Interoperability Conformance Specification: spectralReflectance – Part 1: basic spectral processing

Contents

Foreword

This document has been prepared following the ICC Intellectual Property Policy. This policy is based on the ITU-T/ITU-R/ISO/IEC Guidelines for Implementation of the Common Patent Policy (23 April 2012), with interpretations and clarifications to make it specific to ICC. A Patent Statement and Licensing Declaration form is available.

ICC Interoperability Conformance Specifications, of which this document is an example, may be submitted to the competent ISO Technical Committee for consideration and development as an ISO document. If so, this foreword is to be replaced by the appropriate wording supplied by ISO.

Introduction

ISO 20677-1 defines specifications that provide a platform for defining extended (iccMAX) colour management profiles and systems for various colour workflow domains. It provides a platform for which domain specific specifications can be defined that make use of iccMAX extensions to the existing cross-platform profile format of ISO 15076-1. Thus there is greater flexibility for defining colour transforms and profile connection spaces to meet needs that cannot easily be met with ISO 15076-1. It is not envisioned that all colour management systems that use ISO 20677-1 will implement all the features or capabilities it specifies. Requirements specifying restrictions to iccMAX that apply to a particular workflow are defined in workflow domain specifications known as Interoperability Conformance Specifications, of which this document is one example. Additionally, for some domain specific workflows it is envisioned that workflows will connect both to profiles defined by ISO 20677-1 (iccMAX) and those defined by ISO 15076-1.

An Interoperability Conformance Specification (ICS) is approved and registered by the International Color Consortium (ICC). It defines minimum structural and operational requirements for writing and reading ICC profiles in order to address a specific problem and/or functionality that cannot readily be handled using the profile format defined by ISO 15076-1. An ICS document essentially defines restrictions to ISO 20677-1 for a specific use case.

Interoperability Conformance Specification: spectralReflectance

1 Scope

All parts of this specification define scenario requirements and restrictions to profiles based on ISO 20677-1:2019 for the purpose of connecting multi-spectral data with a spectrally-based Profile Connection Space (PCS).

The particular sub-set of the tags defined in ISO 20677-1:2019 that are required to be present is defined, together with any optional tags that are permitted. The connections between profiles are described, and the processing elements that the CMM is required to support are identified.

This part of this ICS defines transforms with limited processing element support thus enabling spectral imaging workflows with lower implementation requirements.

Other parts of this ICS may define transforms with more extended processing element support for more complicated modeling and color management situations.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20677-1:2019, *Image technology colour management — Extensions to architecture, profile format, and data structure: iccMAX*

NOTE: The most recent version of the iccMAX specification is available on the ICC web site [2].

3 Terms and definitions

All terms and definitions relevant to this document are provided in ISO 20677-1:2019.

3.1 observing conditions

the observer's colour matching functions and illuminant associated with the spectralViewingConditionsTag of the Profile Connection Condition (PCC) used to connect the profile to the PCS.

4 Use case

4.1 Domain

Profiles and workflows conforming to this ICS shall apply to the domain of General (i.e. the domain of application is unspecified).

4.2 Intended use

The intended use of this specification is to define workflows in which multi-spectral data are converted to or from a spectral reflectance PCS. Subsequent conversion to colorimetry can be achieved by applying the illuminant and observer specified in the spectralViewingConditionsTag.

4.3 Restrictions

ISO 20677-1 provides full details of the requirements for iccMAX profiles. This document defines a set of restrictions which apply to profiles created for the specific use case described above. Such restrictions include the sub-set of tags from ISO 20677-1:2019 which are permitted in profiles conforming to this document.

5 Workflow

5.1 Profile sub-classes

A supporting CMM shall support the sub-classes of the profile classes identified in Table 1 for conformance with this ICS. All profile classes are defined in ISO 20677-1.

Table 1. Sub-classes of profile classes defined by this ICS

Profile	Profile class	Sub-class Identifier	Class signature	Sub-class signature
	colorSpace	spectralRefectance	'spac' (73706163h)	'sref' (73726566h)
	Input Device	spectralRefectance	'scnr' (73636e72h)	'sref' (73726566h)

5.2 Connection Scenarios

5.2.1 General

A 'sref' spectralReflectance profile connects *x* input channels (where *x* corresponds to the number of channels of the Data colour space field of the header) to a spectral Profile Connection Space containing *n* spectral channels (where *n* corresponds to the number of spectral PCS channels defined in the header). It can be used as either a source profile, a destination profile, or as a PCC override.

5.2.2 Profiles for ICS workflow scenarios

Table 2 provides overview information about additional profiles that are used to describe several profile connection scenarios conforming to this ICS.

Table 2. Additional profiles referenced in workflow scenarios defined by this ICS

Profile	Description

C	Profile conforming to ISO 20677-1 or ISO 15076-1 containing (a) colorimetric transform(s) with CMM configured to use a colorimetric transform type
S	Profile conforming to ISO 20677-1 containing (a) spectral reflectance transform(s) with the CMM configured to use a spectral transform type
P	Profile conforming to ISO 20677-1 containing Profile Connection Condition tags (spectralViewingConditionsTag, customToStandardPccTag, standardToCustomPccTag)
1	Profile conforming to ISO 20677-1 utilizing Profile Connection Conditions to go into or out of the PCS
2	Profile conforming to ISO 20677-1 or ISO 15076-1

5.2.3 Workflow Scenarios

5.2.3.1 General

The following sections document scenarios that general purpose CMMs should implement to conform to this ICS. For each scenario the profile sequence is depicted along with associated CMM control parameters that select between workflow scenarios.

Note: It is recognized that specialized CMMs may choose to not implement all the scenarios in these sections due to particular configuration or requirements of their supporting application(s).

5.2.3.2 Scenario A.1: Connecting a spectralReflectance profile as source to a destination profile with a colorimetric PCS

Figure 1 – Profile sequence for Scenario A.1

In this scenario a profile conforming to this ICS (profile R from Table 1) is used as a source profile with a spectral PCS connected to an arbitrary profile (profile C from Table 2) that is set up to use colorimetric PCS. The transform type for profile R is “spectral” indicating that the transform from a DToBxTag from profile R is used to transform device values to a spectral reflectance PCS.

A CMM that supports this scenario shall be configured to process profiles in the sequence shown in Figure 1 with the associated CMM control parameters as identified in Table 3 and described by ISO 20677:2019 Annex K.

Table 3. CMM control parameters for Scenario A.1

Profile	CMM Control Parameter	Value
R	Rendering Intent	Any
	Transform Type	Spectral
	PCC Override	None
C	Rendering Intent	Any
	Transform Type	Colorimetric
	PCC Override	None

The observing conditions of profile R are used to convert from spectral reflectance to tristimulus XYZ colorimetry. If the observing conditions from profile R do not match the observing conditions used for profile C then the transform from the CustomToStandardTag in profile R is applied.

The resulting colorimetry is then transformed and applied as needed according to the requirements (ICS or specification) associated with profile C.

5.2.3.3 Scenario B.1: Connecting a spectralReflectance profile as source using a PCC override to a destination profile with a colorimetric PCS

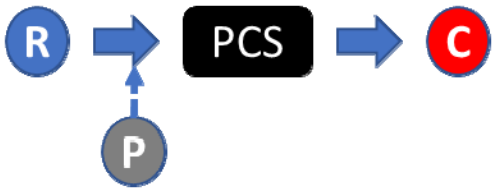

Figure 2 – Profile sequence for Scenario B.1

In this scenario a profile conforming to this ICS (profile R from Table 1) is used as a source profile with a spectral PCS connected to an arbitrary profile (profile C from Table 2) that is set up to use colorimetric PCS. The transform type for profile R is "spectral" indicating that the transform from a DToBxTag from profile R is used to transform device values to a spectral reflectance PCS.

A CMM that supports this scenario shall be configured to process profiles in the sequence shown in Figure 2 with the associated CMM control parameters as identified in Table 4 and described by ISO 20677:2019 Annex K.

Table 4. CMM control parameters for Scenario B.1

Profile	CMM Control Parameter	Value
R	Rendering Intent	Any
	Transform Type	Spectral
	PCC Override	P
C	Rendering Intent	Any
	Transform Type	Colorimetric
	PCC Override	None

Since a profile override is specified, the observing conditions of profile P (from Table 2) are used to convert from spectral reflectance to tristimulus XYZ colorimetry. If the observing conditions from profile P do not match the observing conditions used for profile C then the transform from the customToStandardPccTag in profile P is applied.

The resulting colorimetry shall then be transformed and applied as needed according to the requirements (ICS or specification) associated with profile C.

5.2.3.4 Scenario C.1: Connecting a spectralReflectance profile as source to a destination profile with a spectral PCS

Figure 3 – Profile sequence for Scenario C.1

In this scenario a profile conforming to this ICS (profile R from Table 1) is used as a source profile with a spectral PCS connected to an arbitrary profile (profile S from Table 2) that is set up to a spectral PCS. The transform type for profile R is "spectral" indicating that the transform from a DToBxTag from profile R is used to transform device values to a spectral reflectance PCS.

A CMM that supports this scenario shall be configured to process profiles in the sequence shown in Figure 3 with the associated CMM control parameters as identified in Table 5 and described by ISO 20677:2019 Annex K.

Table 5. CMM control parameters for Scenario C.1

Profile	CMM Control Parameter	Value
R	Rendering Intent	Any
	Transform Type	Spectral
	PCC Override	None
S	Rendering Intent	Any
	Transform Type	Colorimetric
	PCC Override	None

The resulting spectral PCS data shall first be transformed and applied as needed according to the requirements (ICS or specification) associated with profile S.

Note: Spectral PCS sampling, range adjustments, and/or spectral PCS type adjustments are performed as needed according to Annex A of ISO 20677:2019.

5.2.3.5 Scenario D.1: Connecting source profile with a spectral PCS to a spectralReflectance profile as destination

Figure 4 – Profile sequence for Scenario D.1

In this scenario an arbitrary profile (profile S from Table 2) that provided spectral PCS values is connected to a profile conforming to this ICS (profile R from Table 1) used as a destination profile.

A CMM that supports this scenario shall be configured to process profiles in the sequence shown in Figure 4 with the associated CMM control parameters as identified in Table 6 and described by ISO 20677:2019 Annex K.

Table 6. CMM control parameters Scenario D.1

Profile	CMM Control Parameter	Value
S	Rendering Intent	Any
	Transform Type	Spectral
	PCC Override	None
R	Rendering Intent	Any
	Transform Type	Spectral
	PCC Override	None

Device values shall first be transformed to a spectral PCS according to the requirements (ICS or specification) associated with profile S.

The resulting spectral PCS data shall then be transformed to device values using the selected BToDxTag from profile R (since the transform type associated with profile R is 'spectral').

Note: Spectral PCS sampling, range adjustments, and/or spectral PCS type adjustments are performed as needed according to Annex A of ISO 20677:2019.

5.2.3.6 Scenario E.1: Using a spectralReflectance profile as a PCC override

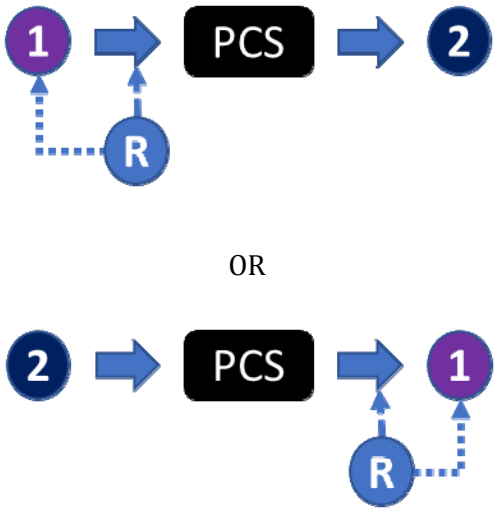

Figure 5 – Profile sequence for Scenario E.1

In this scenario the profile connection conditions of a profile conforming to this specification (profile R from Table 1) are used as a PCC override of an arbitrary profile 1 (from Table 2). The observing conditions in profile R may be used as part of the application of the transform or PCS

conversion/adjustment as required for profile 1. Additionally, the transform from the standardToCustomPccTag or customToStandardPccTag of profile R shall be applied as needed as part of the PCS conversion/adjustment for profile 1 when the PCS specified in the header of profile R is not the standard D50 PCS and does not match the PCS of Profile 2.

A CMM that supports this scenario shall be configured to process profiles in one of the sequences shown in Figure 5 with the associated CMM control parameters as identified in Table 7 and described by ISO 20677:2019 Annex K.

Table 7. CMM control parameters Scenario E.1

Profile	CMM Control Parameter	Value
1	Rendering Intent:	Any
	Transform Type:	Any
	PCC Override:	R
2	Rendering Intent:	Any
	Transform Type:	Any
	PCC Override:	None

In this case scenario other transforms of profile R shall be ignored.

5.3 Other scenario implementation details

Where CMMs support the application of abstract profiles they should also provide support for applying abstract class profiles as part of additional PCS processing associated with the scenarios in section 5.2.

6 Sub-class Profile Requirements

6.1 General

Requirements for iccMAX profiles conforming to this ICS document are listed here. ICC v4 profiles shown in Section 5 above shall conform to ISO 15076-1.

6.2 Requirements

The requirements for the spectralReflectance sub-class of Colorspace class profiles are shown below.

The encoding of the profile header shall be as defined in ISO 20677-1, with the specific requirements shown in Table 8.

Table 8. Header requirements

Header field	Required content
Profile class	‘spac’ (73706163h) or ‘scnr’ (73636e72h)
Profile subclass	‘sref’ (73726566h)
Profile subclass major	1

version	
Profile subclass minor version	0
Profile flags	0
Device attributes	0 or 1
Data colour space	'ncxxxx' where xxxx is a hex value corresponding to the number of spectral channels in the data encoding
MCS	0
Colorimetric PCS	0
Spectral PCS	'rsxxxx' where xxxx is a hex value corresponding to the number of spectral channels in the PCS
Spectral PCS range	Start and end wavelengths of the spectral PCS encoded as float16 values
Bispectral PCS	0

Full details of the encoding of the header fields in Table 8 are given in ISO 20677-1.

6.2.1 Required tags

In addition to the common requirements defined in 8.2 of ISO 20677-1, profiles shall contain the tags listed in Table 9.

Table 9. Required tags

Tag name	Signature	Required content
DToB3	'D2B3'	LutAToBType or multiProcessElementType using any combination of curveSetElement, matrixElement, CLUTElment, extendedCCLUTElement, and tintArrayElement
BToD3	'B2D3'	LutBToAType or multiProcessElementType using any combination of curveSetElement, matrixElement, CLUTElment, extendedCCLUTElement, and tintArrayElement
spectralWhitePointTag	'swpt'	float16NumberType containing an array of values defining the spectral reflectance or emission of the media white point
customToStandardPccTag	'c2sp'	multiProcessElementType containing a single 3x3 matrix element
standardToCustomPccTag	's2cp'	multiProcessElementType containing a single 3x3 matrix element
spectralViewingConditionsTag	'svcn'	Structure defining observer, illuminant and (optionally) surround

The encoding of the tags listed in Table 9 shall be as defined in ISO 20677-1:2019.

Any additional processing elements shall not be present.

6.2.2 Example

The profile Spec400_10_700-D50_2deg-Part1.icc is encoded according to the requirements of this ICS document and is available in the iccMAX Testing suite v.2.1.17 [3].

NOTE An XML representation of Spec400_10_700-D50_2deg-Part1.icc is also provided in the iccMAX Testing suite.

7 Conformance

A profile shall be considered to be in conformance with this ICS document if it meets the following conditions:

- The profile connects to the channels specified in section 5.
- The profile header includes the required content from Table 8.
- All required tags listed in Table 9 are present in the profile.
- The profile structure and all tags conform to ISO 20677-1:2019.

A CMM shall be considered to be in complete conformance with this ICS if it meets the following conditions:

- The CMM can parse profiles that conform to this ICS
- The CMM supports and is capable of processing the channels specified in section 5 and any other profiles listed in Table 2 in the scenarios described in section 5.
- The CMM is able to process the tags listed in Table 9.
- When processing a profile conforming to this ICS, the CMM produces results that are a close approximation to those produced by the iccMAX Demo Implementation [3]

Bibliography

[1] ISO 20677-1:2019, *Image technology colour management — Extensions to architecture, profile format, and data structure*

[2] iccMAX http://www.color.org/iccmax/

[3] iccMAX Demo Implementation http://www.color.org/iccmax/index.xalter#reficcmax

