Interoperability Conformance Specification: extendedRange display and colorSpace – Part 3: Advanced encoding

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.

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1 Scope

All parts of this specification define scenario requirements and restrictions to profiles based on ISO 20677-1:2019 for the purpose of defining relationships between display device encodings for an extended dynamic range display or colour encoding and a colorimetric 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 but more extended illuminant support thus enabling extended dynamic range display space encoding workflows with less implementation requirements with an illuminant that directly corresponds to the white point of a display or working color space. The limited processing element support is the same limited set as provided by part 1 of this specification

This part of this ICS allows for use of a custom colorimetric PCS using different illuminants and observers with associated PCC tags as defined in ISO 20677-1.

Additionally, this part of this ICS allows transforms with more extended processing element support for more complicated modeling and color management situations including algorithmic modeling of color spaces and observer specific spectral modeling.

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 20677:2019.

4 Use case

4.1 Domain

Profiles and workflows conforming to this ICS shall apply to either the domain of display colour management of displays capable of and extended dynamic range or the use of exchange spaces related to a theoretical or ideal display capable of an extended dynamic range.

4.2 Intended use

The intended use of this specification is to define workflows for the colour management of displays with extended dynamic range or images with colour spaces utilizing an extended dynamic range.

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
E	display	extendedRange	'mntr'	'xrng'
E	colorSpace	extendedRange	'spac'	'xrng'

5.2 Connection Scenarios

5.2.1 General

A 'xrng' extendedRange display or colour space profile connects *X* input channels (where *X* corresponds to the number of channels of the Data colour space field of the header) to a XYZ colorimetric Profile Connection Space. For this part of this specification X is limited to 3 (associated with RGB displays). Profiles conformant to this specification can be used as either a source profile or a destination profile.

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 part of this ICS.

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

Profile	Description

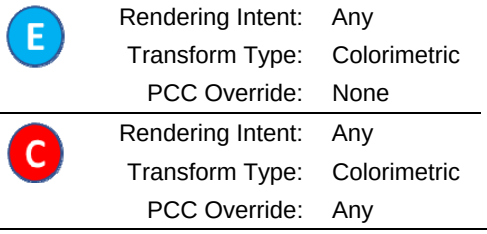
C	Profile conforming to ISO 20677-1 or ISO 15076-1 containing (a) colorimetric transform(s) with CMM configured to use a colorimetric transform type
P	Profile conforming to ISO 20677-1 containing Profile Connection Condition tags (spectralViewingConditionsTag, customToStandardPccTag, standardToCustomPccTag)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

5.2.3 Workflow Scenarios

5.2.3.1 General

The following sections document scenarios that conform to this part of this ICS.

5.2.3.2 Connecting an extendedRange profile as source to a destination profile with a colorimetric PCS

Profile Sequence	Profile Setup
	

In this scenario a profile conforming to this ICS is used as a source profile with a colorimetric PCS connected to an arbitrary profile that is set up to use a colorimetric PCS. The transform type for profile E is "colorimetric" indicating that the transform from an AToBxTag from profile E is used to transform device values to a colorimetric PCS.

This transform from profile E may utilize processing elements including (but not limited to) the emissionMatrixElement and the inverseEmissionMatrixElement to allow for observer specific colour matching functions to be applied to a spectral model of the primaries for the display or colour space. In this case the observer colour matching functions from the spectralViewingConditionsTag from profile E is used to determine the colorimetry to use as part of the matrix operation during processing.

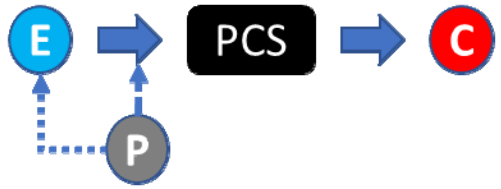
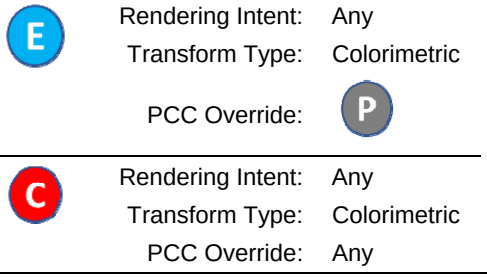
The transform from profile E may also utilize a calculator element that uses one or more CMM environment variables to control processing behaviour. Suitable default behaviour should be implemented in the calculator script if CMM environment variables are either not supported by the CMM or not provided to the CMM by the calling application. (Note: examples of such environment

variables might include a variable for ambient lighting with a signature of 'ambl' (616d626ch) or a variable for gamma selection with a signature of 'gmsl' (676d736ch)).

In this scenario either the observing conditions in profile E are for the standard 2-degree observer under D50 or they match those of profile C.

The resulting colorimetry from the transform in Profile E is transformed and applied as needed according to the rules (ICS or specification) associated with profile C.

5.2.3.3 Connecting an extendedRange profile as source using a PCC override to a destination profile with a colorimetric PCS

Profile Sequence	Profile Setup
	

In this scenario a profile conforming to this ICS is used as a source profile with a colorimetric PCS connected to an arbitrary profile that is set up to use a colorimetric PCS. The transform type for profile E is "colorimetric" indicating that the transform from an AToBxTag from profile E is used to transform device values to a colorimetric PCS.

The transform from profile E may utilize processing elements including (but not limited to) the emissionMatrixElement and the inverseEmissionMatrixElement to allow for observer specific colour matching functions to be applied to a spectral model of the primaries for the display or colour space. In this case the observer colour matching functions from the spectralViewingConditionsTag from profile P is used to determine the colorimetry to use as part of the matrix operation during processing.

The transform from profile E may also utilize a calculator element that uses one or more CMM environment variables to control processing behaviour. Suitable default behaviour should be implemented in the calculator script if CMM environment variables are either not supported by the CMM or not provided to the CMM by the calling application. (Note: examples of such environment variables might include a variable for ambient lighting with a signature of 'ambl' (616d626ch) or a variable for gamma selection with a signature of 'gmsl' (676d736ch)).

If the observing conditions of profile E do not match those of profile C then the transform from the CustomToStandardTag in profile P is applied resulting in standard colorimetry in the PCS.

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

5.2.3.4 Connecting source profile to an extendedRange profile as destination

Profile Sequence	Profile Setup
	1 Rendering Intent: Any Transform Type: Any PCC Override: Any E Rendering Intent: Any Transform Type: Colorimetric PCC Override: None

In this scenario an arbitrary profile is connected to a profile conforming to this ICS used as a destination profile.

Device values are first transformed to a colorimetric PCS according to the rules (ICS or specification) associated with profile 1.

If the observing conditions for profile E do not match those of the PCS resulting from applying profile 1 and the observing conditions for profile E are not the same as the 2-degree observer under D50 then the transform in the standardToCustomPccTag from profile E is applied.

The resulting colorimetry is then transformed by a BToAxTag from profile E since it is using the colorimetric transform type.

The transform from profile E may utilize processing elements including (but not limited to) the emissionMatrixElement and the inverseEmissionMatrixElement to allow for observer specific colour matching functions to be applied to a spectral model of the primaries for the display or colour space. In this case the observer colour matching functions from the spectralViewingConditionsTag from profile E is used to determine the colorimetry to use as part of the matrix operation during processing.

The transform from profile E may also utilize a calculator element that uses one or more CMM environment variables to control processing behaviour. Suitable default behaviour should be implemented in the calculator script if CMM environment variables are either not supported by the CMM or not provided to the CMM by the calling application. (Note: examples of such environment variables might include a variable for ambient lighting with a signature of 'ambl' (616d626ch) or a variable for gamma selection with a signature of 'gmsl' (676d736ch)).

5.2.3.5 Connecting source profile to an extendedRange profile as destination using a PCC override

Profile Sequence	Profile Setup
	1 Rendering Intent: Any Transform Type: Any PCC Override: Any E Rendering Intent: Any Transform Type: Colorimetric PCC Override: P

In this scenario an arbitrary profile is connected to a profile conforming to this ICS used as a destination profile.

Device values are first transformed to a colorimetric PCS according to the rules (ICS or specification) associated with profile 1.

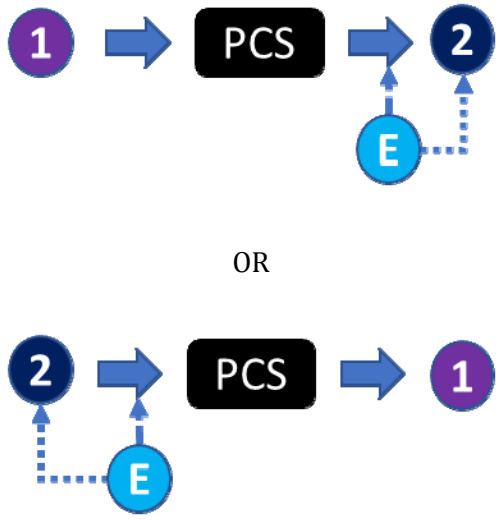
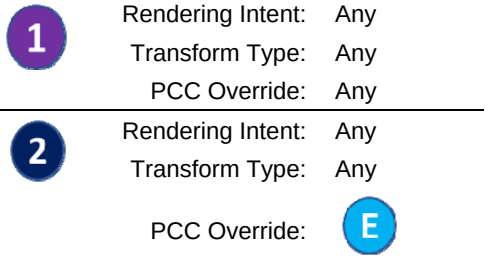
If the observing conditions for profile E do not match those of the PCS resulting from applying profile 1 and the observing conditions for profile E are not the same as the 2-degree observer under D50 then the transform in the standardToCustomPccTag from profile P is applied (as it provides the PCC override).

The resulting colorimetry is then transformed by a BToAxTag from profile E since it is using the colorimetric transform type.

This transform from profile E may utilize processing elements including (but not limited to) the emissionMatrixElement and the inverseEmissionMatrixElement to allow for observer specific colour matching functions to be applied to a spectral model of the primaries for the display or colour space. In this case the observer colour matching functions from the spectralViewingConditionsTag from profile P (as profile P provides the PCC override) is used to determine the colorimetry to use as part of the matrix operation during processing.

The transform from profile E may also utilize a calculator element that uses one or more CMM environment variables to control processing behaviour. Suitable default behaviour should be implemented in the calculator script if CMM environment variables are either not supported by the CMM or not provided to the CMM by the calling application. (Note: examples of such environment variables might include a variable for ambient lighting with a signature of 'ambl' (616d626ch) or a variable for gamma selection with a signature of 'gmsl' (676d736ch)).

5.2.3.6 Using an extendedRange profile as a PCC override

Profile Sequence	Profile Setup
	

In this scenario the profile connection conditions of a profile conforming to this specification are used as a PCC override of an arbitrary profile 2. The observing conditions may be used as part of the application of the transform (via processing elements that use a PCC observer or illuminant to perform transform) or PCS conversion/adjustment for profile 2. Additionally, the transform from the

standardToCustomPccTag or customToStandardPccTag of profile E may be applied as needed as part of the PCS conversion/adjustment for profile 1.

In this case all other transforms of profile E are ignored.

5.3 Other scenario implementation details

Application of abstract class profiles is also possible 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 extendedRange sub-class of display and 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 .

Table 3. Header requirements

Header field	Required content
Profile class	‘mntr’ (6d6e7472h) or ‘spac’ (73706163h)
Profile subclass	‘xrng’ (78726e67h)
Profile subclass major version	3
Profile subclass minor version	0
Profile flags	0
Device attributes	0 or 1
Data colour space	‘RGB ‘(58595a20h) or “ncxxxx” (6e63xxxxh) where xxxx represents the number of device channels in hexidecimal
MCS	0
Colorimetric PCS	‘XYZ‘ (58595a20h)
PCS Illuminant XYZ	Normalized XYZ tristimulus values corresponding to illuminant and observer in spectralViewingConditionsTag
Spectral PCS	0
Spectral PCS range	0
Bispectral PCS	0

Full details of the encoding of the header fields in 3 are given in ISO 20677-1.

6.2.1 Required tags

Profiles shall contain the tags listed in Table .

Table 4. Required tags

Tag name	Signature	Required content
profileDescriptionTag	'desc'	multiLocalizedUnicodeType structure containing invariant and localizable versions of the profile description for display
copyrightTag	'cprt'	multiLocalizedUnicodeType containing copyright information for the profile
AToB1Tag	'A2B1'	multiProcessElementType
BToA1Tag	'B2A1'	multiProcessElementType
mediaWhitePointTag	'mwpt'	XYZType containing XYZ tristimulus values of near diffuse white point in terms of absolute radiance
customToStandardPccTag	'c2sp'	multiProcessElementType
standardToCustomPccTag	's2cp'	multiProcessElementType
spectralViewingConditionsTag	'svcn'	Structure defining observer, illuminant and (optionally) surround

The encoding of the tags listed in Table 4 shall be as defined in ISO 20677-1:2019.

6.2.2 Additional optional tags

Profiles may also contain (but not limited to) the tags listed in Table .

Table 5. Additional optional tags

Tag name	Signature	Content requirements
AToBxTag	'A2Bx' where x≠1	multiProcessElementType
BToAxTag	'B2Dx' where x≠1	multiProcessElementType
gamutBoundaryDescriptionXTag	'gbdX' where X is associated with a rendering intent	gamutBoundaryDescriptionType

6.2.3 Example

The profile Rec2100HlgFull-Part3.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 the example profile 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 3.
- All required tags listed in Table 3 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 conformance with this ICS if it meets the following conditions:

- The CMM is able to 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 4 and Table 5 (as appropriate).
- 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

