DICOM interface. The exact behavior of the SCP is described within this Conformance Statement.

Failure - Indicates that the SCP is unable to perform the request. The request will not be processed unless it is repeated successfully by the SCU at a later time. The exact behavior of the SCP is described in this Conformance Statement.

Certain errors may be reported for any DIMSE message sent to any SOP Class, in some cases, failures or warnings will only be generated if the Print Server has message validation enabled. Status codes that are unique to a particular DIMSE message for particular SOP classes are described for each SOP Class in its sub-section entitled DIMSE Specific Behavior. Statuses include:

<u>Status</u>	<u>Code</u>	<u>Description</u>
INVALID_ATTRIBUTE	0106H	Failure status—Indicates an attribute has been received that is not valid for this message. Processing of the message will fail.
UNRECOGNIZED_ATTRIBUTE	0107H	Warning status—Indicates an attribute has been

<u>Status</u>	<u>Code</u>	<u>Description</u>
		received that is not valid for this message. The attribute will be discarded and processing of the message will continue
DUPLICATE_INSTANCE	0111H	Failure status—The SCU has specified an instance UID for an object that already exists (N-CREATE only). Processing of the message will fail
NO_SUCH_INSTANCE	0112H	Failure status—No object with this instance UID exists. Processing of the message will fail
ATTRIBUTE_OUT_OF_RANGE	0116H	Warning status—An attribute has been received whose value is not within the legal set of possible values (see tables below). If a default has been configured, it will be substituted for the offending value. The validation component can be configured to treat a missing attribute in this manner (i.e. warn and apply default)
INVALID_OBJECT_INSTANCE	0117H	Failure status—The SOP instance UID field in the message is invalid. Processing of the message will fail
NO_SUCH_CLASS	0118H	Failure status—The SOP class UID field in the message is invalid. Processing of the message will fail
MISSING_ATTRIBUTE	0120H	Failure status—A required attribute was not included in the message data set. Processing of the message will fail.
UNRECOGNIZED_OP	0211H	Failure status—The received DIMSE message is not valid for the specified presentation context (see SOP class specific interpretations for this error code below). Processing of the message will fail

2.1.3.2.3.1 Supported Attributes—Possible Values Specifications

The possible values for the supported attributes of the Print Management Service Class are included in the following section, which also describes their usage, as defined by DICOM PS 3.3, Annex C.13.

2.1.3.2.3.2 Supported Attributes—Attribute Usage Specifications

The meaning and behavior of the usage specification for supported attributes of the Print Management Service Class are indicated in the tables below as defined by DICOM PS 3.4-1999, Annex H.2.4. The usage is specified as a pair of letters: the first indicating the SCU usage, the second indicating the SCP usage:

The meaning and behavior of the usage specification for Attributes for the Print Management Service Class are:

- M/M SCU Mandatory / SCP Mandatory - The SCU must provide a value for the Attribute. If the SCU does not supply a value, the PrintSCP returns a MISSING_ATTRIBUTE Failure status. The PrintSCP supports at least one value of the Attribute. If the PrintSCP does not support the value specified by the SCU, it returns an INVALID_ATTRIBUTE Failure status.
- /M SCU Undefined / SCP Mandatory - The SCU's usage of the Attribute is undefined. The PrintSCP supports at least one value of the Attribute.
- U/M SCU Optional / SCP Mandatory - The SCU may provide a value for the Attribute. If the PrintSCP does not support the value specified by the SCU, it returns either an INVALID_ATTRIBUTE Failure status or an ATTRIBUTE_OUT_OF_RANGE Warning status. For Warning status, the PrintSCP applies the default value as defined in the tables below.

U/U SCU Optional / SCP Optional - The SCU may provide a value for the Attribute. If the PrintSCP does not support the value specified by the SCU, but does support the Attribute, it returns either an INVALID_ATTRIBUTE Failure status or an ATTRIBUTE_OUT_OF_RANGE Warning status. For Warning status, the PrintSCP applies the default value as defined in the tables below.

If the PrintSCP does not support the Attribute specified, it returns either an INVALID_ATTRIBUTE Failure status or an UNRECOGNIZED_ATTRIBUTE Warning status along with the behavior defined in the tables below.

If the usage type designation is modified by a "C" (Conditional), e.g., "MC/M", the meaning is modified to include the requirement that the attribute must be supported if the specified condition is met.

Default values are generally defined for SCU optional attributes, and for certain mandatory attributes that are known to be unsupported in certain SCU implementations.

2.1.3.2.3.1 SOP Specific Conformance to Basic Film Session SOP Class

2.1.3.2.3.1.1 Supported DIMSE services—Basic Film Session SOP Class

Table 2.1.3.2.3.1.1 - Basic Film Session SOP Class—Supported DIMSE Services

Name	Description
N_CREATE	Creates the film session
N_SET	Updates the film session
N_DELETE	Deletes the film session
N_ACTION	Prints all film boxes, in the film session, with collated copies

2.1.3.2.3.1.2 DIMSE Specific Behavior—Basic Film Session SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below.

- N-CREATE** The SCU invokes N-CREATE to create an instance of the Film Session. The following error or warning statuses may be returned:

PROCESSING_FAILURE	0110H	A film session already exists. It must be deleted (N-DELETE) before another can be created
--------------------	-------	--
- N-SET** The SCU invokes N-SET to update an existing instance of the Film Session.
- N-ACTION** The SCU invokes N-ACTION to print all Film Boxes contained by the Film Session. The following error or warning statuses may be returned

EMPTY_SESSION	C600H	There are no Film Boxes contained by this film session.
UNRECOGNIZED_OP	0211H	Film Session printing has not been enabled for this association.
- N-DELETE** The SCU invokes N-DELETE to request the SCP to delete the current film session and the entire contained object hierarchy. Any objects still needed for pending print jobs will remain accessible to the server, until all print jobs that reference them are completed.

2.1.3.2.3.1.3 Supported Attributes—Basic Film Session SOP Class

The following attributes are supported for the Film Session SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.1.2 - Basic Film Session SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
NUMBER OF COPIES (2000,0010)	1..99	U/M 1	Out of range values are coerced to the nearest endpoint of the valid range.
PRINT PRIORITY (2000,0020)	HIGH MED LOW	U/M MED	Specifies the priority of the print job.
MEDIUM TYPE (2000,0030)	PAPER BLUE FILM CLEAR FILM DVPAPER DVFILMBLU DVFILMCLR CVPAPER CVFILM	U/M See Section 5.5	Type of medium on which the print job will be printed. Codonics extensions to the standard are indicated in <i>italics</i> . DV (DirectVista) is the Codonics product name for grayscale media; CV (ChromaVista) is the product name for color media. See Table 2.1.3.2.3.1.3 for a description of how standard medium types are mapped.
FILM DESTINATION (2000,0040)	MAGAZINE PROCESSOR BIN_1 BIN_2 BIN_3	U/M BIN_i	BIN_i = the exposed film is deposited in the receiver tray where "i" represents the tray number. By default, the tray number is equivalent to the slot number containing the media cassette from which the film was picked. The MAGAZINE and PROCESSOR values are ignored, in favor of this default scheme.
FILM SESSION LABEL (2000,0050)		U/U None	Human readable label that identifies the film session. This attribute is accepted, but not used.
MEMORY ALLOCATION (2000,0060)		U/U 0	Amount of memory allocated for the film session (in KB). This attribute is accepted, but not used.
E_OWNER_ID (2100,0160)		U/U PrintSCU	Identification of the owner of the film session. This attribute is accepted, but not used.
REFERENCED FILM BOX SEQUENCE (2000, 0500)		N/A	A Sequence which provides references to a set of Film Box SOP Class/Instance pairs. Zero or more Items may be included in this Sequence. This element exists internally to the SCP and cannot be accessed by any SCU.

2.1.3.2.3.1.3.1 Medium Type – Supported Values

The Medium Type string (2000,0030) specifies the medium on which the sheets in the Film Session are to be printed. The Codonics imager is a multi-media imager, and supports several types of grayscale and color media (see imager User's Manual for more information). Therefore, additional values have been added for this field, as a means of more succinctly specifying a medium type. However, the standard values, combined with the type of Print Management Meta SOP Class negotiated for the Film Session, also allow for more specific medium type selection by PrintSCP, as shown in the following table:

Table 2.1.3.2.3.1.3– BFS Medium Type Mapping for Standard Values

Medium Type (standard values)	Grayscale PMM SOP negotiated	Color PMM SOP negotiated
PAPER	DV Paper	CV Paper
BLUE FILM	DV Blue Film	CV Film (clear)
CLEAR FILM	DV Clear Film	CV Film (clear)

It is also possible to override the medium type setting using the Codonics Job Settings mechanism, as described in Section 5.5 Media Selection Algorithm.

2.1.3.2.3.2 SOP Specific Conformance to Basic Film Box SOP Class

2.1.3.2.3.2.1 Supported DIMSE services—Basic Film Box SOP Class

Table 2.1.3.2.3.2.1 - Basic Film Box SOP Class—Supported DIMSE Services

Name	Description
N_CREATE	Creates the film box
N_SET	Updates the film box
N_DELETE	Deletes the film box
N_ACTION	Prints the film box

2.1.3.2.3.2.2 DIMSE Specific Behavior—Basic Film Box SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below.

- **N-CREATE** The SCU invokes N-CREATE to create an instance of the Film Box. The following error or warning statuses may be returned:

INVALID_CREATE_FILM_BOX	C616H	Film session printing is not enabled and a request to create a new film box has been received before the most recent film box has been printed.
-------------------------	-------	---

- **N-SET**

PROCESSING_FAILURE	0110H	Trying to N-SET a film box that is not the most recently created.
--------------------	-------	---

- **N-ACTION** The SCU invokes N-ACTION to print the Film Box.

- **N-DELETE** The SCU invokes N-DELETE to request the SCP to delete the specified film box and the entire contained object hierarchy. Any objects still needed for pending print jobs will remain accessible to the server, until all print jobs that reference them are completed.

PROCESSING_FAILURE	0110H	Trying to N-DELETE a film box that is not the most recently created.
--------------------	-------	--

2.1.3.2.3.2.3 Supported Attributes—Basic Film Box SOP Class

The following attributes are supported for the Basic Film Box SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.2.2 - Basic Film Box SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
IMAGE DISPLAY FORMAT (2010,0010)	See Table 2.1.3.2.3.2.3	M/M STANDARD \\2,2	See Section 2.1.3.2.3.2.3.1

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
ANNOTATION DISPLAY FORMAT ID (2010,0030)	See Section 2.1.3.2.3.2.3.3	U/U None	See Section 2.1.3.2.3.2.3.3
FILM ORIENTATION (2010,0040)	PORTRAIT LANDSCAPE	U/M PORTRAIT	Film orientation. Enumerated Values: PORTRAIT = vertical film position LANDSCAPE = horizontal film position
FILM SIZE ID (2010,0050)	8INX10IN 8_5INX11IN 10INX12IN 10INX14IN 11INX14IN 11INX17IN 14INX14IN 14INX17IN 24CMX24CM 24CMX30CM A4 A3 A LA LA4 XLA XLA4 XLW B	U/M See Section 5.5	Non-standard values have been added to encompass all media sizes supported by Codonics imagers. These additional sizes are indicated in <i>italics</i> .
MAGNIFICATION TYPE (2010,0060)	NONE REPLICATE BILINEAR CUBIC <i>BICUBIC</i> <i>MITCHELL</i> <i>LANCZOS</i> <i>SHARP1</i> <i>SHARP2</i> <i>SHARP3</i>	U/M NONE	Type of interpolation algorithm by which the imager magnifies or decimates the image in order to fit the image in the image box on film. The value NONE indicates no scaling of images, or pixel-for-pixel printing (if the image is too large to fit in the given image cell, it will be cropped to fit). Codonics-specific values have been added, and are indicated in <i>italics</i> . CUBIC is mapped to the Codonics-specific LANCZOS interpolation type (a cubic spline-based algorithm).
SMOOTHING TYPE (2010,0080)		U/U None	This attribute is accepted, but not used.
BORDER DENSITY (2010,0100)	BLACK WHITE Numeric, OD times 100: 0..400	U/U BLACK	A numeric value represents the desired optical density in hundredths of OD (e.g., 150 corresponds with 1.5 OD).
EMPTY IMAGE DENSITY (2010,0110)	BLACK WHITE Numeric, OD times 100: 0..400	U/U BLACK	Density of the image box area on the film that contains no image. A numeric value represents the desired optical density in hundredths of OD (e.g., 150 corresponds with 1.5 OD).
MIN DENSITY (2010,0120)	Numeric, OD times 100: 0..100	U/U 0	Minimum density of the images on the film, expressed in hundredths of OD. If Min Density is lower than minimum imager density, then Min Density is set to minimum imager density.

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
MAX DENSITY (2010,0130)	Numeric, OD times 100: 100..310	U/U 300	Maximum density of the images on the film, expressed in hundredths of OD. If Max Density is higher than maximum imager density, then Max Density is set to maximum imager density.
TRIM (2010,0140)	YES NO	U/U NO	Specifies whether a trim box is printed surrounding each image on the film.
CONFIG. INFORMATION (2010,0150)	See Table 2.1.3.2.3.2.4	U/M None	Character string that contains one or more configuration data values, encoded as characters. See also Section 2.1.3.2.3.2.3.2.
REQUESTED RESOLUTION ID (2020,0050)	STANDARD	U/U STANDARD	Specifies the resolution at which images in this Film Box are to be printed. STANDARD = approximately 4k x 5k printable pixels on a 14 x 17 inch film
REFERENCED FILM SESSION SEQUENCE (2010,0500)	Sequence	M/M	Provides reference to a Film Session SOP Class/Instance pair. Only a single Item is permitted in this Sequence.
REFERENCED IMAGE BOX SEQUENCE (2010,0510)	Sequence	-/M	Provides references to a set of Image Box SOP Class/Instance pairs. One or more Items may be included in this Sequence.
REFERENCED ANNOTATION BOX SEQUENCE (2010,0520)	Sequence	-/MC	Required if Annotation SOP was negotiated. Provides references to a set of Basic Annotation Box SOP Class/Instance pairs. Zero or more Items may be included in this Sequence.
REFERENCED PRESENTATION LUT SEQUENCE (2050,0500)	Sequence	U/MC None	Required if Presentation LUT is supported. Provides reference to a Presentation LUT related SOP Class/Instance pair. Only a single Item is included in this sequence. This element exists internally to the SCP and cannot be accessed by any SCU

2.1.3.2.3.2.3.1 Image Display Format – Supported Values

The Image Display Format string (2010,0010) specifies the image layout for the film. The following values are supported:

Table 2.1.3.2.3.2.3 – BFB Image Display Formats

Image Display Format	Format Parameters	Image Box Count	Description
STANDARD\C,R	C = columns [1..9] R = rows [1..9]	C x R	Film contains up to 9 rows and up to 9 columns of equal size rectangular image boxes. All combinations in this range are supported.
SLIDE	None	24	Film contains 35mm slides
CUSTOMi	i = custom image format, which is one of the following:		
	1 = Unscaled	1	Film contains a single image box, where the image is printed pixel-for-pixel on the film, in its original orientation. No scaling of the image data is done.

Image Display Format	Format Parameters	Image Box Count	Description
	2 = Scaled	1	Film contains a single image box, where the image is printed at its largest possible size. This may involve rotating the image 90 degrees, and scaling it to fill the page.
	8 = MCM Bracketing	1	Film (or films) contain numerous copies of the single image, where the bracketing parameters are varied, and labeled, for each image box. See the imager User's Manual for more information.
	9 = Gamma/Contrast/TCR Bracketing	1	Film (or films) contain numerous copies of the single image, where the bracketing parameters are varied, and labeled, for each image box. See the imager User's Manual for more information.

2.1.3.2.3.2.3.2 Configuration Information – Supported Values

The Configuration Information string (2010,0150) can be used to specify certain parameters specific to Codonics imagers, and to override Magnification Type. A full description of these parameters can be found in the imager User's Manual. The following parameters are supported:

Table 2.1.3.2.3.2.4 – BFB Configuration Information Parameters

Parameter Name	Valid Range
MCM	0..999
TCR	0..100
CONTRAST	-100..+100
GAMMA	0.0 .. 10.0
SCALING	see Magnification Type (2010,0060) in Table 2.1.3.2.3.2.2
LUT	VISUAL, LINEAR, 1..8

Any number of parameters (0..6) may be included in any order, separated by either the backslash character ('\'), or the forward slash character ('/'). Each parameter must be specified as a 'name=value' string without whitespace. The 'name' and 'value' strings are case-insensitive, and need only contain enough characters to make them unique (of course, numerical values must be completely specified). Here is an example string which sets all six parameters:

```
mcm=0\tcr=15\con=10\g=2.25\scal=sharp2\lut=v
```

Note that the names and value ranges for these parameters are taken directly from the menus available on the imager's control panel interface, for easy reference. The values for parameters not specified in this string are determined using the imager's default mechanisms.

The SCALING parameter is included here primarily for use by SCUs that don't support the Magnification Type (2010,0060) attributes in Film Box and Color and Greyscale Image Boxes. If the SCALING parameter is specified in this string, and is set to a value other than 'NONE', it overrides all of the Magnification Type attributes specified elsewhere.

2.1.3.2.3.2.3.3 Annotation Display Format ID – Supported Values

The Annotation Display Format ID string (2010,0030) can be used to specify the layout and format of Basic Annotation Boxes on the film. The format for this string is defined as follows:

```
<format_id> ::= <specifier>*
<specifier> ::= <line_specifier> | <grid_specifier> | <image_specifier>
<line_specifier> ::= <line_count>[<location>][<justification>][<font>]
<grid_specifier> ::= <line_count><grid_separator><column_count><location>[<grid_justification>][<font>]
<image_specifier> ::= <image_indicator>[<location>][<justification>][<font>]
<line_count> ::= '1' .. '9'
<location> ::= 'T' | 'B'
<justification> ::= 'L' | 'C' | 'R'
<font> ::= 'S' | 'M' | 'G'
<grid_separator> ::= 'X'
<column_count> ::= '2' | '3'
<grid_justification> ::= <justification><justification>[<justification>]
<image_indicator> ::= 'I'
```

As per the standard, this string is limited to a maximum of 16 characters. The following table explains the meanings of the various parameters described above.

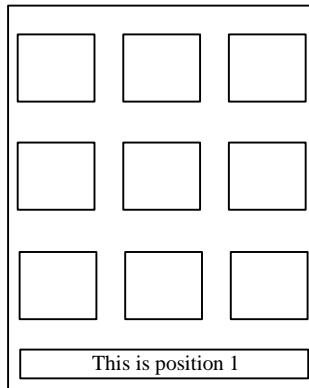
Table 2.1.3.2.3.2.5 – BFB Annotation Display Format ID Parameters

Parameter Name	Values	Use As Default For
line_count	1..9 (number of text lines)	None – this value is required in all cases
location	T : Top (of film or image) B : Bottom (of film or image)	None Line specifier; Image specifier
justification	L : Left C : Center R : Right	First column in grid specifier Line specifier; Image specifier; Middle column in grid specifier Last column in grid specifier
font	S : Small M : Medium G : Large	Image specifier Line specifier; Grid specifier None
column_count	2..3 (number of text columns, 64 characters each)	None – this value is required in all cases

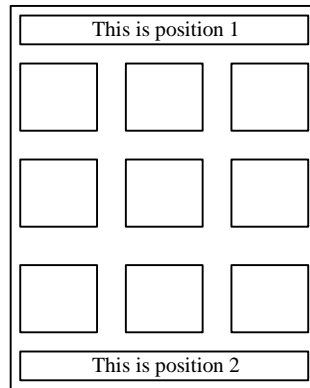
There are basically three types of annotation format specifiers, which can be combined in many different ways to create compound annotation format IDs.

Line Specifier - The first type of specifier is the line specifier, which is the simplest. It specifies a line count, an optional location, an optional justification, and an optional font. If omitted, location defaults to bottom (B), justification defaults to center (C), and font defaults to medium (M). With this specifier, annotation boxes can be placed at the top or bottom of the film. By combining multiple line specifiers in a

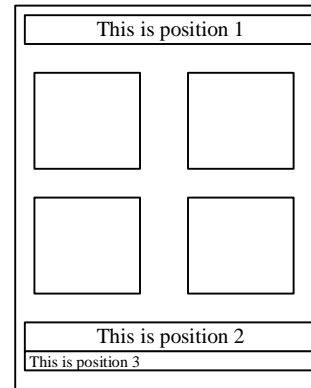
single format ID, annotation boxes can be placed at both the top and bottom, with varying justifications and fonts. Here are some examples (not drawn to scale):



Format ID: 1

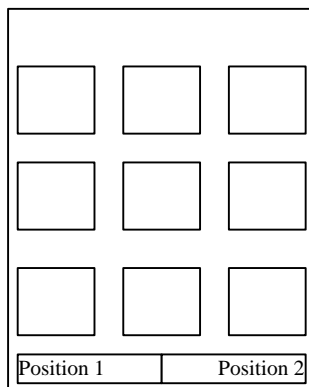


Format ID: 1T1B

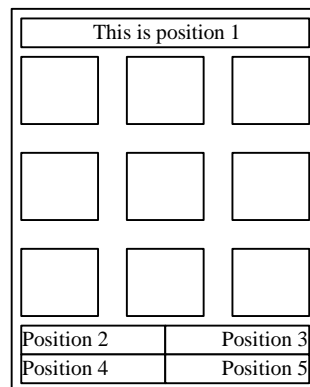


Format ID: 1T1B1BLS

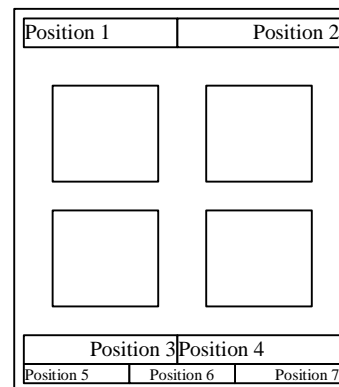
Grid Specifier - The second type of specifier is the grid specifier. It specifies a line and column count, a location, an optional set of justifications, and an optional font. If omitted, justification of each column is as follows: the first column is left-justified (L), the last column is right-justified (R), and if there is a middle column, it is center-justified (C). If omitted, font defaults to medium (M). With this specifier, annotation boxes can be arranged in a grid pattern, with up to 9 lines and 3 columns, at the top or bottom of the film. The main advantage of this format over the line specifier format is that it allows up to 192 characters per single row of text (3 columns X 64 characters per column). As with line specifiers, grid specifiers can be combined with any type of specifier to create various annotation box layouts. Here are some examples (not drawn to scale):



Format ID: 1X2B



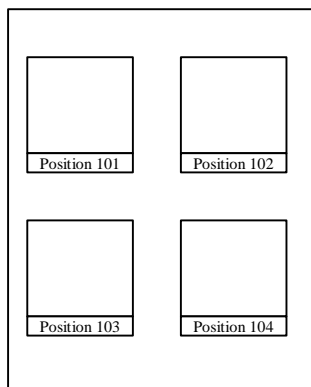
Format ID: 1T2X2B



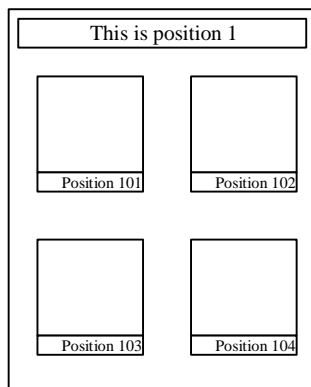
Format ID: 1X2T1X2BRL1X3BS

Image Specifier - The third type of specifier is the image specifier. It specifies an optional location, an optional justification, and an optional font. . If omitted, location defaults to bottom (B), justification defaults to center (C), and font defaults to small (S). With this specifier, annotation boxes can be placed at the top or bottom of each image on the film. As with the other specifiers, image specifiers can be combined with

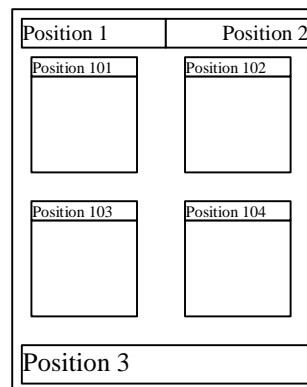
any type of specifier to create various annotation box layouts. Here are some examples (not drawn to scale):



Format ID: I



Format ID: 1TIBR



Format ID: 1X2TITL1BLG

Annotation Positions – The annotation positions are assigned to the annotation boxes in the following way:

- Annotation boxes created via the line and grid specifier formats are numbered cumulatively in left-to-right then top-to-bottom fashion, starting with the value 1.
- Annotation boxes created via the image specifier format are given a position ID equal to the position ID of the image that they are annotating, plus 100. This means they have values from 101 to 181, starting in the upper left and progressing to the lower right, in left-to-right then top-to-bottom fashion.

The diagrams above provide examples of these annotation position numbering schemes in practice.

Font Sizes – Each line of text takes up a fixed-height area of the film, based on the selected font size. The following table indicates the number of lines required for each of the 3 font sizes:

Table 2.1.3.2.3.2.6 – Annotation Text Sizes

Font Size	Height (lines)
S : Small	59
M : Medium	88
G : Large	117

Limitations – There are physical limitations to the layout of annotation boxes on the various kinds of media, based on the size of the font, the number of annotation columns, the film orientation, and the printable area of the media. Because the set of possible layouts is quite large, it is recommended that SCU implementors test a particular format ID before committing it to their application, to ensure an acceptable result.

2.1.3.2.3.3 SOP Specific Conformance to Basic Grayscale Image Box SOP Class

2.1.3.2.3.3.1 Supported DIMSE Services—Basic Grayscale Image Box SOP Class

Table 2.1.3.2.3.3.1 - Grayscale Image Box SOP Class—Supported DIMSE Services

Name	Description
N_SET	Updates a Grayscale Image Box in a previously created film box.

2.1.3.2.3.3.2 DIMSE Specific Behavior—Basic Grayscale Image Box SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below.

- **N-SET** The SCU invokes N-SET to update the image box. The following error or warning statuses may be returned:

PROCESSING_FAILURE	0110H	Trying to N-SET an image that is not in the most recently created film box, or another internal server error has occurred.
OUT_OF_IMAGE_MEMORY	C605H	There is insufficient mass storage available to store the image. This may be a transient condition.

2.1.3.2.3.3.3 Supported Attributes—Basic Grayscale Image Box SOP Class

The following attributes are supported for the Basic Grayscale Image Box SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.3.2 - Basic Grayscale Image Box SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
IMAGE POSITION (2020,0010)	1..81	M/M	The position of the image on the film, based on Image Display Format (2010,0010). See DICOM PS 3.3, C.13.5.1 for specification.
POLARITY (2020,0020)	NORMAL REVERSE	U/M NORMAL	NORMAL: Pixels are printed as by PHOTOMETRIC INTERPRETATION REVERSE: Pixels are printed opposite of PHOTOMETRIC INTERPRETATION
MAGNIFICATION TYPE (2010,0060)	NONE REPLICATE BILINEAR CUBIC <i>BICUBIC</i> <i>MITCHELL</i> <i>LANCZOS</i> <i>SHARP1</i> <i>SHARP2</i> <i>SHARP3</i>	U/U NONE	Will override the corresponding Film Box attribute. Codonics-specific values are indicated in <i>italics</i> .
SMOOTHING TYPE (2010,0080)		U/U None	Accepted but not used.

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
CONFIGURATION INFORMATION (2010,0150)		U/U None	See Table 2.1.3.2.3.2.4 for a description.
REQUESTED IMAGE SIZE (2020,0030)		U/U 0.0	Width (x-dimension) in mm of the image to be printed. This value overrides the size that corresponds with optimal filling of the Image Box. A value of 0.0 indicates that the device will determine the image size. This is typically used for "true size" printing.
REQUESTED DECIMATE/CROP BEHAVIOR (2020,0040)	DECIMATE CROP FAIL	U/U DECIMATE	Specifies how to handle the rendering of the image when the Requested Image Size is greater than the available size of the Image Box. See Section 2.1.3.2.3.3.3.1 for details.
REFERENCED IMAGE OVERLAY BOX SEQUENCE (2020,0130)		U/U None	A sequence which provides references to an Image Overlay Box SOP Class/Instance pair and a specific frame number in multi-frame instances. Zero or one Item may be included in this sequence.
ORIGINAL IMAGE SEQUENCE (2130,00C0)		U/U	Attributes of the original modality images to be printed in this Film Session. This sequence is supported and may be stored with the image data on the Codonics imager device. It is not currently used.
▶ STUDY INSTANCE UID (0020,000D)		MC/M	Required if sequence is present.
▶ SERIES INSTANCE UID (0020,000E)		MC/M	Required if sequence is present.
▶ PATIENT ID (0010,0020)		MC/M	Required if sequence is present and value is known.
▶ REFERENCED SOP CLASS UID (0008,1150)		MC/M	Required if sequence is present. SOP Class UID of the original modality image used to create this Image Box.
▶ REFERENCED SOP INSTANCE UID (0008,1155)		MC/M	Required if sequence is present. SOP Instance UID of the original modality image used to create this Image Box.
▶ REFERENCED FRAME NUMBER (0008,1160)		MC/M	Required if sequence is present and original image is a multi-frame image.
▶ INSTANCE (IMAGE) NUMBER 0020,0013)		MC/M	Required if sequence is present and value is known.
BASIC GRAYSCALE IMAGE SEQUENCE (2020,0110)		M/M	Zero or one item may be included in this sequence. If the sequence is zero length, the SCP will erase the image in this position.

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
▶ SAMPLES PER PIXEL (0028,0002)	1	M/M	Indicates 1 color plane.
▶ PHOTOMETRIC INTERPRETATION (0028,0004)	MONOCHROME1 MONOCHROME2	M/M MONOCHROME1	MONOCHROME2 means the minimum pixel value is displayed as black.
▶ ROWS (0028,0010)	1..8192	M/M	Number of lines in image.
▶ COLUMNS (0028,0011)	1..8192	M/M	Number of pixels in line.
▶ PIXEL ASPECT RATIO (0028,0034)	100\1..1\100	MC/M 1\1	rrr\ccc (Row\Column)
▶ BITS ALLOCATED (0028,0100)	8, 16	M/M	
▶ BITS STORED (0028,0101)	8, 12	M/M	
▶ HIGH BIT (0028,0102)	7, 11	M/M	
▶ PIXEL REPRESENTATION (0028,0103)	0	M/M	000H, indicates unsigned integer.
▶ PIXEL DATA (7FE0,0010)		M/M	000H–FFFH (hex): the actual pixel data stream.

2.1.3.2.3.3.3.1 Requested Decimate/Crop Behavior – Supported Values

When using the Requested Image Size (2020,0030) tag, typically for “true size” printing purposes, it is possible to specify an image size that will not fit within the Image Box, or cell, in which the image is to be printed. In this situation, the Horizon imager’s default behavior is to scale the image to fit the cell, which means that the image is not scaled as large as the Requested Image Size indicated.

In this case, if the original source image size is actually larger than the image cell, then the source image is down-scaled (i.e. scaled using a magnification factor < 1) to fit the cell, and an (optional) “Decimation Warning” message is overlaid on the bottom of the image before it is printed. (This option can be enabled or disabled via the ‘User Settings’ menu of the imager’s front panel interface; when enabled, a warning message is printed on the bottom of all images that are down-scaled to fit the cell.)

However, if the original source image size is smaller than the image cell, then the source image is up-scaled (i.e. scaled using a magnification factor > 1) to fill the cell, though it is not scaled up as much as requested via the Requested Image Size parameter.

For example, assume that an SCU requests a print with the following parameters:

MEDIUM TYPE (2000,0030) = BLUE FILM

FILM SIZE ID (2010,0050) = 14INX17IN

IMAGE DISPLAY FORMAT (2010,0010) = STANDARD\1,1

REQUESTED IMAGE SIZE (2020,0030) = 344.076

BASIC GRAYSCALE IMAGE SEQUENCE (2020,0110):

▶ ROWS (0028,0010) = 2500

▶ COLUMNS (0028,0011) = 2048

On the Horizon imager, which has a pixel size of 79.5 microns, or 0.0795mm (see Section 5.7 Printable Area Configuration), this represents a *requested image width* of:

$$\frac{344.076 \text{ mm}}{0.0795 \text{ mm/pixel}} = 4328 \text{ pixels}$$

Which implies a *requested magnification factor* of:

$$\frac{4328 \text{ pixels}}{2048 \text{ pixels}} = 2.113$$

Which yields a total *requested image size* of:

4328 x 5283 pixels.

However, the *maximum image size* for this format, as defined by the printable area of 14x17 blue film (see Section 5.7 Printable Area Configuration), is:

4322 x 5025 pixels

Therefore, the requested image size can not be honored, so the default behavior results, which is to scale the original image as large as possible within the given cell. Because the request is primarily limited by the height of the available cell, the *actual magnification factor* used to scale the original image is:

$$\frac{5025 \text{ pixels}}{2400 \text{ pixels}} = 2.010$$

Which yields a *printed image size* of:

4116 x 5025 pixels

Clearly, the *printed image size* is smaller than the *requested image size*, but because the original source image was scaled up to fill the cell (using a magnification factor of 2.010), the imager's "Decimation Warning" does not apply.

However, it is possible for the PrintSCU to override this default behavior, using the Requested Decimate/Crop Behavior (2020,0040) tag. This tag can take one of three values:

1) DECIMATE – This value results in the default behavior described above, which is to scale the image to fit the available space, but not as large as requested. This setting yields pixels that are physically smaller than requested, which is why the term "decimate" is used.

2) CROP – This value results in the image being scaled to the Requested Image Size, and then cropped to fit the available image cell. Cropping occurs symmetrically such that the center of the image is maintained (i.e. the outside edges of the image are cropped symmetrically). This yields pixels that are physically correct in size, but some image data is lost around the outside edges of the image.

In the example above, this would result in the following cropping, per side:

$$\frac{(\text{requested_image_width} - \text{maximum_image_width})}{2} = \frac{(4328 - 4322)}{2} = 3 \text{ pixels}$$

and the following cropping, top and bottom:

$$\frac{(\text{requested_image_height} - \text{maximum_image_height})}{2} = \frac{(5283 - 5025)}{2} = 129 \text{ pixels}$$

3) FAIL – This value does not result in a print of any kind, but rather, logs an error message to the imager's error log (which is available via the 'Error Log' utility of the imager's front panel interface). However, the SCU will receive a positive response to the print request (i.e. the print job will be received successfully), even though the print itself will fail. This is a limitation of the current implementation of this feature.

2.1.3.2.3.4 SOP Specific Conformance to Basic Color Image Box SOP Class

2.1.3.2.3.4.1 Supported DIMSE Services—Basic Color Image Box SOP Class

Table 2.1.3.2.3.4.1 - Color Image Box SOP Class—Supported DIMSE Services

Name	Description
N_SET	Updates a Color Image Box in a previously created film box.

2.1.3.2.3.4.2 DIMSE Specific Behavior—Basic Color Image Box SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below.

- **N-SET** The SCU invokes N-SET to update the image box. The following error or warning statuses may be returned:

PROCESSING_FAILURE	0110H	Trying to N-SET an image that is not in the most recently created film box, or another internal server error has occurred.
OUT_OF_IMAGE_MEMORY	C605H	There is insufficient mass storage available to store the image. This may be a transient condition.

2.1.3.2.3.4.3 Supported Attributes—Basic Color Image Box SOP Class

The following attributes are supported for the Basic Color Image Box SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.4.2 - Basic Color Image Box SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
IMAGE POSITION (2020,0010)	1..81	M/M	The position of the image on the film, based on Image Display Format (2010,0010). See DICOM PS 3.3, C.13.5.1 for specification.

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
POLARITY (2020,0020)	NORMAL REVERSE	U/M NORMAL	NORMAL: Pixels are printed as by PHOTOMETRIC INTERPRETATION REVERSE: Pixels are printed opposite of PHOTOMETRIC INTERPRETATION
MAGNIFICATION TYPE (2010,0060)	NONE REPLICATE BILINEAR CUBIC <i>BICUBIC</i> <i>MITCHELL</i> <i>LANCZOS</i> <i>SHARP1</i> <i>SHARP2</i> <i>SHARP3</i>	U/U NONE	Will override the corresponding Film Box attribute. Codonics-specific values are indicated in <i>italics</i> .
SMOOTHING TYPE (2010,0080)		U/U None	Accepted but not used.
CONFIGURATION INFORMATION (2010,0150)		U/U None	See Table 2.1.3.2.3.2.4 for a description.
REQUESTED IMAGE SIZE (2020,0030)		U/U 0.0	Width (x-dimension) in mm of the image to be printed. This value overrides the size that corresponds with optimal filling of the Image Box. A value of 0.0 indicates that the device will determine the image size. . This is typically used for "true size" printing.
REQUESTED DECIMATE/CROP BEHAVIOR (2020,0040)	DECIMATE CROP FAIL	U/U DECIMATE	Specifies how to handle the rendering of the image when the Requested Image Size is greater than the available size of the Image Box. See Section 2.1.3.2.3.3.3.1 for details.
REFERENCED IMAGE OVERLAY BOX SEQUENCE (2020,0130)		U/U None	A sequence which provides references to an Image Overlay Box SOP Class/Instance pair and a specific frame number in multi-frame instances. Zero or one Item may be included in this sequence.
ORIGINAL IMAGE SEQUENCE (2130,00C0)		U/U None	Attributes of the original modality images to be printed in this Film Session. This sequence is supported and may be stored with the image data on the Codonics imager device. It is not currently used.
▶ Study Instance UID (0020,000D)		MC/M	Required if sequence is present.
▶ Series Instance UID (0020,000E)		MC/M	Required if sequence is present.
▶ Patient ID (0010,0020)		MC/M	Required if sequence is present and value is known.

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
▶ Referenced SOP Class UID (0008,1150)		MC/M	Required if sequence is present. SOP Class UID of the original modality image used to create this Image Box.
▶ Referenced SOP Instance UID (0008,1155)		MC/M	Required if sequence is present. SOP Instance UID of the original modality image used to create this Image Box.
▶ Referenced Frame Number (0008,1160)		MC/M	Required if sequence is present and original image is a multi-frame image.
▶ Instance (image) Number 0020,0013)		MC/M	Required if sequence is present and value is known.
BASIC COLOR IMAGE SEQUENCE (2020,0111)		M/M	Zero or one item may be included in this sequence. If the sequence is zero length, the SCP will erase the image in this position.
▶ SAMPLES PER PIXEL (0028,0002)	3	M/M	Indicates 3 color planes.
▶ PHOTOMETRIC INTERPRET. (0028,0004)	RGB	M/M	Indicates pixels are represented in Red/Green/Blue color space.
▶ PLANAR CONFIGURATION (0028,0006)	0000, 0001	M/M	0000 = interleaved pixels (RGRGBRGRB...) 0001 = planar pixels (RRR...GGG...BBB...)
▶ ROWS (0028,0010)	1..8192	M/M	Number of lines in image.
▶ COLUMNS (0028,0011)	1..8192	M/M	Number of pixels in line.
▶ PIXEL ASPECT RATIO (0028,0034)	100\1..1\100	MC/M	rrr\ccc: Row\Column
▶ BITS ALLOCATED (0028,0100)	8	M/M	
▶ BITS STORED (0028,0101)	8	M/M	
▶ HIGH BIT (0028,0102)	7	M/M	
▶ PIXEL REPRESENTATION (0028,0103)	0	M/M	000H, indicates unsigned integer.
▶ PIXEL DATA (7FE0,0010)		M/M	000H–FFFH (hex): the actual pixel data stream.

2.1.3.2.3.5 SOP Specific Conformance to Printer SOP Class

2.1.3.2.3.5.1 Supported DIMSE Services—Printer SOP Class

Table 2.1.3.2.3.5.1 - Printer SOP Class—Supported DIMSE Services

Name	Description
N_EVENT_REPORT	Sends an instance of a Printer SOP to a DICOM Print Client.
N_GET	Retrieves an instance of a Printer SOP for a DICOM Print Client.

2.1.3.2.3.5.2 DIMSE Specific Behavior—Printer SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below. Note that the SOP instance UID of the printer is a well-known UID.

- **N-EVENT-REPORT** The SCP invokes N-EVENT-REPORT to inform the SCU of a change to the printer status. These messages are only generated if the DCF print server is configured to do so.
- **N-GET** The SCU invokes N-GET to retrieve attributes of the Printer SOP.

2.1.3.2.3.5.3 Supported Attributes—Printer SOP Class

The following attributes are supported for the Film Session SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.5.2 - Printer SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
PRINTER STATUS (2110,0010)	NORMAL WARNING FAILURE	U/M	
PRINTER STATUS INFO (2110,0020)	16 characters max. (see table 2.1.3.2.3.5.3)	U/M	Based on PRINTER STATUS, provides additional information. When the Printer Status is NORMAL, Status Info is also NORMAL. See Table 2.1.3.2.3.5.3 for additional values when the Printer Status is WARNING or FAILURE.
PRINTER NAME (2110,0030)	16 characters max.	U/U	User defined name identifying the printer (network hostname).
MANUFACTURER (0008,0070)	Codonics	U/U	Manufacturer of the printer.
MANUFACTURER MODEL NAME (0008,1090)	Horizon	U/U	Manufacturer's model name of the printer.
DEVICE SERIAL NUMBER (0018,1000)	0.0.0.1	U/U	Manufacturer's serial number of the printer (currently unsupported).

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comment
SOFTWARE VERSION (0018,1020)	16 characters max.	U/U	Manufacturer's designation of software version of the printer.
DATE LAST CALIBRATION (0018,1200)	20000229	U/U	Date when the printer was last calibrated (<i>currently unsupported</i>).
TIME LAST CALIBRATION (0018,1201)	090059	U/U	Time when the printer was last calibrated (<i>currently unsupported</i>).

Table 2.1.3.2.3.5.3 - Status Info Summary for Printer Status

Printer Status	Printer Status Info	Description
NORMAL	NORMAL	The printer is functioning properly.
WARNING or FAILURE	BAD SUPPLY MGZ	There is a problem with a film supply cassette. Films from this cassette cannot be transported into the printer.
	CALIBRATING	Printer is performing self calibration, it is expected to be available for normal operation shortly.
	CALIBRATION ERR	An error in the printer calibration has been detected, quality of processed films may not be optimal.
	COVER OPEN	One or more printer or processor covers/drawers/doors are open.
	ELEC CONFIG ERR	Printer configured improperly for this job.
	ELEC DOWN	Printer is not operating due to some unspecified electrical hardware problem.
	ELEC SW ERROR	Printer not operating for some unspecified software error.
	EMPTY 8X10	The 8x10 inch film supply magazine is empty.
	EMPTY 8X10 BLUE	The 8x10 inch blue film supply magazine is empty.
	EMPTY 8X10 CLR	The 8x10 inch clear film supply magazine is empty.
	EMPTY 8X10 PAPR	The 8x10 inch paper supply magazine is empty.
	EMPTY 10X12	The 10x12 inch film supply magazine is empty.
	EMPTY 10X12 BLUE	The 10x12 inch blue film supply magazine is empty.
	EMPTY 10X12 CLR	The 10x12 inch clear film supply magazine is empty.
	EMPTY 10X12 PAPR	The 10x12 inch paper supply magazine is empty.
	EMPTY 10X14	The 10x14 inch film supply magazine is empty.
	EMPTY 10X14 BLUE	The 10x14 inch blue film supply magazine is empty.
	EMPTY 10X14 CLR	The 10x14 inch clear film supply magazine is empty.
	EMPTY 10X14 PAPR	The 10x14 inch paper supply magazine is empty.
	EMPTY 11X14	The 11x14 inch film supply magazine is empty.
	EMPTY 11X14 BLUE	The 11x14 inch blue film supply magazine is empty.
	EMPTY 11X14 CLR	The 11x14 inch clear film supply magazine is empty.
	EMPTY 11X14 PAPR	The 11x14 inch paper supply magazine is empty.
	EMPTY 14X14	The 14x14 inch film supply magazine is empty.

Printer Status	Printer Status Info	Description
	EMPTY 14X14 BLUE	The 14x14 inch blue film supply magazine is empty.
	EMPTY 14X14 CLR	The 14x14 inch clear film supply magazine is empty.
	EMPTY 14X14 PAPER	The 14x14 inch paper supply magazine is empty.
	EMPTY 14X17	The 14x17 inch film supply magazine is empty.
	EMPTY 14X17 BLUE	The 14x17 inch blue film supply magazine is empty.
	EMPTY 14X17 CLR	The 14x17 inch clear film supply magazine is empty.
	EMPTY 14X17 PAPER	The 14x17 inch paper supply magazine is empty.
	EMPTY 24X24	The 24x24 cm film supply magazine is empty.
	EMPTY 24X24 BLUE	The 24x24 cm blue film supply magazine is empty.
	EMPTY 24X24 CLR	The 24x24 cm clear film supply magazine is empty.
	EMPTY 24X24 PAPER	The 24x24 cm paper supply magazine is empty.
	EMPTY 24X30	The 24x30 cm film supply magazine is empty.
	EMPTY 24X30 BLUE	The 24x30 cm blue film supply magazine is empty.
	EMPTY 24X30 CLR	The 24x30 cm clear film supply magazine is empty.
	EMPTY 24X30 PAPER	The 24x30 cm paper supply magazine is empty.
	EMPTY A4 PAPER	The A4 paper supply magazine is empty.
	EMPTY A4 TRANS	The A4 transparency supply magazine is empty.
	<i>EMPTY A PAPER</i>	The A paper supply magazine is empty.
	<i>EMPTY A TRANS</i>	The A transparency supply magazine is empty.
	EXPOSURE FAILURE	The exposure device has failed due to some unspecified reason.
	FILM JAM	A film transport error has occurred and a film is jammed in the printer or processor.
	FILM TRANSP ERR	There is a malfunction with the film transport there may or may not be a film jam.
	NO RECEIVE MGZ	The film receive magazine not available
	NO RIBBON	The ribbon cartridge needs to be replaced.
	NO SUPPLY MGZ	The film supply magazine specified for this job is not available.
	CHECK PRINTER	The printer is not ready at this time, operator intervention is required to make the printer available.
	PRINTER DOWN	The printer is not operating due to some unspecified reason.
	PRINTER INIT	The printer is not ready at this time, it is expected to become available without intervention—for example, it may be in a normal warm-up state.
	PRINTER OFFLINE	The printer has been disabled by an operator or service person.
	RECEIVER FULL	The Film receive magazine is full.
	REQ MED NOT INST	The requested film, paper, or other media supply magazine is installed in the printer, but is not available; it may be available with operator intervention.
	REQ MED NOT AVAI	The requested film, paper, or other media requested is not available on this printer.
	RIBBON ERROR	There is an unspecified problem with the print ribbon.
	SUPPLY EMPTY	The printer is out of film.
	UNKNOWN	There is an unspecified problem.

2.1.3.2.3.7 SOP Specific Conformance to Basic Annotation Box SOP Class

2.1.3.2.3.7.1 Supported DIMSE Services—Basic Annotation Box SOP Class

Table 2.1.3.2.3.7.1 - Basic Annotation Box SOP Class—Supported DIMSE Services

Name	Description
N_SET	Updates an Annotation Box in a previously created film box.

2.1.3.2.3.7.2 DIMSE Specific Behavior—Basic Annotation Box SOP Class

The DCF Print Server conforms to DICOM PS 3.4-1999 for handling of supported DIMSE messages. Optional behavior, error status codes that are unique to a particular DIMSE message for this SOP class and other noteworthy issues are discussed below.

- **N-SET** The SCU invokes N-SET to update the annotation box. The following error or warning statuses may be returned:

PROCESSING_FAILURE	0110H	Trying to N-SET an annotation box that is not in the most recently created film box.
--------------------	-------	--

2.1.3.2.3.7.3 Supported Attributes—Basic Annotation Box SOP Class

The following attributes are supported for the Basic Annotation Box SOP class in DIMSE messages as specified in DICOM PS 3.4-1999, unless otherwise noted.

Table 2.1.3.2.3.7.2 - Basic Annotation Box SOP Class—Supported Attributes

Attribute Name (Tag)	Possible Values	Usage SCU/SCP & Default	Comments
ANNOTATION POSITION (2030,0010)	1..181	M/M	The position of the annotation box in the parent film box. Annotation position sequence depends on the selected Annotation Display Format ID (2010,0030). See section 2.1.3.2.3.2.3.3.
TEXT STRING (2030,0020)	0..64 characters	U/M None	The string is rendered in the appropriate manner, based on the selected Annotation Display Format ID (2010,0030).

2.1.3.2.4 Presentation Context Acceptance Criterion

See Table 2.1.3.2.2.2 for information about presentation context negotiation.

2.1.3.2.5 Transfer Syntax Selection Policies

The transfer syntax for each DICOM presentation context is negotiated independently. The DCF Print Server can be configured to support any or all of the transfer syntaxes listed in Table 2.1.3.2.2.1. The order of preference for selecting a transfer syntax is also configurable. This configuration may vary between associations, however for a given association, it is shared between all SOP classes or presentation contexts. See Section 5 for additional configuration information.

3. COMMUNICATION PROFILES

3.1 TCP/IP Stack

The DCF Print Server provides DICOM 3.0 TCP/IP Network Communication Support as defined in part 8 of the standard.

3.2 Physical Media Support

The DCF Print Server supports DICOM over any IP network supported by the Operating System running on the Codonics device (computer) where the DCF Print Server is installed and running.

4. EXTENSIONS/SPECIALIZATIONS/PRIVATIZATIONS

The DCF does not define any private elements.

5. CONFIGURATION

See Section 1.2 for an overview of the DCF Print Server start-up and configuration process.

5.1 AE Title Presentation Address Mapping

AE Titles are used only during association negotiation with the DCF Print Server. That is, no DIMSE messages or data sets reference other hosts or servers using AE Titles as is common with certain other SOP classes. There is no need for AE Title to presentation address mapping with the Basic Grayscale or Basic Color Print Management Meta SOP classes.

5.2 DCF Print Server Configurable Parameters—Global

The following items are configurable on a global basis and apply to all associations serviced by the DCF Print Server.

Table 5.2.1 - Global Configuration Parameters

Parameter Name	Range	Defaults	Comments
tcp_port	1–32767	104	The TCP port on which the DCF Print Server will listen for incoming DICOM Print Association requests.
max_concurrent_associations	1–12	1, 2, 12	The maximum number of associations that can be simultaneously active. A Horizon imager equipped with a DICOM Lite 1 key allows only 1 association at a time, with a DICOM Lite 2 key allows 2 concurrent associations, and with a standard DICOM key allows 12.

Parameter Name	Range	Defaults	Comments
first_pdu_read_timeout	N/A	30	Association request timeout period—the time is measured from socket accept until an a-assoc-rq PDU is read. Functions as the ARTIM (Association/Request/Reject/Release Timer) timer from DICOM PS 3.8-9.1.2
debug_flags	N/A	0x00000	This parameter is intended for Codonics developer and field-service use only.

5.3 DCF Print Server Configurable Parameters—Per Association

The following items are configurable on a per association basis and apply to an association based on the Calling AE Title. Each software component has debug flags that may be set for diagnostic purposes; these flags may be dynamically accessed via a browser based interface, but are not listed below. Other configuration parameters which are used to control SCP internal behavior are omitted from the lists as well.

The SOP Classes that the DCF Print Server supports are configured by their presence in the appropriate configuration file. See Section 1.2 for additional description of the configuration process. Sop Classes that may be selected are listed in the table below. Those in *italics* are not currently supported by the Codonics imager software, and are therefore never enabled.

Table 5.3.1 - Per Association Configuration Parameters—Supported SOP Classes

Description	SOP UID
basic grayscale print meta sop class	1.2.840.10008.5.1.1.9
<i>print job</i>	<i>1.2.840.10008.5.1.1.14</i>
verification	1.2.840.10008.1.1
annotation box	1.2.840.10008.5.1.1.15
printer	1.2.840.10008.5.1.1.16
basic color print meta sop class	1.2.840.10008.5.1.1.18
<i>presentation lut</i>	<i>1.2.840.10008.5.1.1.23</i>
<i>basic print image overlay box</i>	<i>1.2.840.10008.5.1.1.24.1</i>

The transfer syntax for each DICOM presentation context is negotiated independently. The DCF Print Server can be configured to support any or all of the transfer syntaxes listed below. The order of preference for selecting a transfer syntax is also configurable. This configuration may vary between associations; however, for a given association, it is shared between all SOP classes or presentation contexts. Those in *italics* are not currently supported by the Codonics imager software, and are therefore never enabled.

Table 5.3.2 - Per Association Configuration Parameters—Supported Transfer Syntaxes

Description	SOP UID
implicit-little-endian	1.2.840.10008.1.2
<i>explicit-little-endian</i>	<i>1.2.840.10008.1.2.1</i>
<i>explicit-big-endian</i>	<i>1.2.840.10008.1.2.2</i>

Table 5.3.3 - Per Association Configuration Parameters—DCF Components

Parameter Name	Range	Defaults	Comments
DPS			
scp_association_options:			
send_n_event_report	YES NO	NO	
enable_film_session_printing	YES NO	YES	
dvs_enable	YES NO	NO	Enables or disables the DICOM Validation Services component.
dvs_configuration_group		/dicom/dvs/ PrintSCP.dvs /dicom/dvs/ DicomDefs.dvs	Filename of the configuration group for the DICOM Validation Service component.
printer_failure_status_mapping	WARNING NORMAL	None—no mapping is performed	An OEM printer FAILURE message is mapped to this value for reporting to a requestor.
printer_warning_status_mapping	FAILURE NORMAL	None—no mapping is performed	An OEM printer WARNING message is mapped to this value for reporting to a requestor.
DCS:			
pdu_read_timeout	0 .. 2**32	30	Association request timeout period—number of seconds to block trying to read a PDU fragment, after a connect or read-data-ready poll notification. Functions as the ARTIM (Association/Request/Reject/Release Timer) timer from DICOM PS 3.8-9.1.2.
association_idle_timeout_period	-1, 0, 1..3600	3600	-1 = Never release association unless the SCU requests it, or an error has occurred. 0 = Time-out immediately 1–3600 (seconds) Maximum number of seconds that the DCF Print Server will allow an idle client to maintain an association when no print jobs are pending.
max_pdu_length	1K–16K Bytes (1024–16384)	16K Bytes (16384 Bytes)	The largest PDU that will be sent.
pre_association_script	Shell command	None	Command line of program to be run at the start of an association.
post_association_script	Shell command	None	Command line of program to be run at the end of an association.

5.4 Called AE Titles and Codonics Job Settings

The Codonics imager supports multiple parameter sets known as Job Settings, which affect the parameters associated with a given print job. These are general-purpose, configurable parameter sets that are described in detail in the imager User's Manual. For print jobs submitted via the DICOM 3.0 protocol, a Job Settings parameter set is selected via the Called AE Title used to establish the print Association.

There are System Job Settings, which are pre-configured to select various features such as media combination, print priority, and output bin (see Section 5.6). In addition, there are Custom Job Settings that can be created from the imager's control panel that allow selection of any parameter, or combination of parameters, found in Table 5.4.1.

Within Job Settings, a particular parameter can be assigned either a specific value, or the special value known as Default. If the Job Settings parameter is set to Default then the value for that parameter is taken from the respective DICOM attribute; otherwise, the DICOM attribute's value is overridden by the value in the Job Settings. The following table shows the mapping of Job Settings parameters to DICOM attributes:

Table 5.4.1 – Job Settings Parameter to DICOM Attribute Mapping

Job Settings Parameter	DICOM Attribute (Tag)
Media Type	MEDIUM TYPE (2000,0030)
Media Size	FILM SIZE ID (2010,0050)
Receive Tray	FILM DESTINATION (2000,0040)
Priority	PRINT PRIORITY (2000,0020)
Gamma	CONFIG. INFORMATION (2010,0150) - GAMMA
Contrast	CONFIG. INFORMATION (2010,0150) - CONTRAST
Dmax	MAX DENSITY (2010,0130)
LUT	CONFIG. INFORMATION (2010,0150) - LUT
Polarity	POLARITY (2020,0020)
Saturation	CONFIG. INFORMATION (2010,0150) – TCR (* -1)
MCM	CONFIG. INFORMATION (2010,0150) - MCM
Background	BORDER DENSITY (2010,0100)
Scaling	MAGNIFICATION TYPE (2010,0060)
Rotate	NONE
Antialias	NONE
Decimation Warning	NONE
Captions	NONE
Border Fill	NONE
Coverage	NONE

5.5 Media Selection Algorithm

The Codonics imager supports several mechanisms for selecting the media combination (**media type** and **media size**) for a given print job. These mechanisms include the **Default Media** selections for the imager (there is a Default Media for grayscale prints, and one for color prints, which can be set through the

imager's control panel menus); the relevant DICOM attributes (**Medium Type** and **Film Size ID**); and, the relevant Job Settings parameters (**MediaType** and **MediaSize**). For DICOM print jobs, these mechanisms are all combined using an algorithm that provides maximum flexibility and control over which medium is used for a given job.

The algorithm works as follows:

1. The **media type** and **size** are initialized to those of the **Default Media**, based on whether the current DICOM job is grayscale or color. This guarantees that they start out with valid values, since only valid media combinations are allowed for **Default Media** settings.
2. If the **Medium Type (2000,0030)** is set in the Basic Film Session for the current job, then it overlays the current **media type**, possibly altering its value. This is an attempt to honor the **type** specified by the SCU, if provided. (If not provided, then **media type** retains its default value from step 1.)
3. If the **Film Size ID (2010,0050)** is set in the Basic Film Box for the current job, then it overlays the current **media size**. This is an attempt to honor the **size** specified by the SCU, if provided. (If not provided, then **media size** retains its default value from step 1.)
4. If the Called AE Title for the current Association indicates Job Settings (either System or Custom), then they are processed as follows:
 - If the Job Settings **MediaType** is specified, then it overlays the current **media type**.
 - If the Job Settings **MediaSize** is specified, then it overlays the current **media size**.

This allows Job Settings to override both the imager defaults, and the values sent by the SCU, when both **MediaType** and **Size** are specified in the Job Settings (which they typically are, especially for the System Job Settings used expressly for Media Combination Selection – see column 1 of Table 5.6.1).

5. This yields a **media size** and **type** selection for the current sheet, which must then be compared to the imager's valid media list, which takes into account the model designation and enabled Feature Keys of the current imager. If the selected media combination is valid (supported), then the selection is used, and the current sheet is queued for that media.
6. If the media combination is found to be invalid (not supported) on the current imager, then the values revert back to the **Default Media** settings, from step 1, since these are guaranteed to be valid. (This also ensures that a print is always queued, regardless of the media indicated by the job and its associated parameters.)

Following are some typical use-cases, providing examples of how this algorithm works in practice. For all of the examples, assume that the imager's **Default Media** settings are as follows:

Grayscale Default Media Type / Size = DV Film Blue / 14x17

Color Default Media Type / Size = CV Paper / A

- **Example 1:** SCU specifies nothing media-related (use Defaults)

Called AE Title = PRINT_SCP (no matching JobSettings for this title)

BasicFilmSession.MediaType (2000,0030) = Not Sent

BasicFilmBox.FilmSizeID (2010,0050) = Not Sent

Since no JobSettings are indicated by the Called AE Title, and neither media type nor size are specified in the relevant DICOM attributes, the Default Media selections are used. This yields the following results, based on the type of images sent (color vs. grayscale):

Grayscale Media Type / Size = DV Film Blue / 14x17

Color Media Type / Size = CV Paper / A

- **Example 2:** Size and Type specified by SCU.

Called AE Title = PRINT_SCP (no matching JobSettings for this title)

BasicFilmSession.MediumType (2000,0030) = BLUE FILM

BasicFilmBox.FilmSizeID (2010,0050) = 8INX10IN

Since no JobSettings are indicated by the Called AE Title, and both size and type are sent by the SCU, these values are eligible for use. And, since 8x10 blue film is supported on the current imager, the selection is valid. Thus, the media selection would be the same for color or grayscale images sent with these settings, and would be:

Grayscale and Color Media Type / Size = DV Film Blue / 8x10

- **Example 3:** Only size specified by SCU resulting in valid and invalid combination.

Called AE Title = PRINT_SCP (no matching JobSettings for this title)

BasicFilmSession.MediumType (2000,0030) = Not Sent

BasicFilmBox.FilmSizeID (2010,0050) = 8INX10IN

Since no JobSettings are indicated by the Called AE Title, and only the size is sent by the SCU, it must be combined with the Default Media type to look for a valid media combination. For grayscale jobs, this results in a valid combination, which is:

Grayscale Media Type / Size = DV Film Blue / 8x10

However, for color jobs, it results in an invalid combination (CV Paper / 8x10), and so the selection reverts to the Default Media selection for color, which is:

Color Media Type / Size = CV Paper / A

- **Example 4:** Only type specified by SCU resulting in valid and invalid combination.

Called AE Title = PRINT_SCP (no matching JobSettings for this title)

BasicFilmSession.MediumType (2000,0030) = BLUE FILM

BasicFilmBox.FilmSizeID (2010,0050) = Not Sent

Since no JobSettings are indicated by the Called AE Title, and only the type is sent by the SCU, it must be combined with the Default Media size to look for a valid media combination. For grayscale jobs, this results in a valid combination, which is:

Grayscale Media Type / Size = DV Film Blue / 14x17

However, for color jobs, it results in an invalid combination (DV Film Blue / A), and so again the selection reverts to the Default Media selection for color, which is:

Color Media Type / Size = CV Paper / A

- **Example 5:** Everything specified, including Job Settings (Job Settings win)

Called AE Title = 14x17-dvfc (System Job Settings do exist for this title)

BasicFilmSession.MediumType (2000,0030) = BLUE FILM

BasicFilmBox.FilmSizeID (2010,0050) = 8INX10IN

Since the Called AE Title specifies a particular media combination via one of the System Job Settings, and this combination is supported on the current printer, this selection wins out regardless of the type of job sent. Thus, the selection would be:

Grayscale or Color Media Type / Size = DV Film Clear / 14x17

5.6 Feature Selection Using System Job Settings

There are currently three types of pre-configured System Job Settings designed for selecting the following features: 1) media combination (size and type); 2) print priority; and 3) output tray selection. Using one of these Job Settings names as the Called AE Title for an Association forces those settings for all print jobs within that Association.

The User's Manual contains the definitive list, but the current set is given here as reference. (Note that Job Settings names are not case sensitive.)

Table 5.6.1 – System Job Settings Names (for Called AE Titles)

Media Combination Selection	Print Priority Selection	Output Tray Selection
14x17-dvfb	priority-high	receive-1
14x17-dvfc	priority-medium	receive-2
14x17-dvp	priority-low	receive-3
11x14-dvfb		
11x14-dvfc		
11x14-dvp		
8x10-dvfb		
8x10-dvfc		
8x10-dvp		
a-cvf		
a-cvp		
a-cvt		
a-dvp		
a4-cvf		
a4-cvp		
a4-cvt		
a4-dvp		
defaultcolor*		
defaultgrayscale*		

***NOTE:** These 'default' settings are special System Job Settings names that point to the Default Media selections for color and grayscale print jobs, respectively, as set through the control panel menus. Using one of these forces the Default Media selection indicated, regardless of the DICOM attributes specified by the SCU. This is equivalent to stopping at Step 1 of the Media Selection Algorithm described in Section 5.5.

5.7 Printable Area Configuration

The Codonics imagers have configurable parameters for printable area (or maximum pixel matrix size) for each media type and size combination. They are configured for a given software release, and are currently set to the following values:

Table 5.7.1 – Printable Area per Media Type and Size

Media Type	Media Size	Printable Area (cols x rows)
DV Film (Blue and Clear)	8 X 10	2406 X 2790
	11 X 14	3376 X 4072
	14 X 17	4322 X 5025
DV Paper	A	2580 X 3164
	A4	2514 X 3374
	11 X 14	3376 X 4072
	14 X 17	4322 X 5025
CV Paper	A	2580 X 3400
	A4	2514 X 3620
CV Film	A	2580 X 3400
	A4	2514 X 3620

While not actually configurable, the “dot size” (or size of a single pixel) of the Horizon imager is related to its printable area, and is often required for PrintSCU configuration. For reference, the Horizon pixel size is:

- 79.5 microns (metric), or
- .00313 inches = 3.13 mils (USA)

This yields an approximate dot pitch of 319.5 DPI.

In order to determine the pixel matrix size for each image box in a standard multi-format print, the following formulae are used:

$$\text{image_box_pixel_matrix_cols} = \frac{\text{printable_area_cols} - ((\text{image_format_cols} - 1) \times 3)}{\text{image_format_cols}}$$

$$\text{image_box_pixel_matrix_rows} = \frac{\text{printable_area_rows} - ((\text{image_format_rows} - 1) \times 3)}{\text{image_format_rows}}$$

These formulae represent the fact that a 3 pixel gap is placed between image cells on a standard multi-format print. (Note that integer arithmetic is used, since pixels must be represented as whole numbers.)

For example, assume that an SCU requests a print with the following parameters:

MEDIUM TYPE (2000,0030) = BLUE FILM

FILM SIZE ID (2010,0050) = 14INX17IN

IMAGE DISPLAY FORMAT (2010,0010) = STANDARD\3,4

The Image Box pixel matrix size for each image on the film can be calculated as follows:

$$\text{image_box_pixel_matrix_cols} = \frac{4322 - ((3 - 1) \times 3)}{3} = 1438$$

$$\text{image_box_pixel_matrix_rows} = \frac{5025 - ((4 - 1) \times 3)}{4} = 1254$$

Thus, each image cell on this 14x17, 12-up print has a pixel matrix size of: 1254 x 1438 pixels.

6. SUPPORT OF EXTENDED CHARACTER SETS

The DCF does not currently provide support for multi-byte characters.

The default repertoire for character strings is the Basic G0 Set of the International Reference Version of ISO 646:1990 (ISO-IR 6). See DICOM PS 3.5-1999, Annex E for a table of the DICOM default repertoire and its encoding.

Note: The Basic G0 Set is identical with the common character set of ISO 8859.

7. CODES AND CONTROLLED TERMINOLOGY

The DCF uses the Baseline Context Groups defined in DICOM PS 3.3-1999. No alternative or private Context Groups or Coding Schemes are used.

8. REFERENCES

Quoted below are references to and portions of the sections of DICOM PS 3.0-1999 that relate to the preparation of a conformance statement. In addition, a list of DICOM Change Proposals that have been incorporated within this release of the DCF Print Server is provided.

8.1 DICOM PS 3.2-1999, Annex A (Normative) DICOM Conformance Statement Template

This Annex is a template which shall be used to generate a DICOM Conformance Statement. A DICOM Conformance Statement shall begin with an introduction which sets the framework. The introduction shall describe the implementation and how, in general terms, it uses DICOM to achieve its purposes. ...

8.2 DICOM PS 3.2-1999, Annex B (Informative) DICOM Conformance Statement Sample

This Annex is a sample DICOM Conformance Statement for a fictitious DICOM Implementation. It is presented as an example only. The viability of such an implementation should not be assumed as the purpose of this Annex is only to guide the writer of DICOM Conformance Statements by providing a Conformance Statement example. ...

8.3 DICOM PS 3.4-1999, Annex H.3.4 Print Management Service Class Conformance Statement

The implementation Conformance Statement of these SOP Classes shall follow PS 3.2.

...

The SCP Conformance Statement shall specify the following items:

- maximum number of supported Associations at the same time
- list of supported SOP Classes and Meta SOP Classes
- minimum and maximum number of printable pixel matrix per supported film size
- for each of the supported SOP Classes:
 - list of supported optional SOP Class Attributes and DIMSE Service Elements
 - for each supported Attribute (mandatory and optional Attribute):
 - valid range of values
 - default value if no value is supplied by the SCU
 - status code (Failure or Warning) if SCU supplies a value which is out of range
- for each supported DIMSE Service, the SCP behavior for all specific status codes
- description of each supported custom Image Display Format (2010,0010) e.g., position and dimensions of each composing image box, numbering scheme of the image positions
- description of each supported Annotation Display Format ID (2010,0030) e.g., position and dimensions of annotation box, font, number of characters
- description of each supported configuration table (e.g. identification, content)
- if the SCP supports N-ACTION for the Film Session SOP Class then the SCP shall specify the maximum number of collated films
- in the case of grayscale imagers that print color images, the behavior of printing color images
- for Pull Print Request Meta SOP Class SCPs, behavior when Image Overlay, Annotation, and Presentation LUT options are contained in the Stored Print Storage SOP Class
- if cropping of images is supported, the algorithm for removing rows and columns from the image

8.4 DICOM Correction Proposals Incorporated

Below is a list of DICOM Correction Proposals that have been incorporated in the DCF. The complete text of each correction proposal document is available for download at <http://medical.nema.org/DICOM/CP/> or <http://medical.nema.org/Dicom/final/>. The text below is taken from the correction proposal log located at the same sites.

CP Number	Description from CP Overview Log Document
166	Correction of Retire Reference Print (Image Box Relationship Module)
173	Presentation LUT Parameters, Basic Film Box versus Basic Film Session
178	Add standard paper size to defined terms for Film Size ID
179	Omission in supplement 38 Basic Image Overlay SOP Class
180	Clarification of behavior of Presentation LUT attributes
181	Behavior clarification for Presentation LUT and Basic Print Image Overlay Box SOP Class

— End of Document —