



BSI Standards Publication

Image technology colour management — Architecture, profile format and data structure

Part 1: Based on ICC.1:2022

National foreword

This British Standard is the UK implementation of ISO 15076-1:2025. It supersedes BS ISO 15076-1:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PAI/43, Graphic technology.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Image technology colour
management — Architecture,
profile format and data structure —**

**Part 1:
Based on ICC.1:2022**

*Gestion de couleur en technologie d'image — Architecture,
format de profil et structure de données —*

Partie 1: Sur la base de l'ICC.1:2022

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This third edition cancels and replaces the second edition (ISO 15076-1:2010), which has been technically revised.

The main changes are as follows:

- `cicpTag` has been added to enable HDR metadata to be carried in the profile;
- `metadataTag` and `dictType` have been added to enable flexible definition of additional metadata;
- it has been clarified that PCSXYZ values can be negative;
- Tag tables are now required to define a contiguous sequence of unique tag elements, with no gaps;
- `parametricCurveType` functions in [Table 69](#) have been corrected;
- informative [Annex B](#) content on embedding profiles has been replaced with a reference to an ICC Technical Note;
- informative [Annex E](#) on chromatic adaptation has been updated;
- the Bibliography and normative references have been updated.

Profiles created in conformance with this document are identified as Version 4.4.0.0 profiles.

A list of all parts in the ISO 15076 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 General

This document specifies the profile format defined by the International Color Consortium® (ICC). The intent of this format is to provide a cross-platform profile format for the creation and interpretation of colour data. Such profiles can be used to translate between different colour encodings, and to transform colour data created using one device into another device's native colour encoding. The acceptance of this format by application and operating system vendors allows end users to transparently move profiles, and images with embedded profiles, between different systems. For example, this allows a printer manufacturer to create a single profile for multiple applications and operating systems.

It is assumed that the reader of this document has 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.

0.2 International Color Consortium

The International Color Consortium was formed with the primary intent of developing and administering a colour profile format standard, and for the registration of the associated tag signatures and descriptions. The founding members of this consortium can be found on the ICC website¹⁾.

0.2.1 ICC profile versions

The initial version of the profile specification developed by the ICC has undergone various revisions, and it was agreed by the ICC that its revision 4.2 first be proposed as an International Standard. It is that revision which formed the basis of the first edition, ISO 15076-1:2005.^[28] The second edition, ISO 15076-1:2010,^[29] was based on ICC revision 4.3, which is fully backward compatible with 4.2. This document is based on ICC.1:2022 (the ICC revision 4.4 of ICC.1), and is fully backward compatible with earlier versions. All the technical specifications contained in the previous edition (ISO 15076-1:2010) are also given in this document, and new specifications exclusive to this document are identified in the Foreword. Informative material has also been updated and clarified.

The ICC specification is widely used and is referred to in other ISO standards. [Table 1](#) is provided to assist users to identify the main technical differences between versions.

1) Available from <https://color.org/iccmembers.xalter>

Table 1 — ICC and ISO versions of the ICC profile specification

ISO version	ICC version	Profile version	Main technical changes relative to previous version
ISO 15076-1:2005	ICC.1:2005	4.2	N/A
ISO 15076-1:2010	ICC.1:2010	4.3	Addition of — perceptual intent reference medium colour gamut — new technology signatures — a floating-point device encoding range — a colorimetric intent image state tag — a profile sequence identifier tag Deletion of the mediaBlackPointTag PCSXYZ no longer limited to the PCS illuminant
ISO 15076-1:2024	ICC.1:2024	4.4	Addition of — cicpTag to enable HDR metadata to be carried in the profile — metadataTag and dictType added to enable flexible definition of additional metadata Clarified that PCSXYZ values can be negative Tag tables now required to define a contiguous sequence of unique tag elements, with no gaps parametricCurveType functions corrected

The ICC will continue to administer its own version of this document and, if enhancements are made to ICC.1, they will be considered for future revisions of ISO 15076-1. ICC and ISO/TC 130 will work to ensure that there are no significant differences between the ICC and ISO versions of this document.

The ICC web site (www.color.org) provides supplementary information relevant to ISO 15076-1 and ICC.1 and additional resources for developers and users. It also provides information on how to become a member of ICC.

0.3 Colour management architecture and profile connection space

The underlying architecture assumed in this document is based around a reference colour space that is unambiguously defined. The colour specification method selected was that defined by CIE which is internationally accepted. The CIE system enables a set of tristimulus values (CIEXYZ) to be specified for a coloured stimulus. These tristimulus values enable a user to determine whether colours match in appearance when viewed by a typical observer in a specific viewing environment. It follows that it is possible to define the colour appearance of a sample by these tristimulus values (or some defined transformation of them) for a specified state of viewer adaptation. The colour appearance is simply the appearance of the colour to a typical human observer, as opposed to the physical characteristics of the colour stimulus, which is not fully specified using tristimulus values.

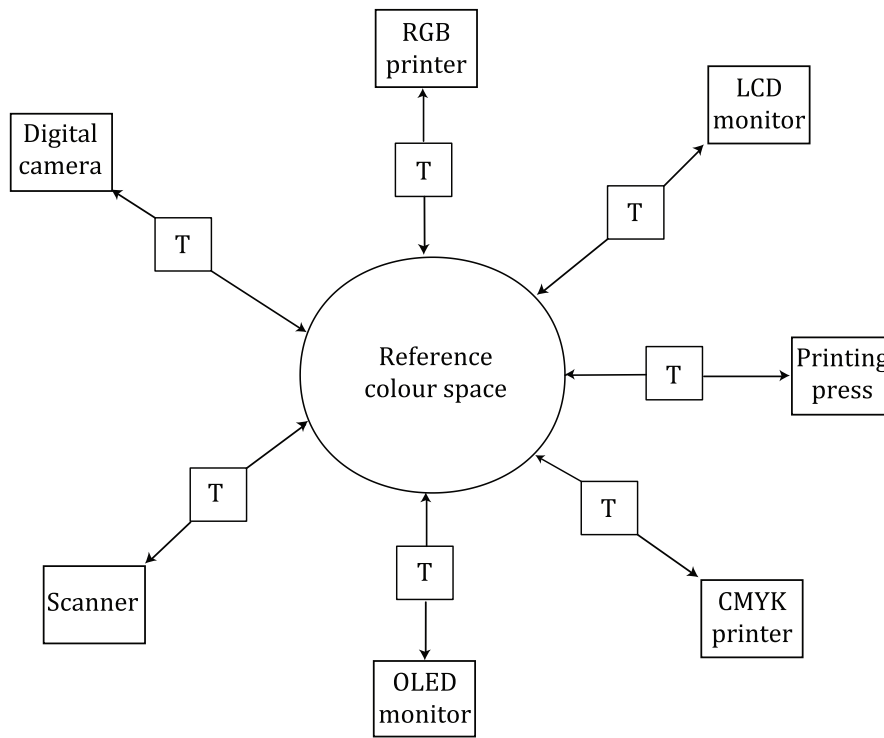
Calculation of the CIEXYZ values for transmitting or reflecting media is achieved from the spectral sum-product of the reflectance or transmittance of the sample, the relative spectral power distribution of the illumination source used to view it and the spectral 'sensitivity' of the standard observer. However, as CIE defines two standard observers, two measurement geometries (for reflecting media) and a large number of standard illuminants, it is necessary to restrict these options in order to have a colour specification system that is not ambiguous for a particular application. For this document, the ICC has defined such a restriction, based on ISO 13655, and the resultant colour spaces are known as PCSXYZ and PCSLAB. Furthermore, the simple CIE system (whether CIEXYZ or the CIELAB values derived from them) does not accommodate the effect of surrounding stimuli to the sample being measured (which can be different for various types of media) or the illumination. Both of these affect appearance so the PCS values do not by themselves specify appearance. To overcome this problem, the PCS is used in two different ways. The first accounts only for the assumed state of chromatic adaptation of the viewer, and describes the colorimetry of actual originals and their reproductions, chromatically adapted to the PCS adopted white chromaticity, through the colorimetric

rendering intents. The second, which describes the colorimetry of an image colour rendered to a standard reference medium under a specified viewing condition, is employed for the perceptual rendering intent and optionally for the saturation rendering intent. Thus, it can incorporate corrections for different states of viewer adaptation and other desired rendering effects, as well as accommodating differences between actual colour encoding and device dynamic ranges and colour gamuts, and those of the perceptual intent reference medium. When required, the viewing conditions can be specified to allow colour appearance to be determined for the colorimetric rendering intents.

In summary, the PCS is based on CIEXYZ (or CIELAB) determined for a specific observer (CIE Standard 1931 Colorimetric Observer, often known colloquially as the 2-degree observer), relative to a specific illuminant chromaticity (that of CIE D50), and measured with a specified measurement geometry (0°:45° or 45°:0°), for reflecting media. Measurement procedures are also defined for transmitting and self-luminous media. Since the conversion from CIEXYZ to CIELAB is quite unambiguous, profile builders can use either colour space for the PCS; the colour management system is able to determine which has been used from a tag in the header.

For colorimetric renderings where the measured data were not obtained relative to a D50 adopted white chromaticity, the profile builder is expected to adapt the data to achieve this. Therefore, a mechanism for identifying the chromatic adaptation used in such situations is provided. For the perceptual rendering intent, the viewing conditions and reference medium are specified in order to provide a clear target for colour rendering and re-rendering (including gamut mapping). In the following paragraphs, the reference colour space, to which reference is made, needs to include the viewing conditions and reference medium when the perceptual intent is being considered. For the perceptual rendering intent, profile builders are expected to undertake any corrections for appearance effects if the viewing conditions used for monitors and transmitting media (such as dark surrounds) differ from those typical for reflecting media, and to account for differences between actual media and the reference medium.

[Figure 1](#) shows how a reference colour space can be used to provide the common interface for transformations between different colour encodings, as used by different devices, or even different operational modes of the same device. Without it, a separate transformation would be required for each pair of device modes. If there are n device modes to be supported in a system, and it is necessary to provide a transformation between each pair of device modes, n^2 transforms would need to be defined and n new transforms would need to be defined every time a new device mode was added. As a new printer device mode can consist simply of a new paper type, this is not a practical solution. By using a reference colour space, only n transforms need be defined and only one new transform needs to be defined each time a new device mode is added; whatever device-to-device transforms are needed can be constructed by linking the source and destination profiles using the reference colour space as the interface.



Key

T colour management transform

Figure 1 — Use of a reference colour space

While images can be encoded directly in PCSXYZ or PCSLAB, this will not generally be the case. A number of colour encodings for open exchange have been standardized to meet a variety of needs. Depending on the use case, different bit depths, image states, reference media and colour gamuts are needed. Devices also have different characteristics resulting in different native encodings. Except for a few cases where default encodings for key system devices are used for exchange (like the sRGB encoding), it is not practical or productive to attempt to restrict system colour encoding support.

For reasons of precision, it is usually desirable to define the transformation between the colour data encoding and the profile connection space (PCS) at a high precision. If the transformation between a colour data encoding and the PCS is provided with an image file, it can be utilized when images are reproduced. In order that the transformation between the colour data encoding and the PCS can be interpreted by all applications it is important that it be defined in an open specification. The profile format defined in this document provides that specification.

0.4 Rendering intents

In general, actual device colour gamuts will fail to match each other, and that of the perceptual intent reference medium, to varying degrees. Because of this mismatch, and because of the needs of different applications, four rendering intents (colour rendering styles) are defined in this document. Each one represents a different colour reproduction objective. The colorimetric rendering intents operate directly on measured colorimetric values, with correction for chromatic adaptation when the measured values were not obtained relative to the PCS adopted white chromaticity. The other rendering intents (perceptual and saturation) operate on colorimetric values which are adjusted in an as-needed fashion to account for any differences between devices, media, and viewing conditions.

Two colorimetric rendering intents are specified in this document, though only one is included fully constructed in the profile. The included media relative colorimetric intent is based on media-relative colorimetry, which is normalized relative to the media white for reflecting, transmitting, and self-luminous media, or, in the case of colour encodings and capture, to the colour encoding values that correspond to the highest perceived brightness. Thus, the media white will have the values of 100, 0, 0 in PCSLAB. This ensures that highlight clipping will not occur when the media-relative colorimetric intent is used. The use

of media-relative colorimetry enables colour reproductions to be defined which maintain highlight detail, while keeping the medium 'white', even when the original and reproduction media differ in colour. However, this rendering intent introduces some change in all colours in the reproduction when the media whites of the source and destination do not match.

The PCS adopted white is defined to be the radiance of a perfect reflecting diffuser illuminated by a source with a spectral power distribution matching that of CIE Illuminant D50. ICC profiles contain the values of the media white, adapted to be relative to the chromaticity of the PCS adopted white. For the ICC-absolute colorimetric rendering intent, all of the colorimetric values are re-calculated to be relative to the tristimulus values of the PCS adopted white. When source and destination viewing conditions are identical and an exact colour match is required for all within-gamut colours (including the source medium colour), it is recommended that the ICC-absolute colorimetric rendering intent is used. This rendering intent can also be useful in other situations.

The colour rendering of the perceptual and saturation rendering intents is vendor specific. The former, which is useful for general reproduction of pictorial images, typically includes tone scale adjustments to map the dynamic range of one medium to that of another, and gamut reshaping and mapping to deal with gamut mismatches. The latter has historically been useful for images which contain objects such as charts or diagrams, and usually involves compromises, such as trading off preservation of hue in order to preserve the vividness of pure colours. As the saturation rendering intent is neither required to contain colorimetric characterization information or to use the perceptual intent reference medium, it is the only option, in proprietary systems, for providing colour rendering and re-rendering transforms to and from custom reference media represented in the PCS. For broader interoperability when using the saturation rendering intent, the perceptual reference medium can be used, and its use indicated.

For perceptual transforms it is necessary, in order to optimize colour rendering, to provide a realistic target for the colour rendering. For this reason, a reference medium and reference viewing condition have been defined which apply only to the perceptual rendering. The reference medium is defined as a hypothetical reflection print on a substrate with a white having a neutral reflectance of 89 %, and a density range of 2,459 3. The reference viewing condition is the P2 condition specified in ISO 3664, i.e. D50 at 500 lx for viewing reflecting media. A neutral surround of 20 % reflectance is assumed. The colour gamut of the reference medium is qualitatively specified as that of a reflection print, and whatever colour gamut is used in the PCS is required to be consistent with the specified dynamic range of the perceptual reference medium. It is recommended that the reference gamut specified in ISO 12640-3 be used as a more explicit target gamut for improved interoperability. It is recommended that profile creators consider this gamut to be the target for perceptual intent colour rendering and re-rendering to the PCS. Likewise, the perceptual intent colour re-rendering from the PCS needs to assume this gamut as the starting gamut for colour re-rendering to the destination medium. However, even when the use of this gamut is indicated, perceptual intent transforms need to be designed to produce the best visual results, and need not conform exactly to this gamut in the PCS.

The choice of a reference medium with a realistic black point for the perceptual intent provides a well-defined aim when colour rendering or re-rendering are required. Inputs with a dynamic range greater than a reflection print (e.g. a slide film image, or the colorimetry of high-range scenes) can have their highlights and shadows smoothly compressed to the range of the reference medium in such a way that these regions can be expanded again without undue loss of detail on output to wide-range media. Likewise, images from original media with limited dynamic range can be colour re-rendered to the expanded dynamic range of the reference medium, in order to produce better quality in subsequent reproductions. Bi-directional transform pairs (e.g. data-to-PCS and PCS-to-data for each rendering intent) in the profiles can be used to undo prior PCS-to-data colour re-rendering so that a differently optimized reproduction can be produced for a different reproduction medium.

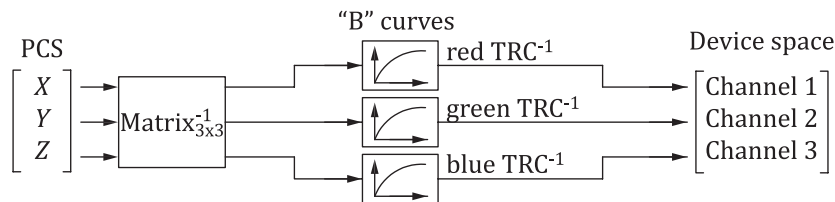
Profiles generally offer different transformations for different rendering intents. When the rendering intent is selected the corresponding transformation is selected by the colour management system. The choice of rendering intent is highly dependent upon the intended use. In general, the perceptual rendering intent is most applicable for the colour re-rendering of natural images, to make pleasing and aesthetically similar, but not exactly matching, reproductions on different media. The ICC-absolute colorimetric rendering intent is most appropriate for a proofing environment, where the colour reproduction obtained on one device is simulated on another. The media-relative colorimetric rendering intent is appropriate when mapping of the source medium white to the destination medium white is desired, but a full colour re-rendering is not.

For those requiring further information, an extended discussion of many of the issues described above is provided in [Annex D](#).

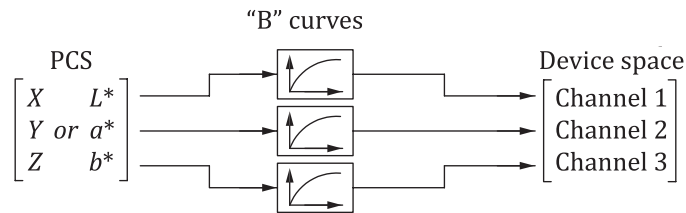
0.5 Colour profiles

Colour profiles provide colour management systems with the information necessary to convert colour data between different colour encodings, including device encodings. This document divides colour devices into three broad classifications, i.e. input devices, display devices and output devices. For each device class, a series of base algorithmic models are described which perform the transformation between colour encodings. [Figures 2](#) and [3](#) show examples of these models, which provide different trade-offs in memory footprint, colour quality and performance results. The matrix tone reproduction curve (TRC) model is explained in detail in [8.3.3](#) and [8.4.3](#), the lutAToBType and lutBToAType in [10.10](#) and [10.11](#), and the multiProcessElementsType in [10.14](#). The necessary parameter data to implement these models is described in the appropriate tag type descriptions in [Clause 10](#). This required data provides the information for the colour management framework default colour management module (CMM) to transform colour information between colour encodings. A representative architecture using these components is illustrated in [Figure 4](#).

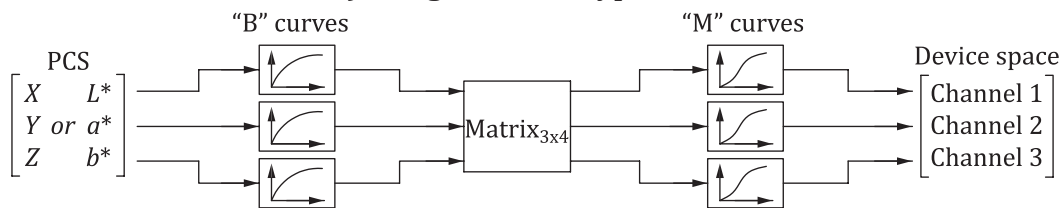
NOTE Only the models shown in [Figures 2](#) d), e), f) and [Figures 3](#) d), e) and f) can be used if the device space has more than three components/colours.



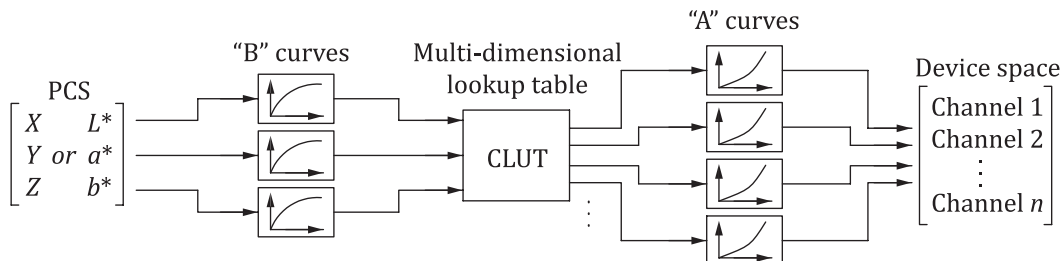
a) Using a matrix/TRC model



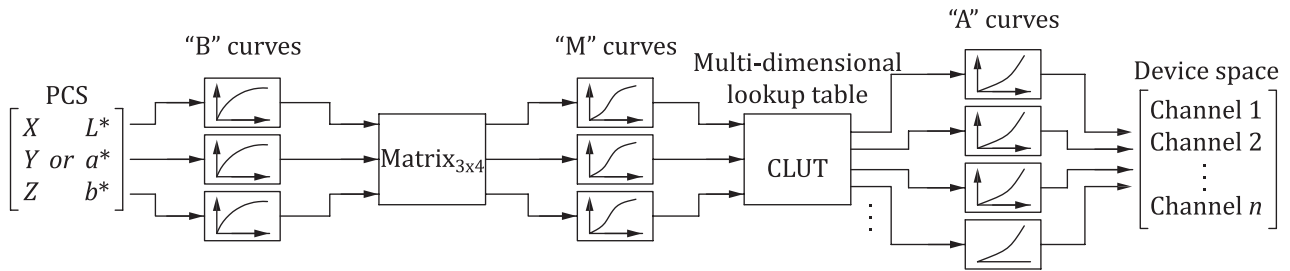
b) Using a lutBToAType model



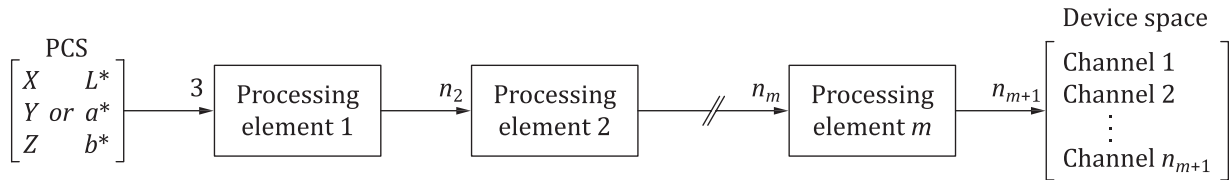
c) Using a lutBToAType model



d) Using a lutBToAType model

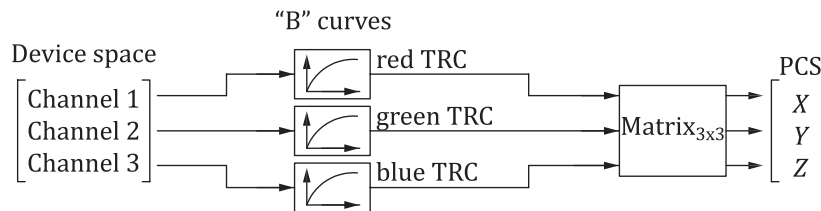


e) Using a lutBToAType model

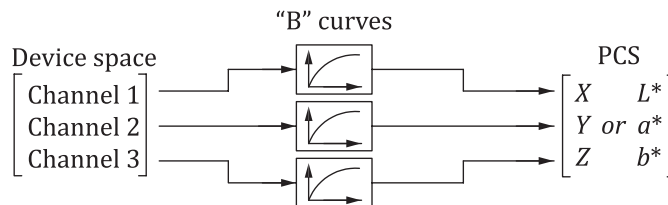


f) Using a multiProcessElementsType tag

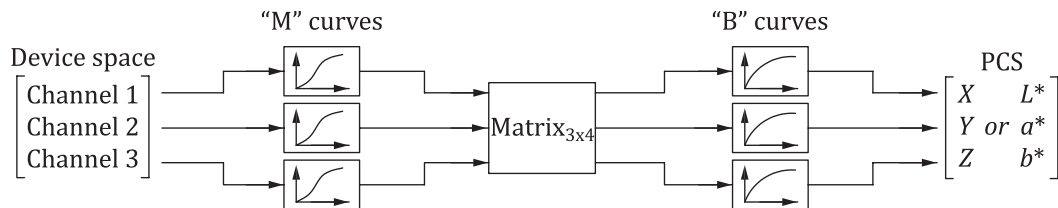
Figure 2 — Examples of different ways of converting a colour from PCS to device space



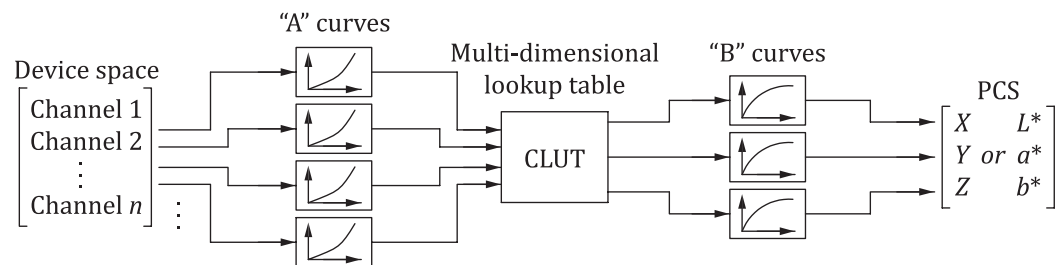
a) Using a matrix/TRC model



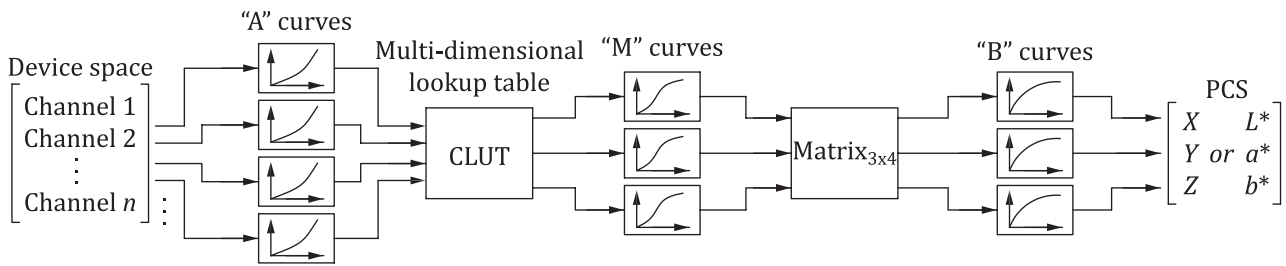
b) Using a lutAToBType model



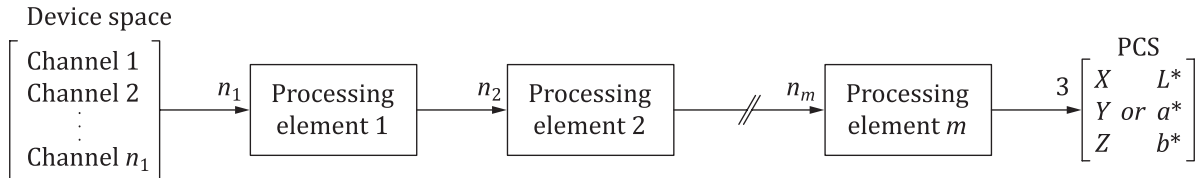
c) Using a lutAToBType model



d) Using a lutAToBType model



e) Using a lutAToBType model



f) Using a multiProcessElementsType tag

Figure 3 — Examples of different ways of converting a colour from device to PCS

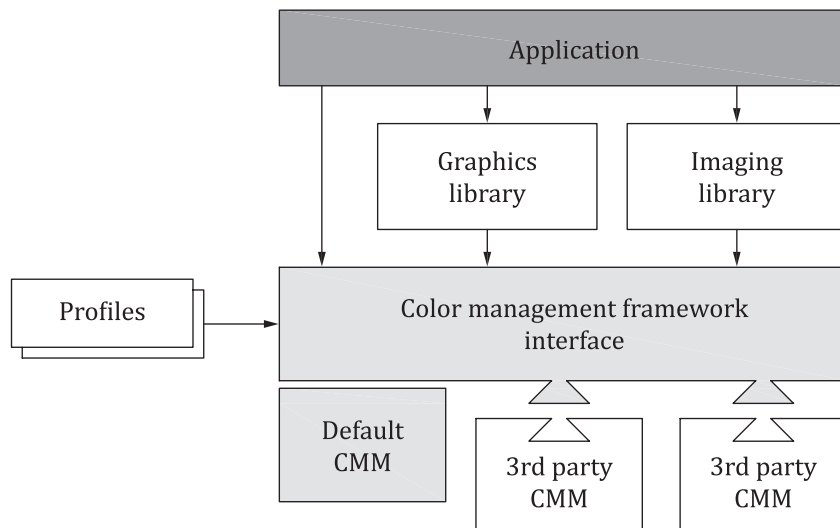


Figure 4 — Colour management architecture

0.6 Profile element structure

The profile structure is defined as a header followed by a tag table followed by a series of tagged elements that can be accessed randomly and individually. This collection of tagged elements provides three levels of information for developers: required data, optional data and private data. An element tag table provides a table of contents for the tagging information in each individual profile. This table includes a tag signature, the beginning address offset and size of the data for each individual tagged element. Signatures in this document are defined as a 4-byte hexadecimal number. This tagging scheme allows developers to read in the element tag table and then randomly access and load into memory only the information necessary to their particular software application. Since some instances of profiles can be quite large, this provides significant savings in performance and memory. The detailed descriptions of the tags, along with their intent, are included later in this document.

The required tags provide the complete set of information necessary for the CMM to translate colour information between the PCS and the data colour encoding. Each profile class determines which combination of tags is required.

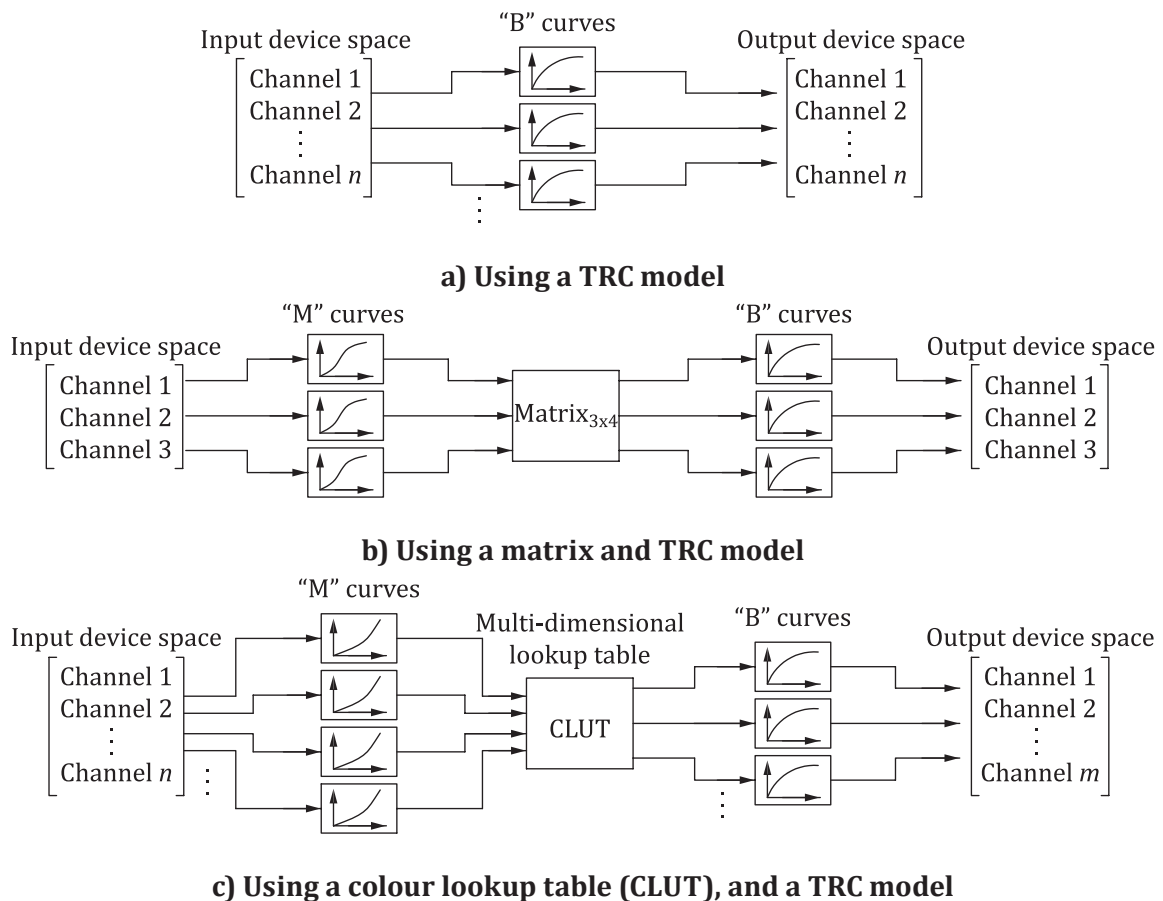
In addition to the required tags for each colour profile, a number of optional tags are defined that can be used for enhanced capabilities. In the case of required and optional tags, all of the signatures, an algorithmic description (where appropriate), and intent are registered with the International Color Consortium. Private data tags allow CMM developers to add proprietary value to their profiles. By registering just the tag signature and tag type signature, developers are assured of maintaining their proprietary advantages while maintaining compatibility with this document. However, since the overall philosophy of this format is to maintain an open, cross-platform standard, developers are encouraged to keep the use of private tags to an absolute minimum.

0.7 Embedded profiles

In addition to providing a cross-platform standard for the colour profile format, this document also describes the convention for embedding these profiles within graphics documents and images. Embedded profiles allow users to transparently move colour data between different computers, networks and even operating systems without having to worry if the necessary profiles are present on the destination systems. The intention of embedded profiles is to allow the interpretation of the associated colour data. Embedding profiles is described in ICC Technical Note 10-21 [20].

0.8 Other profiles

Four profile types, in addition to the device profile types described above, are defined in this document. DeviceLink profiles provide a dedicated transformation from one device encoding to another, which can be useful in situations where such a transformation is used frequently or has required optimisation to achieve specific objectives. (Figure 5 shows the various algorithmic models which can be used to construct a DeviceLink profile.)



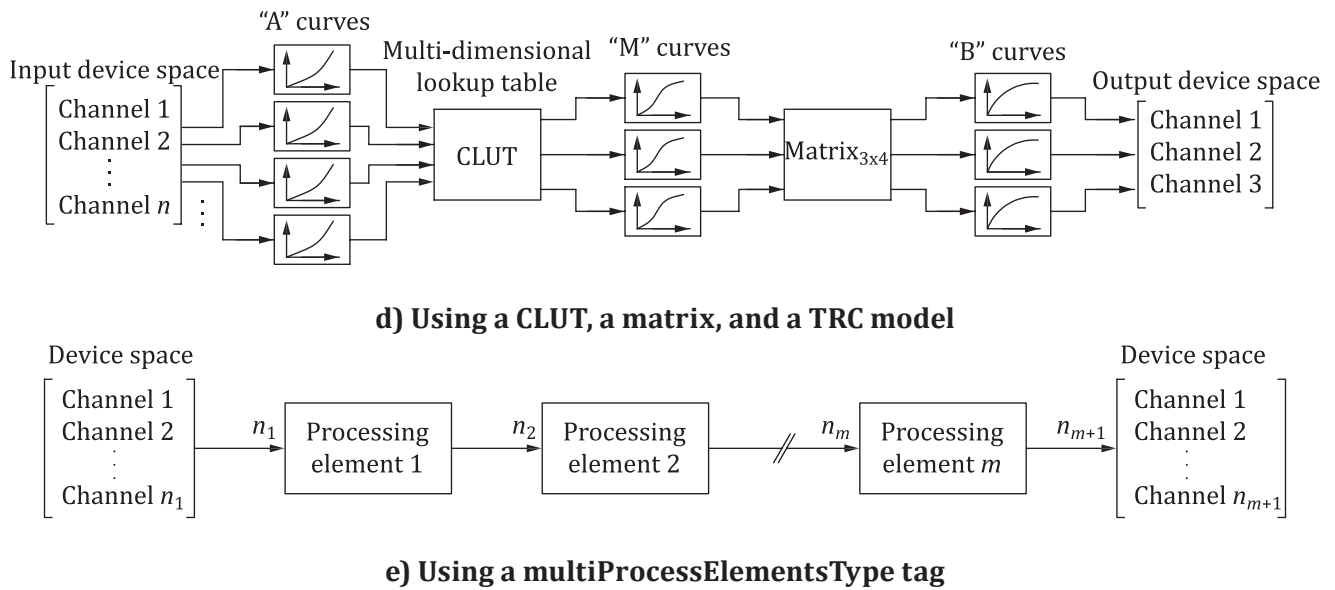


Figure 5 — Examples of converting a colour from device to device using a DeviceLink profile

ColorSpace profiles provide transformations between standard colour encodings and the PCS, providing a means for supporting existing and future colour encodings with backward compatibility. Abstract profiles are defined from PCS to PCS and enable colour transformations to be defined that provide some specific colour effects. NamedColor profiles provide a mechanism for specifying the relationship between device values and the PCS for specific colours, rather than for general images.

0.9 Organizational description of this document

This document addresses a very complex set of issues and it has been organized to provide a clear, clean, and unambiguous explanation of the entire format. To accomplish this, the overall presentation is from a top-down perspective, beginning with the summary overview presented above, followed by the necessary background information and definitions needed for unambiguous interpretation of the text. A description of the PCS and rendering intents is then provided before continuing down at increasing levels of detail into a byte stream description of the format. [Clause 6](#) describes the PCS and rendering intents; [Clause 7](#) describes the structure of the various fields required in a profile; and [Clause 8](#) describes the content of the required tags for each profile class. [Clause 9](#) lists the various tags (optional and required) and briefly summarizes the function of the tags as well as listing the signature and permitted tag types for each. The tag types are defined in [Clause 10](#). [Annex A](#) provides additional information pertaining to the data colour encodings and rendering intents used in this document. [Annex C](#) provides a general description of the PostScript Level 2 tags used in this document while [Annex D](#) provides some background material on the PCS. [Annex E](#) provides additional information pertaining to chromatic adaptation and the chromaticAdaptationTag while [Annex F](#) describes some computational models assumed in this document. [Annex G](#) summarizes in tabular form the required tags for each profile class as specified in [Clause 8](#). [Annex H](#) describes the relationship between this document and the ICC.2 specification.

0.9.1 Normalisation and numeric ranges

A convention adopted in the ICC architecture is to normalise data for PCS processing to the range 0 to 1 inclusive. This range is expressed in this document as [0 1].

0.10 Patent information

ISO draws attention to the fact that it is claimed that conformance with this document can involve the use of a patent concerning the outputResponseTag, (support of the outputResponseTag is optional), given in [9.2.36](#). Further information can be obtained from the ICC patent database²⁾.

2) Available from: <https://www.color.org/ip/patents.xalter>

Image technology colour management — Architecture, profile format and data structure —

Part 1: Based on ICC.1:2022

1 Scope

This document specifies a colour profile format and describes the architecture within which it can operate. This architecture supports the exchange of information which specifies the intended colour image processing of digital data. The required reference colour spaces and the data structures (tags) are also specified.

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.

ISO 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

ISO 639, *Code for individual languages and language groups*

ISO/IEC 646, *Information technology — ISO 7-bit coded character set for information interchange*

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code*

ISO 3664, *Graphic technology and photography — Viewing conditions*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO/IEC 23091-2, *Information technology — Coding-independent code points — Part 2: Video*

DIN 16536-2, *Testing of prints and printing inks in graphic technology — Colour density measurements on on-press or off-press prints — Part 2: Instrument specifications for reflection densitometers and their calibration*

EBU Tech. 3213-E, *EBU standard for chromaticity tolerances for studio monitors*

ITU-R BT.709-2, *Parameter values for the HDTV standards for production and international programme exchange*

SMPTE RP145, *SMPTE C Color Monitor Colorimetry*³⁾

INTERNET R.F.C. 1321, *The MD5 Message-Digest Algorithm*, R. Rivest, April 1992, Available from Internet <<http://www.ietf.org/rfc/rfc1321.txt>>

IEEE 754, *Standard for Binary Floating-Point Arithmetic*⁴⁾

ICC Tag Registry⁵⁾

3) Available from: <<https://store.smpte.org/category-s/22.htm>>

4) Available from: <<http://ieeexplore.ieee.org>>

5) Available from <https://www.color.org/registry/signature/TagRegistry/>

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 terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

adopted white

spectral radiance distribution as seen by an image capture or measurement device and converted to colour signals that are considered to be perfectly achromatic and to have an observer adaptive luminance factor of unity; i.e. colour signals that are considered to correspond to a perfect white diffuser

Note 1 to entry: The adopted white can vary within a scene.

Note 2 to entry: No assumption is to be made concerning the relationship between the adapted or adopted white and measurements of near perfectly reflecting diffusers in a scene, because measurements of such diffusers will depend on the illumination and viewing geometry, and other elements in the scene that can affect perception. It is easy to arrange conditions for which a near perfectly reflecting diffuser will appear to be grey or coloured.

[SOURCE: ISO 22028-1:2016 3.4]

3.1.2

ASCII text string

sequence of bytes, each containing a graphic character specified in ISO/IEC 646, the last character in the string being a NULL (character 0/0)

3.1.3

big-endian

order of addressing the bytes within a 16-bit, 32-bit or 64-bit value, from the most significant to the least significant, as the byte address increases

3.1.4

bit position

position of a bit within a field

Note 1 to entry: bits are numbered such that bit 0 is the least significant bit.

3.1.5

byte

8-bit unsigned binary integer

3.1.6

byte offset

number of bytes from the beginning of a field

3.1.7

CIELAB

CIE 1976 L^* , a^* and b^* values calculated from nCIEXYZ according to CIE 15

3.1.8

CIEXYZ

XYZ tristimulus values based on the CIE 1931 Standard Colorimetric Observer as defined in CIE 15

Note 1 to entry: Y is expressed in candelas per square metre.

3.1.9

nCIEXYZ

CIEXYZ values that have been uniformly scaled so that $Y = 1,0$ for the adopted white

Note 1 to entry: In the ICC specification, this is referred to as ICC-absolute colorimetry.

3.1.10

colour encoding

generic term for a quantized digital encoding of a colour space, encompassing both colour space encodings and colour image encodings

Note 1 to entry: Values specified by an encoding are the closest representation to the colour space or image values permitted by the encoding precision.

[SOURCE: ISO 22028-1:2016, 3.7, modified — Note to entry has been added]

3.1.11

colour management

communication of the associated data required for unambiguous interpretation of colour content data, and application of colour data conversions, as required, to produce the intended reproductions

Note 1 to entry: Colour content can consist of text, line art, graphics, and pictorial images, in raster or vector form, all of which can be colour managed.

Note 2 to entry: Colour management considers the characteristics of input and output devices in determining colour data conversions for these devices.

3.1.12

colour rendering

mapping of image data representing the colour-space coordinates of the elements of a scene to output-referred image data representing the colour-space coordinates of the elements of a reproduction

Note 1 to entry: Colour rendering generally consists of one or more of the following:

- compensating for differences in the input and output viewing conditions,
- tone scale and gamut mapping to map the scene colours onto the dynamic range and colour gamut of the reproduction, and
- applying preference adjustments.

[SOURCE: ISO 22028-1:2016, 3.11]

3.1.13

encoding maximum white

highest luminance achromatic colour that can be represented using a specified colour encoding

Note 1 to entry: For the purpose of this definition, a colour is achromatic if it has the same chromaticity as the adopted white. The choice of the adopted white is an user decision.

3.1.14

fixed point

method of encoding a real number into binary by putting an implied binary point at a fixed bit position

Note 1 to entry: Many of the tag types defined in this ICC specification contain fixed point numbers. Several references can be found (MetaFonts, etc.) illustrating the benefit of fixed point representation when compared to pure floating point representation in very structured circumstances.

3.1.15

hexadecimal

numeral system with a radix, or base, of 16, written using the symbols 0–9 and A–F, or a–f

Note 1 to entry: The notation used to indicate hexadecimal numbers in this ICC specification is xxh.

3.1.16

image state

attribute of a colour image encoding indicating the rendering state of the image data

[SOURCE: ISO 22028-1:2016 3.25]

3.1.17

imaging medium

surface from or through which light is emitted, reflected or transmitted to produce an image

3.1.18

medium black point

reference colour that is used in black point compensation transforms

Note 1 to entry: In a reproduction process, this is usually the near-neutral colour with the lowest luminance that can be produced by an imaging medium, measured using the specified measurement geometry. In a capture process this is usually the colour associated with the device side encoding minimum.

3.1.19

media white point

reference colour that is used as the basis for scaling of media relative transforms

Note 1 to entry: In a reproduction process, the media white point is usually the near-neutral colour with the highest luminance that can be produced by an imaging medium, measured using the specified measurement geometry. In the case where a layer of white ink is printed on the imaging medium, the media white point is usually the colour of this white ink as printed on the imaging medium.

Note 2 to entry: In a capture process the media white point is usually the colour associated with the device side encoding maximum white..

3.1.20

NULL

null

character coded in position 0/0 as specified in ISO/IEC 6429

3.1.21

PCS

profile connection space

colour space used to connect the source and destination profiles

Note 1 to entry: See [Annex D](#) for a full description.

3.1.22

PCS adopted white

adopted white where the spectral radiance distribution is that of the PCS illuminant

3.1.23

PCS illuminant

illuminant with the spectral radiance distribution of CIE illuminant D50 and $nCIEXYZ\ X = 0,964\ 2$, $nCIEXYZ\ Y = 1,0$, $nCIEXYZ\ Z = 0,824\ 9$

3.1.24

PCSLAB

CIELAB values calculated from PCSXYZ

3.1.25

PCSLAB encoding

PCSLAB values that have been encoded as 8-bit or 16-bit numbers, or as floating point numbers

3.1.26

PCSXYZ

$nCIEXYZ$ values that have been linearly scaled so that $PCSXYZ\ X = 0,964\ 2$, $PCSXYZ\ Y = 1,0$, $PCSXYZ\ Z = 0,824\ 9$ for media white

3.1.27

PCSXYZ encoding

PCSXYZ values that have been encoded as 16-bit numbers, or as floating point numbers

3.1.28

picture-referred image state

image state associated with image data that represents the colour-space coordinates of the elements of a hardcopy or softcopy image, encompassing both original-referred image data and output-referred image data

Note 1 to entry: When the phrase “picture-referred” is used as a qualifier to an object, it implies that the object is in a picture-referred image state. For example, picture-referred image data are image data in a picture-referred image state.

Note 2 to entry: Picture-referred image data will generally be colour-rendered for a specific real or virtual imaging medium and viewing condition.

Note 3 to entry: Picture-referred image data can include image data that do not originate from an original scene, such as text, line art, vector graphics and other forms of original artwork.

[SOURCE: ISO 22028-1:2016 3.33]

3.1.29

rendering intent

style of mapping colour values from one image description to another

Note 1 to entry: See [Clause 6](#) and [Annexes A](#) and [D](#) for a description of the four rendering intents (ICC-absolute colorimetric, relative colorimetric, perceptual and saturation) used in ICC profiles

3.1.30

scene

spectral radiances of a view of the natural world as measured from a specified vantage point in space and at a specified time

Note 1 to entry: A scene can correspond to an actual view of the natural world or to a computer-generated virtual scene simulating such a view.

[SOURCE: ISO 22028-1:2016 3.34]

3.1.31

spot colour

single colorant, identified by name, whose printing tone-values are specified independently from the colour values specified in a colour coordinate system

3.1.32

signature

alphanumerical 4-byte value, registered with the ICC

Note 1 to entry: Shorter values are padded at the end with 20h bytes.

3.1.33

viewing flare

veiling glare that is observed in a viewing environment but not accounted for in radiometric measurements made using a prescribed measurement geometry

[SOURCE: ISO 22028-1:2016 3.43]

Note 1 to entry: The viewing flare is expressed as a percentage of the luminance of adapted white.

3.1.34

veiling glare

light, reflected from an imaging medium, that has not been modulated by the means used to produce the image

[SOURCE: ISO 22028-1:2016 3.42]

3.2 Abbreviated terms

ANSI	American National Standards Institute
CIE	<i>Commission Internationale de l'éclairage</i> (International Commission on Illumination)
CICP	Coding-independent code points for video signal type identification
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
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LCD	Liquid crystal display
LUT	Lookup table
PCS	Profile connection space
RGB	Red, green, blue
TIFF	Tagged Image File Format
TRC	Tone reproduction curve

4 Basic number types

4.1 General

The basic numeric types used in this ICC specification are defined in [4.2](#) to [4.15](#).

NOTE As defined in [7.1](#), all profile data is encoded as big-endian.

4.2 dateTimeNumber

A dateTimeNumber is a 12-byte value representation of the time and date, where the byte usage is assigned as specified in [Table 2](#). The actual values are encoded as 16-bit unsigned integers (uInt16Number, see [4.10](#)).

Table 2 — dateTimeNumber

Byte position	Field length bytes	Content	Encoded as
0 to 1	2	Number of the year (actual year, e.g. 1994)	uInt16Number
2 to 3	2	Number of the month (1 to 12)	uInt16Number
4 to 5	2	Number of the day of the month (1 to 31)	uInt16Number
6 to 7	2	Number of hours (0 to 23)	uInt16Number
8 to 9	2	Number of minutes (0 to 59)	uInt16Number
10 to 11	2	Number of seconds (0 to 59)	uInt16Number

All the dateTimeNumber values in a profile shall be in Coordinated Universal Time (UTC, also known as GMT or ZULU Time). Programs that display these values may show the dateTimeNumber as UTC, show the equivalent local time (at current locale), or display both UTC and local versions of the dateTimeNumber.

4.3 float32Number

A float32Number shall be single-precision 32-bit floating-point number as specified in IEEE 754, excluding un-normalized numbers, infinities, and “not a number” (NaN) values.

NOTE 1 A 32-bit IEEE 754 floating-point number has an 8-bit exponent and a 23-bit mantissa.

NOTE 2 Although un-normalized numbers, infinities and NaN values are not stored in the ICC Profile, such values can occur as a result of CMM computations.

4.4 positionNumber

Positions of some data elements are indicated using a position offset with the data element’s size. This data type allows this information to be stored as a single entity. [Table 3](#) shows the positionNumber encoding.

Table 3 — positionNumber encoding

Byte position	Field length bytes	Content	Encoded as
0 to 3	4	Offset to data element in bytes	uInt32Number
4 to 7	4	Size of data element in bytes	uInt32Number

4.5 response16Number

A response16Number is an 8-byte value, used to associate a normalized device code with a measurement value, where byte usage shall be assigned as specified in [Table 4](#).

Table 4 — response16Number

Byte position	Field length bytes	Content	Encoded as
0 to 1	2	16-bit number in the interval [DeviceMin to DeviceMax] ^a	uInt16Number
2 to 3	2	Reserved, shall be zero	
4 to 7	4	Measurement value	s15Fixed16Number
^a DeviceMin is encoded as 0000h and DeviceMax is encoded as FFFFh.			

4.6 s15Fixed16Number

An s15Fixed16Number is a fixed signed 4-byte (32-bit) quantity which has 16 fractional bits as shown in [Table 5](#).

Table 5 — s15Fixed16Number

Number	Encoded as
-32 768	80000000h
0	00000000h
1	00010000h
$32\,767 + (65\,535/65\,536)$	7FFFFFFFh

4.7 u16Fixed16Number

A u16Fixed16Number is a fixed unsigned 4-byte (32-bit) quantity having 16 fractional bits as shown in [Table 6](#).

Table 6 — u16Fixed16Number

Number	Encoded as
0	00000000h
1	00010000h
$65\,535 + (65\,535/65\,536)$	FFFFFFFFh

4.8 u1Fixed15Number

A u1Fixed15Number is a fixed unsigned 2-byte (16-bit) quantity having 15 fractional bits as shown in [Table 7](#).

Table 7 — u1Fixed15Number

Number	Encoded as
0	0000h
1	8000h
$1 + (32\,767/32\,768)$	FFFFh

4.9 u8Fixed8Number

A u8Fixed8Number is an unsigned 2-byte (16-bit) quantity having 8 fractional bits as shown in [Table 8](#).

Table 8 — u8Fixed8Number

Number	Encoded as
0	0000h
1	0100h
$255 + (255/256)$	FFFFh

4.10 uInt16Number

A uInt16Number is an unsigned 2-byte (16-bit) integer.

4.11 uInt32Number

A uInt32Number is an unsigned 4-byte (32-bit) integer.

4.12 uInt64Number

A uInt64Number is an unsigned 8-byte (64-bit) integer.

4.13 uInt8Number

A uInt8Number is an unsigned 1-byte (8-bit) integer.

4.14 XYZNumber

An XYZNumber is a set of three fixed signed 4-byte (32-bit) quantities used to encode CIEXYZ, nCIEXYZ, and PCSXYZ tristimulus values where byte usage is assigned as specified in Table 9. Although the CIE specifies that for reflecting and transmitting media Y should be normalized such that it has the value 100,0 for the perfect diffusing reflector or transmitter, in this ICC specification, for reasons of coding efficiency, Y is specified such that it has the value 1,0 for the perfect diffusing reflector or transmitter for nCIEXYZ.

NOTE 1 Signed numbers are employed for this type to accommodate negative values arising during calculations.

Table 9 — XYZNumber

Byte position	Field length bytes	Content	Encoded as
0 to 3	4	CIEXYZ X, nCIEXYZ X, or PCSXYZ X	s15Fixed16Number
4 to 7	4	CIEXYZ Y, nCIEXYZ Y, or PCSXYZ Y	s15Fixed16Number
8 to 11	4	CIEXYZ Z, nCIEXYZ Z, or PCSXYZ Z	s15Fixed16Number

4.15 Seven-bit ASCII

Alpha-numeric values, and other input and output codes, shall conform to the character coding specified in ISO/IEC 646.

5 Conformance

Any colour management system, application, utility or device driver that claims conformance with this ICC specification shall have the ability to read the profiles as they are defined in this ICC specification. Any profile-generating software and/or hardware that claims conformance with this ICC specification shall have the ability to create profiles as they are defined in this ICC specification.

Signatures for CMM type, device manufacturer, device model, profile tags and profile tag types shall be registered to ensure that all profile data is uniquely defined. The registration authority for these data is the ICC Technical Secretary.

NOTE The ICC Web Site (www.color.org) provides contact information.

6 Profile connection space, rendering intents and device encoding

6.1 General considerations

The PCS is the reference colour space in which colours are encoded in order to provide an interface for connecting source and destination transforms. The PCS values constitute an encoding of a CIE colorimetric specification.

Four rendering intents are specified in this ICC specification:

- a) ICC-absolute colorimetric;
- b) media-relative colorimetric;

- c) perceptual;
- d) saturation.

Each represents a type of colour rendering (mapping of colour values) that is useful for various imaging workflows. The colorimetric intents preserve the colorimetry of in-gamut colours at the expense of out-of-gamut colours. The mapping of out-of-gamut colours is not specified but should be consistent with the intended use of the transform. The perceptual and saturation rendering intents modify colorimetric values to account for any differences between devices, media, and viewing conditions.

The requirements for these rendering intents are given in [6.2](#) and discussed further in [Annex D](#).

Profiles are required to contain transformations for one, or more, of these rendering intents. [Clause 6](#) specifies which rendering intents are required, and which are optional, for the various classes of profiles.

NOTE When present, the colorimetricIntentImageStateTag indicates the image state of the colorimetry produced by the colorimetric intent transforms.

6.2 Rendering intents

6.2.1 General

The colorimetric rendering intents operate on measurement-based colorimetric values as adapted to the PCS adopted white chromaticity. This adaptation, when required, shall be indicated in the chromaticAdaptationTag. Chromatic adaptation should be calculated using the linear Bradford model. Details of this model are provided in [Annex E](#).

NOTE 1 The original measurement values can be determined from PCS values by applying the inverse chromatic adaptation transformation. This inversion is not usually performed. Since the PCS values are already adapted to the PCS adopted white chromaticity when constructing the profiles, neither the forward nor the inverse chromatic adaptation transforms need to be applied by the CMM in normal use of the profiles.

For the other intents transformations shall be assumed to be specified relative to the PCS illuminant. However, for these transformations profiles are not required to specify any chromatic adaptation that may have been employed in the calculation of the transformation data.

In transforms for the media-relative and ICC-absolute colorimetric intents for Input profiles, the PCS values may represent a colour rendering of the actual original captured. Likewise, for Output profiles, the PCS values may be colour rendered by the output device to the actual medium. However, unless the colorimetricIntentImageStateTag is present, the PCS values resulting from such transforms shall be interpreted as the colorimetry of the original and reproduction, regardless of whether such colorimetry is the actual colorimetry. If the colorimetricIntentImageStateTag is present, then the interpretation of the colorimetry of the resulting PCS values shall be according to the value recorded in that tag.

NOTE 2 All PCS colorimetry is picture-referred unless otherwise indicated in the colorimetricIntentImageStateTag.

6.2.2 Media-relative colorimetric intents

Transformations for the Media-relative colorimetric intent shall re-scale the in-gamut, chromatically adapted tristimulus values such that the white point of the actual medium is mapped to the PCS white point (for either input or output) as defined in [6.3.2](#).

NOTE Transforms for the media-relative colorimetric intent represent media-relative measurements of the captured original (for Input profiles), or media-relative colour reproductions produced by the output device (for Output profiles) unless otherwise indicated in the colorimetricIntentImageStateTag.

6.2.3 ICC-absolute colorimetric intent

Transformations for the ICC-absolute colorimetric intent shall leave the chromatically adapted nCIEXYZ tristimulus values of the in-gamut colours unchanged.

The DToB3 and BToD3 tags contain separate transforms for the ICC-absolute colorimetric intent. This allows for an absolute expression of colorimetric data, limited only by the range of float32Number values. The mediaWhitePointTag is not used in processing DToB3 and BToD3 tags.

When DToB3 and BToD3 tags are not present (or not used), profiles do not contain a separate transform for the ICC-absolute colorimetric intent. [6.3.2](#) describes how to obtain the ICC-absolute colorimetric transform using the mediaWhitePointTag, which specifies the CIE 1931 XYZ tristimulus values of the white point of the actual medium as represented in the PCS. In this way, ICC-absolute colorimetric rendering may be obtained by using the media-relative colorimetric intent transformations (AToB1, BToA1) for the source and destination profiles and scaling the PCS values by the ratio of the destination profile mediaWhitePointTag to the source profile mediaWhitePointTag (see [Annex D](#) for more information). As specified in [9.2.34](#), for monitor profiles the mediaWhitePointTag shall be set to the PCS white point (defined in [6.3.4.3](#)). Likewise, if the viewer is assumed to completely adapt to the white point of the medium for any other media (i.e. the media white looks like a perfect reflecting diffuser) the mediaWhitePointTag should be set to the PCS white point.

NOTE 1 Transforms for the ICC-absolute colorimetric intent represent measurements of the captured original relative to a hypothetical perfectly reflecting or transmitting diffuser (for Input profiles), or colour reproductions produced by the output device relative to a hypothetical perfectly reflecting or transmitting diffuser (for Output profiles), unless otherwise indicated in the in the colorimetricIntentImageStateTag.

NOTE 2 This definition of ICC-absolute colorimetry is sometimes called “relative colorimetry” in CIE terminology, since the data has been normalized relative to the perfect diffuser viewed under the same illumination source as the sample.

6.2.4 Perceptual intent

In perceptual transforms the PCS values represent hypothetical measurements of a colour reproduction on the reference reflective medium. By extension, for the perceptual intent, the PCS represents the appearance of that reproduction as viewed in the reference viewing environment by a human observer adapted to that environment. The exact colour rendering of the perceptual intent is vendor specific.

NOTE 1 The reference medium and viewing environment are defined in [6.3.3](#).

NOTE 2 The perceptual intent is useful when it is not required to exactly maintain image colorimetry (such as with natural images), with input and output media that are substantially different.

NOTE 3 When using the perceptual intent, the colour rendering to the reference medium serves to ensure that Input and Output profiles from different manufacturers will work reasonably well together, although the results from different combinations of profiles will likely be different due to the proprietary nature of the colour rendering contained in this intent.

6.2.5 Saturation intent

The exact colour rendering of the saturation intent is vendor specific and involves compromises such as trading off preservation of hue in order to preserve the vividness of pure colours.

6.3 Profile connection space

6.3.1 Chromatic adaptation

The PCS adopted white chromaticity shall be the chromaticity of the D50 illuminant defined in ISO 3664.

6.3.2 Colorimetric specification

6.3.2.1 General

The measurement parameters for the PCS, and all other colour spaces defined in this ICC specification, shall be based on ISO 13655. The colorimetry shall be assumed not to contain any flare or other defect caused by inadequacies in the optical system of the instrument and illumination used to make the measurements, but shall be assumed to include the surface reflection component normally associated with the prescribed measurement geometry.

The PCS colour space encodings shall be based on media-relative colorimetry in which tristimulus values are relative to the values in the mediaWhitePointTag. For the perceptual rendering intent the medium for calculation of the media-relative colorimetry shall be the reference medium defined in [6.3.3](#).

6.3.2.2 Translation between media-relative colorimetric data and ICC-absolute colorimetric data

The translation from ICC-absolute colorimetric data to media-relative colorimetry data is given by [Formulae \(1\) to \(3\)](#).

$$X_r = \left[\frac{X_i}{X_{mw}} \right] X_a \quad (1)$$

$$Y_r = \left[\frac{Y_i}{Y_{mw}} \right] Y_a \quad (2)$$

$$Z_r = \left[\frac{Z_i}{Z_{mw}} \right] Z_a \quad (3)$$

where

X_r, Y_r, Z_r are the media-relative colorimetric data (i.e. PCSXYZ);

X_a, Y_a, Z_a are the ICC-absolute colorimetric data (i.e. nCIEXYZ);

X_{mw}, Y_{mw}, Z_{mw} are the nCIEXYZ values of the media white point as specified in the mediaWhitePointTag;

X_i, Y_i, Z_i are the PCSXYZ values of the PCS white point defined in [6.3.4.3](#).

The translation from media-relative colorimetry data to ICC-absolute colorimetric data is given by [Formulae \(4\) to \(6\)](#):

$$X_a = \left[\frac{X_{mw}}{X_i} \right] X_r \quad (4)$$

$$Y_a = \left[\frac{Y_{mw}}{Y_i} \right] Y_r \quad (5)$$

$$Z_a = \left[\frac{Z_{mw}}{Z_i} \right] Z_r \quad (6)$$

6.3.2.3 Computation of PCSLAB

When values are encoded as PCSLAB, these shall be computed from the PCSXYZ tristimulus values as specified in [Annex A](#), noting that (as shown in [Formulae \(7\) to \(9\)](#)):

$$\frac{X}{X_n} \quad \text{is replaced by} \quad \frac{X_r}{X_i} \quad \left(\text{or } \frac{X_a}{X_{mw}} \right) \quad (7)$$

$$\frac{Y}{Y_n} \quad \text{is replaced by} \quad \frac{Y_r}{Y_i} \quad \left(\text{or } \frac{Y_a}{Y_{mw}} \right) \quad (8)$$

$$\frac{Z}{Z_n} \quad \text{is replaced by} \quad \frac{Z_r}{Z_i} \quad \left(\text{or} \quad \frac{Z_a}{Z_{mw}} \right) \quad (9)$$

where

X, Y, Z are the CIE tristimulus values;

X_n, Y_n, Z_n are the CIE values of the illuminant white point.

6.3.3 Reference viewing environment and medium for the perceptual rendering intent

6.3.3.1 General

Because perceptual rendering generally involves mapping the colours of a source to be well-suited for a destination medium (i.e. colour rendering and/or colour re-rendering), it is desirable that the perceptual intent PCS reference medium (PRM) and associated viewing conditions be well-defined. Then, the source profile can perceptually render from the source to the PRM, and the destination profile can perceptually render from the PRM to the destination medium. The PRM, in the PCS, serves as the common intermediate representation. Well-defined viewing conditions are required because they will affect the appearance of colour content represented on the PRM.

Perceptual rendering remains a proprietary art, due both to the current state of perceptual rendering algorithms, and also to the fact that viewer and application specific preferences can affect the nature of a desired reproduction (when exact colour matching is not the objective). It is not practical or desirable to specify standard perceptual rendering algorithms. Consequently, it is also not practical or desirable to require that perceptual rendering intents match an exact perceptual intent reference medium gamut (PRMG). Gamut mapping could be applied to clip the results of a perceptual rendering algorithm to a specific target gamut, but that would result in a loss of information and invertibility. Therefore, the reference medium white point, black point, and viewing conditions attributes of the PRM are defined precisely, and the PRM gamut is defined to be a fuzzy target that can be used as the aim of perceptual rendering transforms, but does not have to be exactly matched.

6.3.3.2 Perceptual intent reference medium (PRM) characteristics

The reference medium is defined as a hypothetical print on a substrate specified to have a neutral reflectance of 89 %. The darkest printable colour on this medium is assumed to have a neutral reflectance of 0,309 11 %, which is 0,347 31 % of the substrate reflectance. These shall be assumed to be the white point and black point of the reference medium respectively.

NOTE The reference medium therefore has a linear dynamic range of 287,9:1 and a density range of 2,459 3.

6.3.3.3 Perceptual intent reference medium gamut (PRMG)

Perceptual rendering intent and saturation rendering intent transforms may optionally use the reflection colour gamut specified in ISO 12640-3, and provided in [Table 10](#), as the PRMG. This colour gamut boundary description is intended only as an optional target for perceptual and saturation rendering intents, and these transforms should not clip to it. It is provided to enable improved interoperability of perceptual and saturation transforms.

Table 10 — Maximum chroma values C_{ab}^*

h_{ab} [°]	Maximum C_{ab}^* for $L^*=$																				
	3,137 3	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0	0	11	26	39	52	64	74	83	91	92	91	87	82	75	67	57	47	37	25	13	0
10	0	10	24	38	50	62	73	82	90	92	91	87	82	75	67	58	48	37	26	13	0
20	0	10	23	37	50	62	73	84	93	94	94	90	85	78	70	60	50	39	27	14	0
30	0	9	22	35	48	61	74	86	98	100	101	96	90	83	75	65	54	42	30	15	0
40	0	8	21	34	47	60	73	83	93	97	101	99	97	90	83	73	61	47	34	17	0
50	0	8	20	32	43	55	66	77	88	95	99	101	100	98	92	85	72	56	40	20	0
60	0	7	17	27	37	47	57	67	76	84	91	96	100	102	103	98	90	72	51	26	0
70	0	6	16	25	34	43	52	60	68	76	83	90	96	100	104	107	109	100	74	37	0
80	0	6	15	23	32	40	48	57	64	71	78	85	91	97	103	107	110	113	110	70	0
90	0	6	14	22	30	39	47	55	62	68	75	82	88	95	101	106	112	117	120	123	0
100	0	6	14	22	30	38	46	54	61	68	74	81	88	94	100	106	109	112	112	92	0
110	0	6	14	22	31	39	47	55	63	69	76	83	89	96	100	103	106	107	102	75	0
120	0	6	15	24	32	41	49	58	66	73	80	87	93	98	101	102	99	91	73	50	0
130	0	6	16	25	35	44	54	63	72	80	87	93	97	101	99	94	86	73	56	34	0
140	0	7	18	28	38	48	57	67	77	86	95	98	101	97	93	85	75	61	44	26	0
150	0	7	19	30	40	51	62	72	83	92	97	99	96	91	85	76	66	52	37	22	0
160	0	7	20	32	44	56	68	80	92	96	99	97	92	87	79	70	59	46	33	19	0
170	0	8	20	32	43	53	64	75	85	91	96	93	89	82	75	65	55	42	30	17	0
180	0	8	20	31	41	52	62	72	81	87	92	90	86	79	71	61	52	40	28	15	0
190	0	8	20	30	40	50	60	68	76	82	87	85	82	76	69	60	50	39	27	14	0
200	0	8	20	30	38	47	56	63	70	76	82	81	77	72	66	58	49	38	27	14	0
210	0	8	20	29	37	46	53	60	66	73	79	80	75	70	64	57	49	38	27	14	0
220	0	8	20	29	37	45	52	59	65	71	76	75	72	68	63	56	48	38	27	14	0
230	0	9	20	29	38	46	53	59	65	70	75	73	71	66	61	54	46	36	26	13	0
240	0	10	22	31	40	48	55	61	67	71	74	70	66	61	56	49	41	32	23	12	0
250	0	11	24	34	43	51	59	65	70	73	71	68	63	58	52	45	38	30	21	11	0
260	0	14	27	38	48	57	64	69	73	73	70	66	61	56	50	43	35	28	20	10	0
270	0	17	32	45	55	65	70	75	75	73	70	66	61	55	49	42	34	27	19	10	0
280	0	21	42	55	68	75	81	80	79	76	72	67	61	55	49	41	34	26	18	9	0
290	0	26	52	68	83	86	89	87	84	80	75	69	63	57	50	42	35	27	18	10	0
300	0	25	69	82	95	94	93	91	88	85	79	73	66	59	52	44	36	28	19	10	0
310	0	21	51	74	91	97	100	98	95	90	84	77	70	63	55	47	39	30	20	10	0
320	0	18	41	62	79	91	102	101	98	95	89	83	76	68	60	51	42	32	22	11	0
330	0	16	35	53	71	82	91	100	104	102	98	91	84	76	67	57	47	36	24	12	0
340	0	14	31	46	61	73	83	92	101	103	99	95	89	80	71	61	50	38	26	13	0
350	0	12	28	42	55	68	77	86	94	96	93	90	85	77	68	58	48	37	25	13	0

The L^* , C^* and h values specified in this table are relative to the reference medium white with a reflectance factor of 0,89. To calculate values relative to a perfect reflecting diffuser, it is necessary to convert the table values to X , Y and Z values, scale the resulting X , Y and Z values by a factor of 0,89, and convert back to L^* , C^* and h relative to the perfect reflecting diffuser.

The values in this table are calculated for illuminant D50 and the CIE 1931, 2°, standard observer.

NOTE 1 If the resolution of the data needs to be finer it would normally be adequate to obtain it by linear interpolation of the quoted data.

NOTE 2 This data in this table can also be downloaded from <https://www.color.org/resources/gamut/gamut-analysis.xalter>

When the PRMG is used as the target colour gamut for perceptual and saturation transforms, this should be indicated with the corresponding profile tags as described in 9.2.37 and in 9.2.46.

Furthermore, as several popular source-to-destination colour re-rendering algorithms are defined via transformations of primaries and secondaries, approximate locations for red, green, blue, cyan, magenta and yellow in the PRMG have also been specified. These coordinates are provided in Table 11.

Table 11 — Approximate location of PRMG primary and secondary colours

Colour co-ordinate	Red	Yellow	Green	Cyan	Blue	Magenta
L_{ab}^*	41	95	60	50	21	42
C_{ab}^*	98	123	100	76	95	102
h_{ab}	29	90	140	220	300	340

6.3.3.4 Perceptual intent reference medium viewing conditions

The reference viewing environment shall be based on standard viewing condition P2, as specified for graphic arts and photography in ISO 3664, but extended to include an “average” surround, i.e. the illumination of the image shall be assumed to be similar to the illumination of the rest of the environment. The surfaces immediately surrounding the image shall be assumed to be a uniform matt grey with a reflectance of 20 %. The reference viewing environment shall also be assumed to have a level of viewing flare of 0,007 5 (3/4 %) of the luminance of the reference medium in the reference viewing environment (1,06 cd/m²). If the actual viewing environment differs from the reference viewing environment perceptual transforms shall be used to compensate for the difference in viewing environments.

NOTE ISO 3664 describes the appropriate illumination level for practical appraisal of prints as 500 lx (P2), which is specified to be typical of the level found in actual home and office viewing environments. This was deemed to be most appropriate for the reference viewing environment.

6.3.4 Colour space encodings for the PCS

6.3.4.1 General

The colorimetric data defined in [6.3.2](#) and [6.3.3](#) may be specified either as PCSXYZ or PCSLAB data. When specified as PCSXYZ data they shall be encoded using 16 bits per component while when specified as PCSLAB data they shall be encoded as either 8 bits per component or 16 bits per component. Additionally, within the context of DToBx and BToDx tags PCSXYZ or PCSLAB data shall be encoded using float32Number values that directly express PCSXYZ or PCSLAB colorimetry.

When converting from float32Number-based to integer-based encoding, component-wise clipping shall be applied if the floating-point value is outside the range that can be encoded as integers.

NOTE 1 These alternative methods are provided in order to satisfy conflicting requirements for accuracy and storage space. The profile header specifies which encoding method has been used. While supporting multiple encodings increases the complexity of colour management, it provides flexibility in addressing different user requirements such as colour accuracy and memory footprint.

NOTE 2 The PCS encodings do not represent a quantization of the connection space. The purpose of the encodings is to allow points within the space to be specified. Since the processing models benefit from interpolation between table entries, the interpolated AToB results need to be used as the inputs to the BToA transforms. The AToB results are not rounded to the nearest encoding value. (AToB and BToA transforms are defined in [10.10](#) and [10.11](#))

6.3.4.2 General PCS encoding

For the 16-bit integer based PCSXYZ encoding, each component (PCSXYZ X, PCSXYZ Y, and PCSXYZ Z) is encoded as a u1Fixed15Number. This encoding was chosen to allow for PCSXYZ values that have an X or Z greater than 1.

For the XYZNumber based PCSXYZ encoding, each component (PCSXYZ X, PCSXYZ Y, and PCSXYZ Z) is encoded as a s15Fixed16Number. For the float32Number-based PCS encodings the actual PCSXYZ or PCSLAB values are directly encoded. The relationship between PCSXYZ encodings is shown in [Table 12](#).

Table 12 — PCSXYZ *X*, *Y* or *Z* encoding

Value (<i>X</i> , <i>Y</i> or <i>Z</i>)	u1Fixed15Number	s15Fixed16Number	float32Number
0	0000h	00000000h	0,0
1	8000h	00010000h	1,0
1,0 + (32 767,0 / 32 768,0)	FFFFh	0001FFFEh	1,999 969 482 421 875
NOTE 1,999 969 482 421 875 is 1 + 32 767 / 32 768 expressed as a float32Number.			

For the PCSLAB encodings, the PCSLAB L^* values have a different encoding than the PCSLAB a^* and PCSLAB b^* values. The PCSLAB L^* encoding is shown in [Table 13](#).

Table 13 — PCSLAB L^* encoding

Value (PCSLAB L^*)	uInt8Number	uInt16Number	float32Number
0	00h	0000h	0,0
100	FFh	FFFFh	100,0

The PCSLAB a^* and PCSLAB b^* encoding is shown in [Table 14](#).

Table 14 — PCSLAB a^* or PCSLAB b^* encoding

Value (PCSLAB a^* or PCSLAB b^*)	uInt8Number	uInt16Number	float32Number
-128	00h	0000h	-128,0
0	80h	8080h	0,0
127	FFh	FFFFh	127,0

NOTE 1 The integer encoding is not “two’s complement” encoding, but a linear scaling after an offset of 128. This encoding was chosen to prevent discontinuities in CLUTs when going from negative to positive values.

NOTE 2 It is possible to convert between the 8-bit and 16-bit encodings by multiplying or dividing by 257. (See [A.4](#).)

NOTE 3 Both the lut16Type and the namedColor2Type tag types (and only those tag types) use a legacy 16-bit encoding of PCSLAB L^* , PCSLAB a^* and PCSLAB b^* which is retained for backwards compatibility with an earlier profile version (version 2). To avoid confusion this encoding is specified in [10.8](#) “lut16Type”.

NOTE 4 PCSXYZ values can be negative in certain situations, and where used it is possible to encode them using an s15Fixed16Number or a float32Number. On conversion to PCSLAB, negative PCSXYZ values are typically clipped on a per-component basis to values in the PCSLAB range.

6.3.4.3 PCS encodings for white and black

In transforms for the media-relative colorimetric, perceptual, and saturation rendering intents (all intents other than ICC-absolute colorimetric), the white point of the medium is represented in PCSXYZ and PCSLAB formats as shown in [Table 15](#).

NOTE For the perceptual intent, the medium is the perceptual reference medium.

Table 15 — Encodings of PCS white point

Component	Value	8-bit encoding	16-bit encoding
PCSLAB L^*	100	FFh	FFFFh
PCSLAB a^*	0	80h	8080h
PCSLAB b^*	0	80h	8080h
PCSXYZ <i>X</i>	0,964 2	—	7B6Bh
PCSXYZ <i>Y</i>	1,000 0	—	8000h
PCSXYZ <i>Z</i>	0,824 9	—	6996h

In transforms for all intents the perfect absorber (a theoretical medium that reflects absolutely no light) is represented in PCSXYZ and PCSLAB formats as shown in [Table 16](#). Other reflectance values are mapped linearly to PCSXYZ.

Table 16 — Perfect absorber encodings

Component	Value	8-bit encoding	16-bit encoding
PCSLAB L^*	0	00h	0000h
PCSLAB a^*	0	80h	8080h
PCSLAB b^*	0	80h	8080h
PCSXYZ X	0	—	0000h
PCSXYZ Y	0	—	0000h
PCSXYZ Z	0	—	0000h

In transforms for the perceptual intent, the black point of the perceptual reference medium is defined in [Table 17](#) in PCSLAB and PCSXYZ.

Table 17 — Encodings of the perceptual reference medium black point

Component	Value	8-bit encoding	16-bit encoding
PCSLAB L^*	3,137 3	08h	0808h
PCSLAB a^*	0	80h	8080h
PCSLAB b^*	0	80h	8080h
PCSXYZ X	0,003 357	—	006Eh
PCSXYZ Y	0,003 479	—	0072h
PCSXYZ Z	0,002 869	—	005Eh
NOTE Due to limited numerical precision, PCSXYZ Y might not exactly match PCSLAB L^* .			

NOTE Due to limited numerical precision, Y encoded as 114 (0072h) does not exactly match L^* encoded as 8 (08h).

Perceptual transforms developed to meet ICC specifications prior to version 4.0 frequently use zero to represent the black point, and thus do not conform to this specification. Such transforms should be adjusted by scaling the black point as needed. The white point should remain unchanged and all other values should be mapped linearly in XYZ. The following equations can be used for the adjustment of such a transform to the above PCS encoding.

$$X_p = X_t \cdot (1 - X_b / X_i) + X_b$$

$$Y_p = Y_t \cdot (1 - Y_b / Y_i) + Y_b$$

$$Z_p = Z_t \cdot (1 - Z_b / Z_i) + Z_b$$

where: X_t Y_t Z_t = original PCS XYZ value in the transform

X_b Y_b Z_b = XYZ values for the PCS perceptual black point ($X = 0,003\ 357$, $Y = 0,003\ 479$, $Z = 0,002\ 869$)

X_i Y_i Z_i = XYZ values of the PCS white point ($X = 0,964\ 2$, $Y = 1,000\ 0$, $Z = 0,824\ 9$)

X_p Y_p Z_p = the adjusted PCS XYZ value

6.4 Converting between PCSXYZ and PCSLAB encodings

Conversions between the PCSXYZ and PCSLAB encodings shall use the equations of the form specified in ISO 13655.

When converting to integer-based encodings, any colours in the PCSXYZ encoding range that are outside of the PCSLAB encoding range shall be clipped on a per-component basis to the outside limits of the range of

PCSLAB when transforming from PCSXYZ into PCSLAB. Conversely, any colours that occur in the PCSLAB encoding range that are outside of the encoding range of PCSXYZ shall be clipped on a per-component basis to the PCSXYZ range when transforming from PCSLAB into PCSXYZ.

When converting to float32Number-based encodings, conversion between PCSXYZ and PCSLAB is performed and encoded using the float32Number encoding of PCS values as defined in [6.3.4.2](#). No clipping is performed. In order to calculate PCSLAB values from negative PCSXYZ values, the straight line portion of the PCSLAB colour component transfer function below 0,008 856 shall be extended linearly below zero.

6.5 Device encoding

The specification of device value encoding is determined by the device. Normally, device values in the range [0 1] are encoded using a 0 to 255 (FFh) range when using 8 bits and are encoded using a 0 to 65 535 (FFFFh) range when using 16 bits. When encoding using float32Number values in DToBx and BToDx tags, device values may be outside the range [0 1].

7 Profile requirements

7.1 General

7.1.1 An ICC profile shall include the following elements, in the order shown, as a single file:

- a) a 128-byte profile header as defined in [7.2](#);
- b) a profile tag table as defined in [7.3](#);
- c) a profile tagged element data as defined in [7.4](#).

This is illustrated in [Figure 6](#).

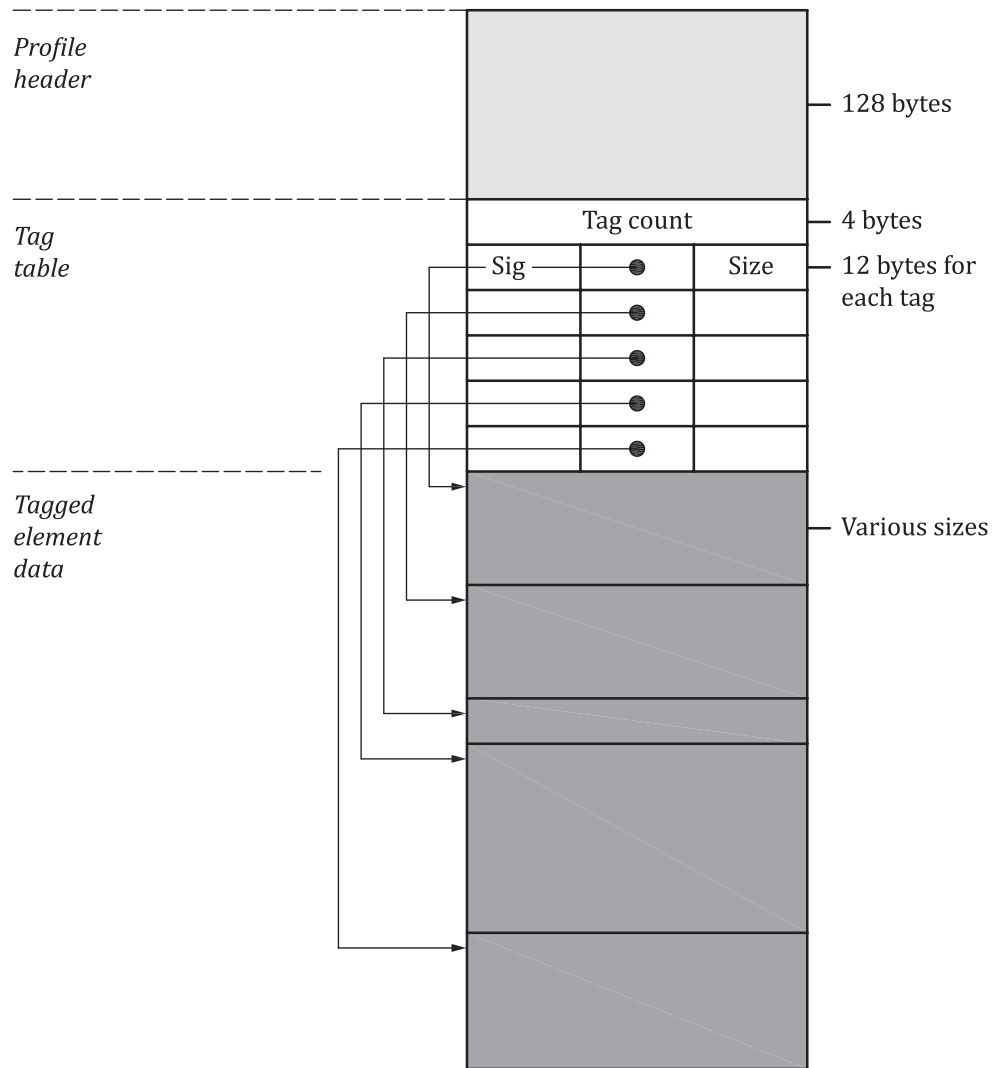


Figure 6 — Profile structure

7.1.2 The required tags for each profile type are tabulated in [Clause 8](#). The definition of all publicly available tags and their signatures is contained in [Clause 9](#) along with the permitted tag types for each tag. Tag types are defined in [Clause 10](#).

Within the profile structure:

- all profile data shall be encoded as big-endian;
- the first set of tagged element data shall immediately follow the tag table;
- all tagged element data, including the last, shall be padded by no more than three following pad bytes to reach a 4-byte boundary;
- all pad bytes shall be NULL.

NOTE 1 This implies that the length is required to be a multiple of four.

NOTE 2 The above restrictions result in two key benefits. First, the likelihood of two profiles which contain the same tag data, yet have different checksum values, is reduced. Second, all profiles are reduced to a minimum size.

7.2 Profile header

7.2.1 General requirements

The profile header provides the necessary information to allow a receiving system to properly search and sort ICC profiles. The profile header is 128 bytes in length and contains 18 fields. [Table 18](#) gives the byte position, field length, and content of each element in the profile header. The encoding of the field contents shall be as defined in [7.2.2](#) to [7.2.19](#).

NOTE 1 Having a fixed length header allows for performance enhancements in profile searching and sorting applications.

NOTE 2 For ColorSpace and Abstract profiles (see [8.7](#) and [8.8](#)) some of these fields are not relevant and can be set to zero.

Table 18 — Profile header fields

Byte position	Field length bytes	Field contents	Encoded as
0 to 3	4	Profile size	UInt32Number
4 to 7	4	Preferred CMM type	See 7.2.3
8 to 11	4	Profile version number	See 7.2.4
12 to 15	4	Profile/Device class	See 7.2.5
16 to 19	4	Colour space of data (possibly a derived space)	See 7.2.6
20 to 23	4	PCS	See 7.2.7
24 to 35	12	Date and time this profile was first created	dateTimeNumber
36 to 39	4	'acsp' (61637370h) profile file signature	See 7.2.9
40 to 43	4	Primary platform signature	See 7.2.10
44 to 47	4	Profile flags to indicate various options for the CMM such as distributed processing and caching options	See 7.2.11
48 to 51	4	Device manufacturer of the device for which this profile is created	See 7.2.12
52 to 55	4	Device model of the device for which this profile is created	See 7.2.13
56 to 63	8	Device attributes unique to the particular device setup such as media type	See 7.2.14
64 to 67	4	Rendering Intent	See 7.2.15
68 to 79	12	The nCIEXYZ values of the illuminant of the PCS	XYZNumber
80 to 83	4	Profile creator signature	See 7.2.17
84 to 99	16	Profile ID	See 7.2.18
100 to 127	28	Bytes reserved for future expansion and shall be set to zero (00h)	

7.2.2 Profile size field (bytes 0 to 3)

The value in the profile size field shall be the exact size obtained by combining the profile header, the tag table, and the tagged element data, including the pad bytes for the last tag. It shall be encoded as a uint32Number.

7.2.3 Preferred CMM type field (bytes 4 to 7)

This field may be used to identify the preferred CMM to be used. If used, it shall match a CMM type signature registered in the ICC Tag Registry (see [Clause 5](#)). If no preferred CMM is identified, this field shall be set to zero (00000000h). All CMMs should be registered with ICC.