

ISO/TC 42

Secretariat: ANSI

Voting begins on:  
2023-03-23

Voting terminates on:  
2023-05-18

---

---

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

Part 5:

### High dynamic range and wide colour gamut encoding for still images (HDR/ WCG)

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

*Partie 5: Plage dynamique élevée et codage large de la gamme de  
couleurs pour les images fixes (HDR/WCG)*

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.



---

---

Reference number  
ISO/DTS 22028-5:2023(E)

© ISO 2023

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

ISO/DTS 22028-5

<https://standards.iteh.ai/catalog/standards/sist/4a5c003c-df0f-4d42-93af-4b1d0f150813/iso-dts-22028-5>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms, definitions and acronyms</b> .....	<b>1</b>
<b>4 Requirements</b> .....	<b>4</b>
4.1 General introduction.....	4
4.2 Colour image encoding.....	4
4.2.1 General.....	4
4.2.2 Colour primaries and white point.....	4
4.2.3 Baseline colour encoding.....	5
4.3 Transfer functions.....	7
4.3.1 General.....	7
4.3.2 Hybrid Log-Gamma (HLG) system.....	7
4.3.3 Perceptual quantizer (PQ) system.....	7
4.4 Reference viewing environment.....	8
4.5 Reference display.....	8
4.5.1 General.....	8
4.5.2 Default reference display colour primaries.....	8
4.5.3 Default nominal peak luminance.....	8
4.5.4 Default black point.....	9
4.5.5 Default nominal diffuse white luminance.....	9
4.6 Metadata.....	9
4.6.1 General.....	9
4.6.2 Coding-independent code points for video signal type identification: CICP metadata.....	9
4.6.3 Reference environment metadata.....	10
4.6.4 Colour volume metadata.....	10
4.6.5 Diffuse white luminance metadata.....	11
4.6.6 Scene-referred metadata.....	11
<b>5 Colour mapping</b> .....	<b>11</b>
5.1 General.....	11
5.2 Colour conversions.....	11
<b>Annex A (normative) Extended HDR/WCG colour encoding</b> .....	<b>13</b>
<b>Annex B (informative) ITU-R transfer functions</b> .....	<b>14</b>
<b>Annex C (informative) HDR signalling</b> .....	<b>15</b>
<b>Annex D (informative) Workflows for the different transfer functions</b> .....	<b>16</b>
<b>Annex E (informative) Image states and linear light colorimetric interpretations</b> .....	<b>18</b>
<b>Annex F (informative) Display tone mapping</b> .....	<b>20</b>
<b>Bibliography</b> .....	<b>21</b>

## 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 (see [www.iso.org/directives](http://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 (see [www.iso.org/patents](http://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.

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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 42, *Photography*.

A list of all parts in the ISO 22028 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](http://www.iso.org/members.html).

## Introduction

This document has been developed to meet the industry need for a complete, fully documented, publicly available specification of high dynamic range (HDR) and wide colour gamut (WCG) image encodings for digital still images.

High dynamic range images, that have been produced to look correct on high dynamic range displays, can provide a better user experience than standard dynamic range images. High dynamic range images allow a greater range of shadow and highlight detail to be conveyed, with sufficient precision and acceptable artifacts, including sufficient separation of diffuse white and specular highlights.

Wide colour gamut images, in addition, can represent a wider range of colours and allow for better colour reproduction. These two features are commonly bundled together. In this document, for simplicity, we will refer to both such features using the HDR/WCG acronym.

ITU-R has published requirements and guidelines for HDR/WCG television production and exchange, the foundation of the blooming HDR/WCG video and movie ecosystems. There are now a growing number of HDR/WCG displays (Smartphones, TVs, computer displays) that consumers use in their daily life, but a limited amount of HDR/WCG still image content is available.

In parallel, digital cameras improve over time and capture more and more dynamic range. To overcome the limitations of sensing technology, HDR images can be generated by fusing several images captured with different exposures. But so far, the digital still imaging industry has not settled on a reference HDR/WCG image encoding for consumers.

The purpose of this document is to provide requirements and guidelines for colour encoding of HDR/WCG still images. The digital still imaging industry will benefit from these requirements and guidelines. They will help establish a standard and open HDR/WCG ecosystem, to take better advantage of HDR cameras and displays. These colour encoding requirements and guidelines can be leveraged in the specification of HDR/WCG file formats.

The encoding and decoding methods specified in this document are from ITU-R BT.2100-2, to ensure full compatibility with existing HDR/WCG devices and the associated video and movie ecosystems. Metadata is specified in this document to support the communication of scene-referred and display-referred image states in accordance with ISO 22028-1.

The outline of this document is as follows. The scope is defined in [Clause 1](#), the normative references are listed in [Clause 2](#). [Clause 3](#) lists the terms, definitions, and acronyms. [Clause 4](#) covers the colour image encoding requirements.

[Annex A](#) (normative) specifies the extended HDR/WCG colour encoding.

[Annex B](#) (informative) lists a selection of highly relevant ITU-R Rec. BT.2100-2 tables.

[Annex C](#) (informative) lists relevant ISO/IEC 23000-22/Amd.2 tables, that are related to metadata recommended in this document.

[Annex D](#) (informative) presents different HDR workflows.

[Annex E](#) (informative) provides information about ISO 22028-1 image states and the linear light interpretations of HDR image signal values specified in ITU-R BT.2100-2.

[Annex F](#) (informative) presents tone mapping options.



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

## Part 5: High dynamic range and wide colour gamut encoding for still images (HDR/WCG)

### 1 Scope

This document defines a set of colour image encodings for use in storage, transmission, and display of high dynamic range and wide colour gamut (HDR/WCG) digital still images. It defines the colour encodings, the mandatory and optional metadata, and the reference viewing conditions for HDR/WCG images.

### 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 22028-1:2016, *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 1: Architecture and requirements*

ISO/IEC 23091-2:2021/ITU-T H.273, *Information technology — Coding-independent code points — Part 2: Video*

ISO/IEC/TR 23091-4:2021/ITU-T H.SUPPLEMENT 19, *Information technology — Coding-independent code points — Part 4: Usage of video signal type code points*

RECOMMENDATION ITU-R BT 2100-2 (07/2018): *Image parameter values for high dynamic range television for use in production and international programme exchange*

### 3 Terms, definitions and acronyms

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

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

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

#### 3.1 coding-independent code points for video signal type identification CICP

metadata that describes the colour image characteristics of the associated picture

**3.2**

**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

[SOURCE: ISO 22028-1:2016, 3.9, modified — Notes to entry were deleted.]

**3.3**

**colour volume**

space of all colours and intensities that a device or signal can reproduce or convey

[SOURCE: ISO/IEC TR 23091-4:2021, 3.6/ITU-T H.SUPPLEMENT 19]

**3.4**

**content colour volume**

**CCV**

metadata that describes the colour volume (colour primaries, white point, and luminance range) characteristics of the associated picture

**3.5**

**content light level**

**CLL**

metadata that describes the light level characteristics (maximum and average) of the associated picture

**3.6**

**diffuse white**

stimulus that an observer adapted to the displayed content in the viewing environment would judge to be neutral and to have a luminance factor of unity

**3.7**

**display light**

image values that result from applying the reference EOTF to the encoded image signal values

**3.8**

**display viewing colorimetry**

colorimetry appropriate for a targeted display with specified viewing conditions

Note 1 to entry: The display viewing colorimetry typically depends on the creative intent for the content.

**3.9**

**display referred**

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 display and viewing conditions

**3.10**

**electrical-electrical transfer function**

**EETF**

transfer function that adjusts the electronic signal, e.g. to tone map it to a lower display range

**3.11**

**electro-optical transfer function**

**EOTF**

transfer function which converts the non-linear signal into display light



**3.12****high dynamic range and wide colour gamut encoding  
HDR/WCG encoding**

Colour image encoding that can contain wider variations in brightness, with a dynamic range significantly higher than that of a standard dynamic range encoding, and a wider range of colours with more saturated colours than standard colour gamut encodings

**3.13****high dynamic range image  
HDR image**

image that contains wider variations in brightness, with a dynamic range significantly higher than that of a standard dynamic range image

**3.14****highlights**

image pixels with colorimetric values higher than those of the reference diffuse white

**3.15****image**

data structure that contains pixels and image-related data

[SOURCE: ISO/IEC 12087-1:1995, 3.1.3]

**3.16****mastering display**

a display that is used or targeted for viewing while authoring the content

**3.17****mastering display colour volume****MDCV**

metadata that identifies the colour volume (the colour primaries, white point chromaticity, and luminance range) of a mastering display

[SOURCE: SMPTE ST 2086:2018]

**3.18****nominal peak luminance**

luminance resulting on a display from the specified encoding peak white signal level

Note 1 to entry: The peak white signal level is specified to be lower than the peak signal level for narrow range encodings.

**3.19****nominal diffuse white luminance**

display luminance a viewer would consider, on average, correspond to a perfectly reflecting diffuser in the scene when viewing the mastering display

**3.20****opto-electronic transfer function****OETF**

transfer function that converts scene light into non-linear signal values

**3.21****opto-optical transfer function****OOTF**

transfer function that converts scene light to display light

**3.22****nominal diffuse white**

diffuse white value typical for the content encoding that is assumed for general purposes, independent of specified content or other information about the actual diffuse white

### 3.23

#### scene light

image values that result from applying the inverse reference OETF to the encoded image signal values

### 3.24

#### transfer function

single variable, monotonic mathematical function applied individually to one or more colour channels

### 3.25

#### wide colour gamut

#### WCG

gamut that has saturated colour primaries and includes a broad range of saturated colours

Note 1 to entry: It is wider than a standard colour gamut such as sRGB.

Note 2 to entry: WCG encodings provide a means to encode images with more saturated colours than standard colour gamut encodings, to represent a wider range of colours and allow for better colour reproduction.

## 4 Requirements

### 4.1 General introduction

The colour image encodings specified in this document conform to the requirements defined in ISO 22028-1:2016, Clause 5, and include a colour space representation, associated metadata, a reference viewing environment, and a reference medium.

Colour image encoding and transfer functions are specified in [4.2](#) and [4.3](#) respectively. The reference viewing environment and the reference display are defined in [4.4](#) and in [4.5](#) respectively. These subclauses provide context for interpreting the intended colour appearance of the encoded image colorimetry. The associated metadata are specified in [4.6](#). The most relevant ITU-R BT.2100-2 properties are referred to in [Annex B](#) of this document.

### 4.2 Colour image encoding

#### 4.2.1 General

Two sets of colour encodings are defined, baseline and extended. Images shall conform either to the baseline colour encoding defined in [4.2.3](#), or to the extended colour encoding defined in [Annex A](#). Image readers shall support the baseline colour encoding, and may support the extended colour encoding.

The baseline colour encoding is recommended for cameras, TVs, and image readers on other consumer devices. It is fully compatible with ITU-R BT.2100-2 and recommended for image exchanges with wider viewing compatibility. The extended colour encoding is intended for applications where dedicated hardware and/or software are used.

#### 4.2.2 Colour primaries and white point

Images shall use the colour primaries and white point, as defined in Table 2, System colorimetry, of ITU-R BT.2100-2.

[Table 1](#) reproduces the chromaticity coordinates of the RGB primaries and white point of the colour encoding space specified in ITU-R BT.2100-2.

**Table 1 — Chromaticity coordinates of the RGB primaries and white point of the colour encoding space**

Parameter		Values		
		Optical spectrum (informative)	Chromaticity coordinates (CIE, 1931)	
			x	y
Primary colours	Red primary (R)	monochromatic 630 nm	0,708	0,292
	Green primary (G)	monochromatic 532 nm	0,170	0,797
	Blue primary (B)	monochromatic 467 nm	0,131	0,046
Reference white		D65 per ISO 11664-2:2007	0,312 7	0,329 0
Colour matching functions		CIE 1931		

### 4.2.3 Baseline colour encoding

Images conforming to the baseline colour encoding shall comply with the specifications defined in Table 9 in ITU-R BT.2100-2. Images shall use the non-constant luminance  $Y'$ ,  $C'_B$ ,  $C'_R$  signal format defined in Table 6 in ITU-R BT.2100-2.

[Table 2](#) partially reproduces the Table 9 of ITU-R BT.2100-2.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

[ISO/DTS 22028-5](#)

<https://standards.iteh.ai/catalog/standards/sist/4a5c003c-df0f-4d42-93af-4b1d0f150813/iso-dts-22028-5>