INTERNATIONAL STANDARD

ISO 22028-2

First edition
2013-04-15

Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange —

Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)

Photographie et technologie graphique — Codages par couleurs étendues pour stockage, manipulation et échange d'image numérique —

Partie 2: Codage d'image en couleurs RVB par référence de sortie par voie métrique

Reference number
ISO 22028-2:2013(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 42, *Photography*.

This first edition cancels and replaces ISO/TS 22028-2:2006, which has been technically revised.

ISO 22028 consists of the following parts, under the general title *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange*:

— *Part 1: Architecture and requirements*

— *Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)*

— *Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB)* [Technical Specification]

Introduction

This part of ISO 22028 has been developed in order to meet the industry need for a complete, fully-documented, publicly-available definition of a wide-primary output-referred extended gamut red-green-blue (RGB) colour image encoding. This colour image encoding provides a way to represent output-referred images that does not limit the colour gamut to those colours capable of being displayed on typical monitors, as is the case with the sRGB colour encoding, or require the use of negative RGB colourimetry coordinates, as is the case with extended sRGB colour encodings like bg-sRGB.

An extended colour-gamut colour encoding is particularly desirable for professional photography applications. For example, colours used for company logos can be outside a monitor gamut and would therefore need to be clipped or compressed to a less saturated colour. Similarly, photographic prints can contain colours outside a monitor RGB colour gamut. By using a standard output-referred extended gamut colour image encoding, images containing such colours can be stored, interchanged, manipulated, and later printed, without limiting or distorting the colours of the final output.

The Reference output medium metric RGB (ROMM RGB) colour image encoding specified in this part of ISO 22028 meets the needs of these types of applications.

Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange —

Part 2:
Reference output medium metric RGB colour image encoding (ROMM RGB)

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This part of ISO 22028 defines a family of extended colour-gamut output-referred RGB colour image encodings designated as reference output medium metric RGB (ROMM RGB). Digital images encoded using ROMM RGB can be manipulated, stored, transmitted, displayed, or printed by digital still picture imaging systems. Three precision levels are defined using 8-, 12- and 16-bits/channel.

2 Normative references

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

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

ISO 22028-1:2004, *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 1: Architecture and requirements*

ISO 11664-1:2007, *(CIE S 014-1/E:2006) Colorimetry – Part 1: CIE standard colorimetric observers*

3 Terms and definitions

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

3.1
adapted white
colour stimulus that an observer who is adapted to the viewing environment would judge to be perfectly achromatic and to have a luminance factor of unity; i.e. absolute colorimetric coordinates that an observer would consider to be a perfect white diffuser

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

3.2
additive RGB colour space
colorimetric colour space having three colour primaries (generally red, green and blue) such that CIE XYZ tristimulus values can be determined from the RGB colour space values by forming a weighted combination of the CIE XYZ tristimulus values for the individual colour primaries, where the weights are proportional to the radiometrically linear colour space values for the corresponding colour primaries

Note 1 to entry: A simple linear 3 × 3 matrix transformation can be used to transform between CIE XYZ tristimulus values and the radiometrically linear colour space values for an additive RGB colour space.

Note 2 to entry: Additive RGB colour spaces are defined by specifying the CIE chromaticity values for a set of additive RGB primaries and a colour space white point, together with a colour component transfer function.

3.3
colorimetric colour space
colour space having an exact and simple relationship to CIE colorimetric values

Note 1 to entry: Colourimetric colour spaces include those defined by CIE (e.g. CIE XYZ, CIELAB, CIELUV), as well as colour spaces that are simple transformations of those colour spaces (e.g. additive RGB colour spaces).

3.4
colour component transfer function
single variable, monotonic mathematical function applied individually to one or more colour channels of a colour space

Note 1 to entry: Colour component transfer functions are frequently used to account for the nonlinear response of a reference device and/or to improve the visual uniformity of a colour space.

Note 2 to entry: Generally, colour component transfer functions will be nonlinear functions such as a power-law (i.e. “gamma”) function or a logarithmic function. However, in some cases a linear colour component transfer function can be used.

3.5
colour encoding
generic term for a quantized digital encoding of a colour space, encompassing both colour space encodings and colour image encodings

3.6
colour gamut
solid in a colour space, consisting of all those colours that are either: present in a specific scene, artwork, photograph, photomechanical, or other reproduction; or capable of being created using a particular output device and/or medium

3.7
colour image encoding
digital encoding of the colour values for a digital image, including the specification of a colour space encoding, together with any information necessary to properly interpret the colour values such as the image state, the intended image viewing environment and the reference medium

Note 1 to entry: In some cases, the intended image viewing environment will be explicitly defined for the colour image encoding. In other cases, the intended image viewing environment can be specified on an image-by-image basis using metadata associated with the digital image.

Note 2 to entry: Some colour image encodings will indicate particular reference medium characteristics, such as a reflection print with a specified density range. In other cases, the reference medium will be not applicable, such as with a scene-referred colour image encoding, or will be specified using image metadata.

Note 3 to entry: Colour image encodings are not limited to pictorial digital images that originate from an original scene, but are also applicable to digital images with content such as text, line art, vector graphics and other forms of original artwork.

3.8
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;

— applying preference adjustments.

3.9
colour space
geometric representation of colours in space, usually of three dimensions

[CIE Publication 17.4:1987, 845-03-25]

3.10
colour space encoding
digital encoding of a colour space, including the specification of a digital encoding method, and a colour space value range

Note 1 to entry: Multiple colour space encodings can be defined based on a single colour space where the different colour space encodings have different digital encoding methods and/or colour space value ranges. (For example, 8-bit sRGB and 10-bit e-sRGB are different colour space encodings based on a particular RGB colour space.)

3.11
colour space white point
colour stimulus to which colour space values are normalized

Note 1 to entry: It is not necessary that the colour space white point correspond to the assumed adapted white point and/or the reference medium white point for a colour image encoding.

3.12
continuous colour space values
real-valued, unbounded colour space values that have not been encoded using a digital encoding method

3.13
extended gamut
colour gamut extending outside that of the standard sRGB reference display as defined by IEC 61966-2-1

3.14
gamut mapping
mapping of the colour space coordinates of the elements of a source image to colour space coordinates of the elements of a reproduction to compensate for differences in the source and output medium colour gamut capability

Note 1 to entry: The term “gamut mapping” is somewhat more restrictive than the term “colour rendering” because gamut mapping is performed on colourimetry that has already been adjusted to compensate for viewing condition differences and viewer preferences, although these processing operations are frequently combined in reproduction and preferred reproduction models.

3.15
ICC profile
International Color Consortium’s file format, used to store transforms from one colour encoding to another, e.g. from device colour coordinates to profile connection space, as part of a colour management system

3.16
image state
attribute of a colour image encoding indicating the rendering state of the image data

Note 1 to entry: The primary image states defined in this document are the scene-referred image state, the original-referred image state and the output-referred image state.

3.17
luminance factor
ratio of the luminance of the surface element in the given direction to that of a perfect reflecting or transmitting diffuser identically illuminated

[CIE Publication 17.4:1987, 845-04-69]

3.18
medium black point
neutral colour with the lowest luminance that can be produced by an imaging medium in normal use, measured using the specified measurement geometry

Note 1 to entry: It is generally desirable to specify a medium black point that has the same chromaticity as the medium white point.

3.19
medium white point
neutral colour with the highest luminance that can be produced by an imaging medium in normal use, measured using the specified measurement geometry

3.20
output-referred image state
image state associated with image data that represents the colour space coordinates of the elements of an image that has undergone colour rendering appropriate for a specified real or virtual output device and viewing conditions

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

Note 2 to entry: Output referred image data are referred to the specified output device and viewing conditions. A single scene can be colour rendered to a variety of output-referred representations depending on the anticipated output viewing conditions, media limitations, and/or artistic intents.

Note 3 to entry: Output-referred image data can become the starting point for a subsequent reproduction process. For example, sRGB output-referred image data are frequently considered to be the starting point for the colour re-rendering performed by a printer designed to receive sRGB image data.

3.21
tristimulus values
amounts of the three reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

[CIE Publication 17.4:1987, 845-03-22]

3.22
veiling glare
light, reflected from an imaging medium, that has not been modulated by the means used to produce the image

Note 1 to entry: Veiling glare lightens and reduces the contrast of the darker parts of an image.

Note 2 to entry: In CIE Publication 122, the veiling glare of a display is referred to as ambient flare.

3.23
viewing flare
veiling glare that is observed in a viewing environment but not accounted for in radiometric measurements made using a prescribed measurement geometry

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

4 Requirements

4.1 General

Reference output medium metric RGB (ROMM RGB) is an extended gamut RGB colour image encoding for representing the colourimetry of output-referred image data in an output-referred image state on a reference medium. The output-referred image data has the intended colour appearance when viewed in a reference viewing environment. The image colourimetry is encoded in terms of an additive RGB colour space associated with a hypothetical additive colour device having a specified set of primaries, no cross-talk between the colour channels and a luminance dynamic range defined by an associated medium black point and medium white point.

Three different precision levels are defined, and shall be identified as ROMM8 RGB, ROMM12 RGB and ROMM16 RGB, for 8-, 12- and 16-bits/channel (24-, 36- and 48-bits/pixel) representations, respectively.

The image colourimetry shall be based on flareless (or instrument flare corrected) colourimetric measurements. All chromaticity and tristimulus values specified in this document shall be based on the CIE 1931 two-degree Standard Observer defined in ISO 11664.

Flareless colourimetric measurements should be considered equivalent to those obtained from real reflection media measured using the 0/45 geometry specified in ISO 13655 (without polarizing means). Therefore, colourimetric quantities referred to in this part of ISO 22028 should be considered to include a level of flare typical of such measurements.

The colour image encoding defined in this International Standard conforms to the requirements defined in ISO 22028-1:2004, Clause 5.

4.2 Reference viewing environment

The reference viewing environment shall be such that the adapted white has the chromaticity values of CIE Illuminant D_{50} (x_0 = 0,345 7, y_0 = 0,358 5).

The absolute luminance level of the adapted white in the reference viewing environment shall be 160 cd/m^2.

NOTE 1 This absolute luminance level is equivalent to that of a perfect white Lambertian reflector illuminated with 500 lx as specified in ISO 3664 for the practical appraisal of prints.

NOTE 2 The luminance of the adapting field can be assumed to be 20 % of the luminance of the adapted white.

The reference viewing environment shall be characterized by an “average” surround. This means that the area immediately surrounding the image border shall be assumed to be a uniform grey having the chromaticity values of CIE Illuminant D_{50} (x_0 = 0,345 7, y_0 = 0,358 5) and a luminance factor of 0,2 relative to the adapted white.

The reference viewing environment shall be assumed to have a level of viewing flare that is 0,75 % of the adapted white with the chromaticity values of CIE Illuminant D_{50} (x_0 = 0,345 7, y_0 = 0,358 5).

NOTE 3 If the actual output viewing environment differs significantly from that specified here, appropriate transformations might be necessary to determine the corresponding colourimetry that would produce the intended colour appearance in the reference viewing environment. However, for actual viewing environments similar to the reference viewing environment, it might not be necessary to make such adjustments. The reference viewing environment was selected to make such adjustments unnecessary for many practical applications.