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Image technology colour management — Extensions to architecture, profile format and data structure

Gestion des couleurs dans les technologies de l'image — Extensions d'architecture, de format de profil et de structure de données

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Contents

Page

Foreword ... **ix**

Introduction ... **x**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions and abbreviated terms ... **1**
3.1 Terms and definitions ... 1
3.2 Abbreviated terms ... 2

4 Extended basic types ... **3**
4.1 General ... 3
4.2 Extended basic type listing ... 3
4.2.1 azimuthNumber ... 3
4.2.2 float16Number ... 3
4.2.3 float64Number ... 4
4.2.4 horizontalNumber ... 4
4.2.5 Sparse matrix encodings ... 4
4.2.6 sparseMatrixEncodingType ... 6
4.2.7 spectralRange ... 7
4.2.8 tintArray ... 7
4.2.9 valueEncodingType ... 7
4.2.10 verticalNumber ... 8
4.2.11 zenithNumber ... 8

5 Conformance ... **9**

6 Expanded PCSs, rendering intents and device encoding ... **9**
6.1 General considerations ... 9
6.2 Extensions to device colour encoding ... 9
6.3 Extensions to PCSs ... 10
6.3.1 General ... 10
6.3.2 Profile connection conditions ... 10
6.3.3 Spectral PCSs ... 11
6.3.4 BRDF connection ... 13
6.3.5 Directional viewing connection ... 13
6.4 Multiplex connection spaces ... 13
6.4.1 General ... 13
6.4.2 MCS signature encoding ... 14
6.5 Colour encoding space profiles ... 14

7 Profile requirements ... **15**
7.1 General ... 15
7.2 Profile header ... 17
7.2.1 General ... 17
7.2.2 Extended profile header field definitions ... 17
7.2.3 ColourEncodingSpace class profile header field definitions ... 18
7.2.4 Profile size field (bytes 0 to 3) ... 18
7.2.5 Preferred CMM type field (bytes 4 to 7) ... 18
7.2.6 Profile version and sub-version field (bytes 8 to 11) ... 18
7.2.7 Profile/device class field (bytes 12 to15) ... 19
7.2.8 Data colour space field (Bytes 16 to 20) ... 19
7.2.9 PCS field (Bytes 20 to 23) ... 20
7.2.10 Date and time field (bytes 24 to 35) ... 21
7.2.11 Profile file signature field (bytes 36 to 39) ... 21
7.2.12 Primary platform field (bytes 40 to 43) ... 21
7.2.13 Profile flags field (bytes 44 to 47) ... 21
7.2.14 Device manufacturer field (bytes 48 to 51) ... 22

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Document Preview
ISO 20677:2019
https://standards.iteh.ai/catalog/standards/sist/...-a2eb-20829f36b1dd/iso-20677-2019

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7.2.15 Device model field (bytes 52 to 55) 22
7.2.16 Device attributes field (bytes 56 to 63) 22
7.2.17 Rendering intent field (bytes 64 to 67) 23
7.2.18 PCS illuminant field (bytes 68 to 79) 23
7.2.19 Profile creator field (bytes 80 to 83) 23
7.2.20 Profile ID field (bytes 84 to 99) 23
7.2.21 Spectral PCS field (bytes 100 to 103) 24
7.2.22 Spectral PCS range field (bytes 104 to 109) 25
7.2.23 Bi-Spectral PCS range field (bytes 110 to 115) 25
7.2.24 MCS field (bytes 116 to 119) 26
7.2.25 Profile/device sub-class (bytes 124 to 127) 26
7.2.26 Reserved field (bytes 124 to 127) 26
7.3 Tag table 26
7.3.1 Overview 26
7.3.2 Tag count (byte position 0 to 3) 27
7.3.3 Tag signature (byte position 4 to 7 and repeating) 27
7.3.4 Offset to beginning of tag data element (byte position 8 to 11 and repeating) 27
7.3.5 Tag data element size (byte position 12 to 15 and repeating) 27
7.4 Tag data 28

8 Required tags 28
8.1 General 28
8.2 Common requirements 28
8.3 Input profiles 28
8.4 Display profiles 29
8.5 Output profiles 29
8.6 DeviceLink profile 30
8.7 ColorEncodingSpace profile 30
8.8 ColorSpace profile 31
8.9 Abstract profile 31
8.10 NamedColor profile 31
8.11 MultiplexIdentification profile 32
8.12 MultiplexLink profile 32
8.13 MultiplexVisualization profile 32
8.14 Precedence order of tag usage 32
8.14.1 General 32
8.14.2 Input, display, output or colour space profile types 32
8.14.3 Abstract profile types 33
8.14.4 DeviceLink profile types 33
8.14.5 MultiplexIdentification profile types 33
8.14.6 MultiplexLink profile types 33
8.14.7 MultiplexVisualization profile types 33
8.14.8 MCS to parameter-based BRDF profile table usage 34
8.14.9 BRDF profile table usage 34
8.14.10 Parameter-based BRDF profile table usage 35
8.14.11 Directional profile table usage 35

9 Tag definitions 36
9.1 General 36
9.2 Specific tag listing 36
9.2.1 AToB0Tag 36
9.2.2 AToB1Tag 37
9.2.3 AToB2Tag 37
9.2.4 AToB3Tag 37
9.2.5 AToM0Tag 37
9.2.6 brdfColorimetricParameter0Tag 38
9.2.7 brdfColorimetricParameter1Tag 38
9.2.8 brdfColorimetricParameter2Tag 38
9.2.9 brdfColorimetricParameter3Tag 39

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ISO 20677:2019

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9.2.10 brdfSpectralParameter0Tag 39
9.2.11 brdfSpectralParameter1Tag 39
9.2.12 brdfSpectralParameter2Tag 40
9.2.13 brdfSpectralParameter3Tag 40
9.2.14 brdfAToB0Tag 40
9.2.15 brdfAToB1Tag 41
9.2.16 brdfAToB2Tag 41
9.2.17 brdfAToB3Tag 41
9.2.18 brdfBToA0Tag 42
9.2.19 brdfBToA1Tag 42
9.2.20 brdfBToA2Tag 43
9.2.21 brdfBToA3Tag 43
9.2.22 brdfBToD0Tag 43
9.2.23 brdfBToD1Tag 44
9.2.24 brdfBToD2Tag 44
9.2.25 brdfBToD3Tag 45
9.2.26 brdfDToB0Tag 45
9.2.27 brdfDToB1Tag 45
9.2.28 brdfDToB2Tag 46
9.2.29 brdfDToB3Tag 46
9.2.30 brdfMToB0Tag 46
9.2.31 brdfMToB1Tag 47
9.2.32 brdfMToB2Tag 47
9.2.33 brdfMToB3Tag 47
9.2.34 brdfMToS0Tag 48
9.2.35 brdfMToS1Tag 48
9.2.36 brdfMToS2Tag 48
9.2.37 brdfMToS3Tag 49
9.2.38 BToA0Tag 49
9.2.39 BToA1Tag 50
9.2.40 BToA2Tag 50
9.2.41 BToA3Tag 50
9.2.42 BToD0Tag 50
9.2.43 BToD1Tag 51
9.2.44 BToD2Tag 51
9.2.45 BToD3Tag 51
9.2.46 calibrationDateTimeTag 52
9.2.47 charTargetTag 52
9.2.48 colorEncodingParamsTag 52
9.2.49 colorSpaceNameTag 52
9.2.50 colorantOrderTag 53
9.2.51 colorantOrderOutTag 53
9.2.52 colorantInfoTag 53
9.2.53 colorantInfoOutTag 53
9.2.54 colorimetricIntentImageStateTag 53
9.2.55 copyrightTag 55
9.2.56 customToStandardPccTag 55
9.2.57 cxfTag 56
9.2.58 deviceMfgDescTag 56
9.2.59 deviceModelDescTag 56
9.2.60 directionalAToB0Tag 56
9.2.61 directionalAToB1Tag 57
9.2.62 directionalfAToB2Tag 57
9.2.63 directionalAToB3Tag 58
9.2.64 directionalBToA0Tag 58
9.2.65 directionalBToA1Tag 59
9.2.66 directionalBToA2Tag 59
9.2.67 directionalBToA3Tag 59

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO 20677:2019
https://standards.iteh.ai/catalog/standards/iso/54278abb-779b-47a9-a2eb-20829f36b1dd/iso-20677-2019

9.2.68 directionalBToD0Tag 60
9.2.69 directionalBToD1Tag 60
9.2.70 directionalBToD2Tag 61
9.2.71 directionalBToD3Tag 61
9.2.72 directionalDToB0Tag 61
9.2.73 directionalDToB1Tag 62
9.2.74 directionalDToB2Tag 62
9.2.75 directionalDToB3Tag 62
9.2.76 DToB0Tag 63
9.2.77 DToB1Tag 63
9.2.78 DToB2Tag 63
9.2.79 DToB3Tag 64
9.2.80 gamutBoundaryDescription0Tag 64
9.2.81 gamutBoundaryDescription1Tag 64
9.2.82 gamutBoundaryDescription2Tag 64
9.2.83 gamutBoundaryDescription3Tag 64
9.2.84 multiplexDefaultValuesTag 64
9.2.85 multiplexTypeArrayTag 65
9.2.86 measurementInfoTag 65
9.2.87 measurementInputInfoTag 65
9.2.88 mediaWhitePointTag 66
9.2.89 metadataTag 66
9.2.90 MToA0Tag 66
9.2.91 MToB0Tag 67
9.2.92 MToB1Tag 67
9.2.93 MToB2Tag 67
9.2.94 MToB3Tag 68
9.2.95 MToS0Tag 68
9.2.96 MToS1Tag 68
9.2.97 MToS2Tag 69
9.2.98 MToS3Tag 69
9.2.99 namedColorTag 69
9.2.100 perceptualRenderingIntentGamutTag 70
9.2.101 profileDescriptionTag 70
9.2.102 profileSequenceInformationTag 70
9.2.103 referenceNameTag 70
9.2.104 saturationRenderingIntentGamutTag 71
9.2.105 spectralViewingConditionsTag 71
9.2.106 spectralWhitePointTag 71
9.2.107 standardToCustomPccTag 71
9.2.108 surfaceMapTag 72
9.2.109 technologyTag 72

10 Tag type definitions 72
10.1 General 72
10.2 Specific tag type listing 72
10.2.1 colorantOrderType 72
10.2.2 curveType 73
10.2.3 dataType 74
10.2.4 dateTimeType 74
10.2.5 dictType 74
10.2.6 embeddedHeightImageType 76
10.2.7 embeddedNormalImageType 77
10.2.8 float16ArrayType 78
10.2.9 float32ArrayType 79
10.2.10 float64ArrayType 79
10.2.11 gamutBoundaryDescriptionType 79
10.2.12 lutAToBType 80
10.2.13 lutBToAType 83

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO 20677:2019
https://standards.iteh.ai/catalog/standards/iso/5427/8abb-479b-47a9-a2eb-20829f36b1dd/iso-20677-2019

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10.2.14 measurementType ... 86
10.2.15 multiLocalizedUnicodeType ... 88
10.2.16 multiProcessElementsType ... 88
10.2.17 parametricCurveType ... 89
10.2.18 s15Fixed16ArrayType ... 91
10.2.19 signatureType ... 91
10.2.20 sparseMatrixArrayType ... 91
10.2.21 spectralViewingConditionsType ... 92
10.2.22 tagArrayType ... 94
10.2.23 tagStructType ... 95
10.2.24 u16Fixed16ArrayType ... 95
10.2.25 uInt16ArrayType ... 96
10.2.26 uInt32ArrayType ... 96
10.2.27 uInt64ArrayType ... 96
10.2.28 uInt8ArrayType ... 97
10.2.29 utf16Type ... 97
10.2.30 utf8Type ... 97
10.2.31 utf8ZipType ... 97
10.2.32 XYZType ... 98
10.2.33 zipXmlType ... 98

11 multiProcessingElementType definitions ... 99
11.1 General ... 99
11.2 Specific processing element listing ... 99
11.2.1 calculatorElement ... 99
11.2.2 curveSetElement ... 114
11.2.3 CLUTElement ... 117
11.2.4 emissionCLUTElement ... 117
11.2.5 emissionMatrixElement ... 119
11.2.6 emissionObserverElement ... 121
11.2.7 extendedCLUTElement ... 122
11.2.8 inverseEmissionMatrixElement ... 122
11.2.9 JabToXYZElement ... 124
11.2.10 matrixElement ... 125
11.2.11 sparseMatrixElement ... 125
11.2.12 reflectanceCLUTElement ... 126
11.2.13 reflectanceObserverElement ... 128
11.2.14 tintArrayElement ... 130
11.2.15 XYZToJabElement ... 130
11.2.16 “Future” expansion elements ... 131

12 Struct tag type definitions ... 132
12.1 General ... 132
12.2 Struct tag type listing ... 132
12.2.1 brdfTransformStructure ... 132
12.2.2 colorantInfoStructure ... 138
12.2.3 colorEncodingParamsStructure ... 139
12.2.4 measurementInfoStructure ... 144
12.2.5 namedColorStructure ... 146
12.2.6 profileInfoStructure ... 152
12.2.7 tintZeroStructure ... 155

13 Tag Array Type definitions ... 157
13.1 General ... 157
13.2 Tag array indentifier type listing ... 157
13.2.1 namedColorArray ... 157
13.2.2 profileInfoArray ... 157

Annex A (informative) **Elemental calculations and inter-PCS operations ... 158**

Annex B (informative) **Gamut Boundary Description ... 183**

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ISO 20677:2019
https://standards.iteh.ai/catalog/standards/sist/54278d1b-779b-47c9-a2ab-20820f36b1dd/iso-20677-2019

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Annex C (informative) **ICC colour appearance model transformations** **186**
Annex D (informative) **Named colour profiles** **188**
Annex E (informative) **Sparse matrix operations** **190**
Annex F (informative) **calculatorElement text representation and examples** **194**
Annex G (informative) **BRDF overview and description** **198**
Annex H (informative) **Directional emissive colour** **208**
Annex I (informative) **Multiplex connection spaces** **209**
Annex J (informative) **ColorEncodingSpace profiles** **214**
Annex K (informative) **Workflow scenarios and CMM processing control options** **215**
Bibliography **220**

iTeh Standards
(https://standards.iteh.ai)
Document Preview

ISO 20677:2019
https://standards.iteh.ai/catalog/standards/iso/54278abb-779b-47a9-a2eb-20829f36b1dd/iso-20677-2019

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Introduction

0 General

This document defines specifications that provide a platform for defining extended (iccMAX) colour management profiles and systems for various colour workflow domains. It can be thought of as an extension to ISO 15076-1, defined by the International Color Consortium® (ICC). ISO 15076-1 specifies a profile format that is intended to provide a cross-platform profile format for the creation and interpretation of colour data. Central to ISO 15076-1 is the encoding of colour transforms between device colour encodings and profile connection spaces (PCSs) based upon D50 colorimetry with the CIE 1931 Standard 2-degree observer. For many workflows ISO 15076-1 has proven adequate for defining successful colour management systems. For other workflows ISO 15076-1 has been found to be limited in the flexibility of encoding colour transforms as well as defining means of profile colour connection that incorporate physical attributes of colour in addition to mere colour appearance.

The intent of this document is to provide a platform on which domain-specific specifications can be defined that make use of these extensions to the existing cross-platform profile format of ISO 15076-1. Thus, there is greater flexibility for defining colour transforms and PCSs to meet needs that cannot easily be met with ISO 15076-1. As such, it is not envisioned that all colour management systems that use this document will implement all the features or capabilities specified by this document. Specific requirements related to what is necessary to be implemented and supported relative to this document can be found in workflow domain specifications. Additionally, for some domain-specific workflows it is envisioned that there will be the need for simultaneous support for and interaction between ISO 15076-1 and profiles defined by this document.

It is assumed that the reader of this document has a good understanding of ISO 15076-1 as well as a good understanding of colour science and imaging, such as familiarity with CIE, ISO and IEC colour standards, general knowledge of device measurement and characterization, and familiarity with at least one operating system level colour management system.

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The following subclauses introduce a few of the more significant differences from ISO 15076-1.

0.1 Extended profile connection spaces

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0.1.1 ISO 15076-1 PCS encoding

In ISO 15076-1 PCS transform results are encoded relative to D50 with a 2-degree observer. If and when ISO 15076-1-based profiles are used in conjunction with this document, the PCS encoding specified in ISO 15076-1 are used with necessary conversions as needed.

0.1.2 Extended PCS encoding

PCS encoding is extended to allow PCS transform results to be relative to arbitrary illuminants and observers. Profile connection conditions (PCC) provided by either a profile or directly to the colour management module (CMM) can be applied to convert between different illuminants and observers. Additionally, a profile can define use of a spectrally-based PCS independent of the colorimetric-based PCS usage, with separate transform data between device encoding and the colorimetry and spectral PCS encodings.

0.2 Extended transform encoding

0.2.1 ISO 15076-1 transform encoding

ISO 15076-1 defines transforms using integer encoding in AToBx and BToAx tags. Floating point transform encoding can additionally be specified in optional DToBx and BToDx tags using multi-processing element tags.

Integer-based LUT tags have specific requirements for transform data and order.

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The multi-processing element tag type allows a sequence of transform elements to be applied in order to transform between device encoding and PCS encoding. The processing elements consist of matrices, one-dimensional curve sets and *n*-dimensional lookup tables.

0.2.2 iccMAX extended transform encoding

Spectrally-based PCS transforms are encoded using DToBx/BToDx tags when a spectral PCS is used. Colorimetric-based PCS transforms are encoded in matrix/TRC based profiles or AToBx/BToAx tags. Additionally, AToBx/BToAx tag transforms can be encoded using the multi-processing element tag type.

The multi-processing element tag type is extended to provide greater flexibility as well as encoding brevity in defining transforms. Extended elements include a stack-based programmable transform calculator, single-segment curves, N-D lookup tables with integer encoding, colour appearance model (CAM) conversions, sparse matrix processing and tint arrays.

Multi-processing element-based tags are used to define PCC within a profile. The CMM applies these tags as needed to perform PCS conversions.

0.2.3 Late-binding processing elements

The multi-processing element tag type has been extended to allow for processing elements that provide late-binding of the observer and/or illuminant from the PCC utilized by the profile. Either spectral information inside select processing elements is converted to colorimetric data shortly before processing of colour transforms is to be performed, or spectral to colorimetric transforms are established for processing of colour transformations. This late-binding of spectral to colorimetric processing is based on the PCC utilized by the multi-processing element. The media-white point and illuminant colorimetry used for absolute/relative PCS processing is also adjusted based upon the combined profile/PCC relationships when late-binding processing elements are used.

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0.3 Colour encoding space profiles

0.3.1 General

In ISO 15076-1, profiles define transforms that go from device to PCS. However, in some workflows the essential requirement is a method of defining what the data are rather than providing a transform that converts the data into a representation of colour.

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0.3.2 Colour space encoding

This document establishes a ColorEncodingSpace profile class to define profiles that can be used when the content owner wishes to identify the colour encoding of digital colour content and does not wish to provide a colour transformation to be used in converting or adapting the digital colour content from the identified current colour space encoding to any other colour space encoding.

0.4 Multiplex connection space profiles

0.4.1 General

Generally, the data encoding sides of profile transforms are not used to connect profiles using ISO 15076-1. Connection of data encoding channels is only meaningful when the number, order and encoding of the data encoding channels are identical. However, in some workflows, flexibility in the number and order of the channels is desirable with a meaningful way of identifying the encoding of the channels.

0.4.2 Multiplex connection space encoding

This document defines an additional profile connection mechanism that allows multiplex connection space (MCS) channels to be connected. MCS connection provides a means of defining flexible connection between “device like” channels of profiles that are identified by name. Order and existence of channels is flexible with the ability for a profile to specify subset requirements on the MCS channels in the connected profile and default values specified for missing channels. The input profile class

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has been extended to have an optional tag that connects to an MCS. Additionally, MultiplexLink and MultiplexVisualization profile classes have been defined for MCS processing.

0.5 Bidirectional reflection distribution function (BRDF) and directional emission profiles

0.5.1 General

ISO 15076-1 assumes 0:45 measurement geometry for reflection prints and diffuse radiance of displays. However, in many conditions colour appearance can change due to changes in lighting or viewing angle. Such goniochromatic effects cannot be encoded or communicated using ISO 15076-1.

0.5.2 Bidirectional reflection distribution function encoding

This document provides the ability to encode bidirectional reflection distribution function (BRDF) information, as well as example surface information, that 3D rendering systems can use to emulate goniochromatic effects. In this case the BRDF information is provided directly to the 3D rendering system without extensive colour management system involvement. Additionally, BRDF information can be used to define and communicate goniochromatic properties of named colours.

0.5.3 Directional emission function encoding

This document provides the ability to encode directional emission information which can be used to define and communicate goniochromatic properties of colours by viewing angle and relative position on a display.

0.6 Rendering intents

In ISO 15076-1 four rendering intents are defined: perceptual, media-relative colorimetry, ICC-absolute colorimetry and saturation. For the purposes of supporting spectrally-based PCSs, the media-relative colorimetry and ICC-absolute colorimetry intents are referred to in this document as media-relative and ICC-absolute intents which apply to both colorimetric as well as spectral conditions.

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Image technology colour management — Extensions to architecture, profile format and data structure

1 Scope

This document is based on ISO 15076-1, and describes an expanded profile specification and profile connections that permit greater flexibility and functionality than ISO 15076-1. All definitions and requirements in ISO 15076-1 are therefore in force unless otherwise specified by this document. This document defines minimum structural and operational requirements for writing and reading ICC profiles. Additional workflow requirements and restrictions are defined in domain-specific interoperability conformance specification (ICS) documents approved and registered by the ICC.

In this document, some ISO 15076-1 types have been removed, and others have been added. A colour management module (CMM) compatible with profiles conforming to this document will have backwards compatibility with profiles conforming to ISO 15076-1.

Where the name of a type in this document is the same as a type in ISO 15076-1, the type definition is based on the ISO 15076-1 definition. The exception is the definition of the MPE type, which has been expanded.

Where the extensions described in this document are not required in a particular workflow, ISO 15076-1 is used as the basis for colour management profiles and architectures.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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ISO 15076-1, *Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2010*

ISO 17972-1, *Graphic technology — Colour data exchange format — Part 1: Relationship to CxF3 (CxF/X)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
profile connection conditions
PCC
information used to define illuminant, observer for PCS along with transforms to convert to and from custom colorimetry and standard D50 colorimetry for the standard 2° observer

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3.1.2
profile connection space
PCS
colour space used to connect the source and destination profiles

Note 1 to entry: See ISO 15076-1:2010, Annex D for a full description.

3.2 Abbreviated terms

ANSI	American National Standards Institute
BRDF	bidirectional reflectance distribution function
CAM	colour appearance model
CIE	*Commission Internationale de l'eclairage* (International Commission on Illumination)
CLUT	colour lookup table (multi-dimensional)
CMM	colour management module
CMY	cyan, magenta, yellow
CMYK	cyan, magenta, yellow, key (black)
CRD	colour rendering dictionary
CRT	cathode-ray tube
EPS	encapsulated postscript
ICC	International Color Consortium
ICS	interoperability conformance specification
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LCD	liquid crystal display
LUT	lookup table
MCS	multiplex connection space
PCC	profile connection conditions
PCS	profile connection space
RGB	red, green, blue
TIFF	tagged image file format
TRC	tone reproduction curve

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