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Information technology — JPEG 2000 image coding system — Part 1:Core coding system

AMENDMENT 6: Updated ICC profile support, bit depth and resolution clarifications

Technologies de l'information — Système de codage d'images JPEG 2000 — Partie 1: Système de codage de noyau

AMENDEMENT 6: Support de profil ICC, profondeur de bit et clarifications de la résolution mis à jour

Reference number

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Foreword

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Amendment 6 to ISO/IEC 15444-1:2004 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. The identical text is published as ITU-T Rec. T.800 (08/2002)/Amd.6.

This corrected version of ISO/IEC 15444-1:2004/Amd.6 replaces the version dated 2013-05-01.

INTERNATIONAL STANDARD
RECOMMENDATION ITU-T

Information technology – JPEG 2000 image coding system:

Core coding system

Amendment 6

Updated ICC profile support, bit depth and resolution clarifications

1) Clause 2.2 Additional References

Add the following references:

– ISO 15076-1:2005, *Image technology colour management – Architecture, profile format and data structure – Part 1: Based on ICC.1:1998-09, File format for Color Profiles*.

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

2) Clause 4.1 Abbreviations

Replace:

ICC International Colour Consortium

With:

ICC International Color Consortium

3) Clause I.2.3 Greyscale, colour, palette, multi-component specification

Replace:

I.2.3 Greyscale, colour, palette, multi-component specification

The JP2 file format provides two methods to specify the colourspace of the image. The enumerated method specifies the colourspace of an image by specifying a numeric value that specifies the colourspace. In this Recommendation | International Standard, images in the sRGB colourspace and greyscale images can be defined using the enumerated method.

The JP2 file format also provides for the specification of the colourspace of an image by embedding a restricted form of an ICC profile in the file. That profile shall be of either the Monochrome or Three-Component Matrix-Based class of input profiles as defined by the ICC Profile Format Specification, ICC.1:1998-09. This allows for the specification of a wide range of greyscale and RGB class colourspaces, as well as a few other spaces that can be represented by those two profile classes. See J.9 for a more detailed description of the legal colourspace transforms, how those transforms are stored in the file, and how to process an image using that transform without using an ICC colour management engine.

While restricted, these ICC profiles are fully compliant ICC profiles and the image can thus be processed through any ICC compliant engine that supports profiles as defined in ICC.1:1998-09.

In addition to specifying the colourspace of the image, this Recommendation | International Standard provides a means by which a single component palettized image can be decoded and converted back to multiple-component form by the translation from index space to multiple-component space. Any such depalettization is applied before the colourspace is interpreted. In the case of palettized images, the specification of the colourspace of the image is applied to the multiple component values stored in the palette.

With:

I.2.3 Greyscale, colour, palette, multi-component specification

The JP2 file format provides two methods to specify the colourspace of the image. The enumerated method specifies the colourspace of an image by specifying a numeric value that identifies the colourspace. In this Recommendation | International Standard, images in the sRGB and sYCC colourspaces and greyscale images can be defined using the enumerated method.

The JP2 file format also provides for the specification of the colourspace of an image by embedding one of a restricted subset of ICC Input and Display profiles in the file. The restricted subset of ICC profiles is defined in clause I.3.2. Their use allows for the specification of a wide range of greyscale and RGB class colourspaces, as well as some other spaces that can be represented by those two profile classes.

In addition to specifying the colourspace of the image, this Recommendation | International Standard provides a means by which a single component palettized image can be decoded and converted back to multiple-component form by the translation from index space to multiple-component space. Any such depalettization is applied before the colourspace is interpreted. In the case of palettized images, the specification of the colourspace of the image is applied to the multiple component values stored in the palette.

4) Clause I.3.2 Restricted ICC profile method

Replace:

I.3.2 Restricted ICC profile method

An application may also specify the colourspace of an image using two restricted types of ICC profiles. This method handles the specification of the most commonly used RGB and greyscale class colourspaces through a low-complexity method.

An ICC profile is a standard representation of the transformation required to convert one colourspace into another colourspace. With respect to the JP2 file format, an ICC profile defines how decompressed samples from the codestream are converted into a standard colourspace (the Profile Connection Space (PCS)). Depending on the original colourspace of the samples, this transformation may be either very simple or very complex.

The ICC Profile Format Specification defines two specific classes of ICC profiles that are simple to implement, referred to within the profile specification as Monochrome Input and Three-Component Matrix-Based Input Profiles. These profiles limit the transformation from the source colourspace to the PCSXYZ to the application of a non-linearity curve and a 3 × 3 matrix. It is practical to expect all applications, including simple devices, to be able to process the image through this transformation. Thus all conforming applications are required to correctly interpret the colourspace of any image that specifies the colourspace using this subset of possible ICC profile types.

For the JP2 file format, profiles shall conform to the ICC profile definition as defined by the ICC Profile Format Specification, ICC.1:1998-09, as well as the restrictions specified above. See J.9 for a more detailed description of the legal colourspace transforms, how those transforms are stored in the file, and how to process an image using that transform without using an ICC colour management engine.

With:

I.3.2 Restricted ICC profile method

An application may also specify the colourspace of an image using a restricted subset of ICC profiles. This method handles the specification of the most commonly used RGB and greyscale class colourspaces through a low-complexity method.

An ICC profile is a standard representation of the transformation required to convert one colourspace into another colourspace. With respect to the JP2 file format, an ICC profile defines how decompressed samples from the codestream are converted into a standard colourspace (the Profile Connection Space (PCS)). Depending on the original colourspace of the samples, this transformation may be either very simple or very complex.

ISO 15076-1:2010 defines two classes of ICC profiles, Input and Display, with profile types that are simple to implement. They are the Monochrome and Three-Component Matrix-Based Input Profiles and the Monochrome and Three-Component Matrix-Based Display profiles. These profiles limit the transformation from the source colourspace to the PCSXYZ to the application of either a non-linearity curve in the case of the Monochrome Input and Display profiles or a non-linearity curve and a 3 × 3 matrix in the case of the Three-Component Matrix-Based Input and Display Profiles. All applications, including simple devices, are expected to be able to process the image through these transformations. All conforming applications are required to correctly interpret the colourspace of any image that

specifies the colourspace using this restricted subset of possible ICC profile types. Although restricted, these ICC profiles are fully compliant ICC profiles and the image can therefore be processed through any ICC compliant engine that supports profiles as defined in ISO 15076-1:2005.

NOTE – ICC.1:1998-09 specifies what are known as V2 ICC profiles. The restricted ICC profile subset defined here are compatible with the most recent specification for the V2 ICC Profile Format, ISO 15076-1:2005. This was followed by a major revision of the ICC Profile Format to V4, which is specified in ISO 15076-1:2010. The move from V2 to V4 ICC profiles requires a change in Colour Management Modules (CMMs), which implement ICC-compliant colour transformations. However, it is common practice for V4 CMMs to support V2 profiles and the majority of profiles that a CMM has to process are still V2.

For the JP2 file format, profiles shall conform to the ICC profile definition as defined by ISO 15076-1:2005, including the restrictions specified above. Clause J.9 has a more detailed description of the legal colourspace transforms, how those transforms are stored in the file, and how to process an image using that transform without using an ICC colour management engine.

5) Clause I.5.3.1 Image Header Box

Add the following NOTE at the end of I.5.3.1:

NOTE – While clause I.5.3.1.1 defines the default image dimension in pixels, the relation to physical dimensions is given by the Capture Resolution Box (see I.5.3.7.1) and the Display Resolution Box (see I.5.3.7.2). Note that image pixels might not be square.

6) Clause I.5.3.3 Colour Specification box

Replace the first paragraph of clause I.5.3.3:

Each Colour Specification box defines one method by which an application can interpret the colourspace of the decompressed image data. This colour specification is to be applied to the image data after it has been decompressed and after any reverse decorrelating component transform has been applied to the image data.

With:

Each Colour Specification box defines one method by which an application can interpret the colourspace of the decompressed image data. This colour specification is to be applied to the channel, representing signed or unsigned integers, and associated to colours according to the Channel Definition Box (see clause I.5.3.6). The reconstructed numerical values of channel number i are to be interpreted using the value BPC^i in combination with the relevant colourspace definition.

The symbol BPC^i is here defined as follows. It shall be identical to the value of the B^j field of the Palette Box (see clause I.5.3.4) if channel i is the output of palette column j, or to the value of the Bits Per Component Box BPC^j if channel i is the direct output of component j, or to the value of the BPC field of the Image Header Box if no Bits Per Component Box is present. BPC^i identifies the number of bits (bit precision) of the numerical values carried by channel i, including the sign bit if present, minus one.

If the colourspace is defined by an ICC profile, the input channels should carry unsigned values; usage of signed samples is discouraged and currently not defined by the ICC. The values x^i of channel i shall be mapped to device colour values d^i, as follows.

$$d^i = Lmax^i * x^i / (2^{BPCi+1} - 1)$$

Here, $Lmax^i$ is the maximum input value associated with the relevant ICC tone reproduction curve.

If the colourspace is an enumerated colourspace and the values x^i for channel i are unsigned quantities, they shall be mapped to colour values d^i according to

$$d^i = Lmin^i + (Lmax^i - Lmin^i) * x^i / (2^{BPCi+1} - 1)$$

for the purpose of establishing a correct interpretation with respect to the colourspace. Here, $Lmin^i$ and $Lmax^i$ are the minimum and maximum allowed values for the relevant colour channel, in the numerical framework used to define the colourspace.

If, however, the values x^i for channel i, are signed quantities, they shall be mapped to colour values d^i according to

$$d^i = Lzero^i + (Lmax^i - Lzero^i) * x^i / (2^{(BPCi \text{ AND } 0x7f)} - 1)$$

for the purpose of establishing a correct interpretation with respect to the colourspace. Here $Lmax^i$ is again the maximum allowed value for the relevant colour, in the numerical framework used to define the colourspace, while $Lzero^i$ is the value of channel i in the representation of the colour that corresponds to the absence of any scene radiance, the complete absorption of visible light or the achromatic level, if this interpretation is applicable and all channel values are uniquely defined in this case.

Table I.10 defines both the enumerated colourspaces and the corresponding values of $Lzero^i$, $Lmin^i$ and $Lmax^i$ for this Recommendation | International Standard.

Replace Table I.9 – Legal METH values:

Value	Meaning
1	**Enumerated Colourspace**. This colourspace specification box contains the enumerated value of the colourspace of this image. The enumerated value is found in the EnumCS field in this box. If the value of the METH field is 1, then the EnumCS shall exist in this box immediately following the APPROX field, and the EnumCS field shall be the last field in this box
2	**Restricted ICC profile**. This Colour Specification box contains an ICC profile in the PROFILE field. This profile shall specify the transformation needed to convert the decompressed image data into the PCSXYZ, and shall conform to either the Monochrome Input or Three-Component Matrix-Based Input profile class, and contain all the required tags specified therein, as defined in ICC.1:1998-09. As such, the value of the Profile Connection Space field in the profile header in the embedded profile shall be 'XYZ\040' (0x5859 5A20) indicating that the output colourspace of the profile is in the XYZ colourspace. Any private tags in the ICC profile shall not change the visual appearance of an image processed using this ICC profile. The components from the codestream may have a range greater than the input range of the tone reproduction curve (TRC) of the ICC profile. Any decoded values should be clipped to the limits of the TRC before processing the image through the ICC profile. For example, negative sample values of signed components may be clipped to zero before processing the image data through the profile. See J.9 for a more detailed description of the legal colourspace transforms, how those transforms are stored in the file, and how to process an image using that transform without using an ICC colour management engine. If the value of METH is 2, then the PROFILE field shall immediately follow the APPROX field and the PROFILE field shall be the last field in the box.
other values	Reserved for other ISO use. If the value of METH is not 1 or 2, there may be fields in this box following the APPROX field, and a conforming JP2 reader shall ignore the entire Colour Specification box.

With:

Value	Meaning
1	**Enumerated Colourspace**. This colourspace specification box contains the enumerated value of the colourspace of this image. The enumerated value is found in the EnumCS field in this box. If the value of the METH field is 1, then the EnumCS shall exist in this box immediately following the APPROX field, and the EnumCS field shall be the last field in this box.
2	**Restricted ICC profile**. This Colour Specification box contains an ICC profile in the PROFILE field. This profile shall specify the transformation needed to convert the decompressed image data into the PCS_{XYZ}, and shall conform to either the Monochrome Input, the Three-Component Matrix-Based Input profile class, the Monochrome Display or the Three-Component Matrix-Based Display class and contain all the required tags specified therein, as defined in ISO 15076-1:2005. As such, the value of the Profile Connection Space field in the profile header in the embedded profile shall be 'XYZ\040' (0x5859 5A20) indicating that the output colourspace of the profile is in the XYZ colourspace. Any private tags in the ICC profile shall not change the visual appearance of an image processed using this ICC profile. The components from the codestream may have a range greater than the input range of the tone reproduction curve (TRC) of the ICC profile. Any decoded values should be clipped to the limits of the TRC before processing the image through the ICC profile. For example, negative sample values of signed components may be clipped to zero before processing the image data through the profile. See J.9 for a more detailed description of the legal colourspace transforms, how those transforms are stored in the file, and how to process an image using that transform without using an ICC colour management engine. If the value of METH is 2, then the PROFILE field shall immediately follow the APPROX field and the PROFILE field shall be the last field in the box.
other values	Reserved for other ISO use. If the value of METH is not 1 or 2, there may be fields in this box following the APPROX field, and a conforming JP2 reader shall ignore the entire Colour Specification box.

Replace Table I.10 – Legal EnumCS values:

Value	Meaning
16	sRGB as defined by IEC 61966–2–1
17	greyscale: A greyscale space where image luminance is related to code values using the sRGB non-linearity given in Eqs. (2) through (4) of IEC 61966–2–1 (sRGB) specification: $Y' = Y_{8bit} / 255$ (I-1) for $(Y' \le 0{,}04045)$, $Y_{lin} = Y' / 12{,}92$ (I-2) for $(Y' > 0{,}04045)$, $Y_{lin} = \left(\frac{Y' + 0{,}055}{1{,}055}\right)^{2{,}4}$ where Y_{lin} is the linear image luminance value in the range 0.0 to 1.0. The image luminance values should be interpreted relative to the reference conditions in Section 2 of IEC 61966–2–1.
18	sYCC as defined by IEC 61966-2-1 Amd. 1. NOTE – It is not recommend to use ICT or RCT specified in Annex G sYCC image data. See J.15 for guidelines on handling YCC codestreams.
other values	Reserved for other ISO uses

With:

Value	Meaning
16	sRGB as defined by IEC 61966-2-1with $Lmin_i$=0 and $Lmax_i$=255. This colourspace shall be used with channels carrying unsigned values only.
17	greyscale: A greyscale space where image luminance is related to code values using the sRGB non-linearity given in Equations (2) through (4) of IEC 61966-2-1 (sRGB) specification: $Y' = d^i$ (I-1) for $(Y' \le 0{,}04045)$, $Y_{lin} = Y' / 12.92$ (I-2) for $(Y' > 0.04045)$, $Y_{lin} = \left(\frac{Y' + 0.055}{1.055}\right)^{2.4}$ where Y_{lin} is the linear image luminance value in the range 0.0 to 1.0 and d^i is the channel input value scaled according to clause I.5.3.3 with $Lmin^i$=0 and $Lmax^i$=1.0. The image luminance values should be interpreted relative to the reference conditions in Section 2 of IEC 61966-2-1. This colourspace shall be used with channels carrying unsigned values only.
18	sYCC as defined by IEC 61966-2-1 Amd. 1with $Lmin_i$=0 and $Lmax_i$=255. This colourspace shall be used with channels carrying unsigned values only. NOTE – It is not recommend to use ICT or RCT specified in Annex G with sYCC image data. See J.15 for guidelines on handling YCC codestreams.
other values	Reserved for other ISO uses

In clause I.5.3.3, replace the paragraph defining the PROFILE field:

PROFILE: ICC profile. This field contains a valid ICC profile, as specified by the ICC Profile Format Specification, which specifies the transformation of the decompressed image data into the PCS. This field shall not exist if the value of the METH field is 1. If the value of the METH field is 2, then the ICC profile shall conform to the Monochrome Input Profile class or the Three-Component Matrix-Based Input Profile class as defined in ICC.1:1998-09.