
**Information technology — High
efficiency coding and media delivery
in heterogeneous environments —**

**Part 15:
Signalling, backward compatibility and
display adaptation for HDR/WCG video**

*Technologies de l'information — Codage à haut rendement et
fourniture de supports dans les environnements hétérogènes —*

*Partie 15: Signalisation, compatibilité amont et adaptation de
l'affichage pour la vidéo HDR/WCG*





COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2018

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
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviated terms	3
5 Conventions	4
5.1 General.....	4
5.2 Arithmetic operators.....	5
5.3 Bit-wise operators.....	5
5.4 Assignment operators.....	6
5.5 Relational, logical and other operators.....	6
5.6 Mathematical functions.....	6
5.7 Order of operations.....	7
6 Overview	8
7 HEVC signalling mechanisms applicable to HDR/WCG video	9
7.1 General.....	9
7.2 VUI syntax elements.....	9
7.3 SEI messages applicable for HDR/WCG video.....	10
7.3.1 General.....	10
7.3.2 Mastering display colour volume SEI message.....	10
7.3.3 Content light level information SEI message.....	11
7.3.4 Ambient viewing environment SEI message.....	11
7.3.5 Alternative transfer characteristics SEI message.....	11
7.3.6 Tone mapping information SEI message.....	11
7.3.7 Colour remapping information SEI message.....	12
7.4 Overview of PQ and HLG transfer functions.....	13
7.4.1 General.....	13
7.4.2 Reference PQ EOTF.....	14
7.4.3 Reference HLG OETF.....	15
7.5 IC _{TCP} colour representation.....	16
7.5.1 General.....	16
7.5.2 Pre-encoding process.....	17
7.5.3 Encoding process.....	20
7.5.4 Decoding process.....	22
7.5.5 Post-decoding process.....	22
8 Bitstream SDR backward compatibility with single-layer coding	24
8.1 General.....	24
8.2 Approach 1: usage of HLG for “static” bitstream SDR backward compatibility.....	24
8.2.1 General.....	24
8.2.2 HLG pre-encoding conversion process.....	25
8.2.3 Encoding process.....	27
8.2.4 Decoding process.....	29
8.2.5 HLG post-decoding conversion.....	29
8.2.6 Colour representation conversion: Y’CbCr to R’G’B’.....	30
8.3 Approach 2: usage of SEI messages for “dynamic” bitstream SDR backward compatibility.....	30
8.3.1 General.....	30
8.3.2 CRI applied in Y’CbCr 4:2:0 domain.....	31
8.3.3 CRI applied in Y’CbCr 4:4:4 domain.....	32
8.3.4 TMI applied in R’G’B’ 4:4:4 domain.....	33

8.3.5	Derivation of DRA functions	34
8.3.6	Settings with colour remapping information SEI message	35
8.3.7	Settings with tone mapping information SEI message	36
9	Bitstream SDR backward compatibility with dual-layer SHVC coding	37
9.1	General	37
9.2	Encoding and decoding stages	37
10	Display adaptation	39
10.1	General	39
10.2	Display SDR backward compatibility	39
10.2.1	Conversion and coding process example	39
10.2.2	Using colour remapping information SEI message	41
	Bibliography	43

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC 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).

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

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. A technically aligned twin text is published as ITU-T H.Sup18.

A list of all parts in the ISO/IEC 23008 series can be found on the ISO website.

Introduction

High dynamic range (HDR) video is a type of video content in which the sample values represent a larger luminance range than conventional standard dynamic range (SDR) video. HDR video can provide an enhanced viewer experience and can more accurately reproduce scenes that include, within the same image, dark areas and bright highlights, such as emissive light sources and reflections. Wide colour gamut (WCG) video, on the other hand, is video characterized by a wider spectrum of colours compared to what has been commonly available in conventional video. Recent advances in capture and display technology have enabled consumer distribution of HDR and WCG content. However, given the characteristics of such content, special considerations may need to be made, in terms of both processing and compression, compared to conventional content.

This document relates to HDR/WCG video coding and distribution, using single-layer or dual-layer coding, with the signalling specified for Rec. ITU-T H.265 | ISO/IEC 23008-2 High efficiency video coding (HEVC), and when applicable, Rec. ITU-T H.264 | ISO/IEC 14496-10 Advanced video coding (AVC).

This document serves several purposes:

- It provides a survey of identified video usability information (VUI) syntax elements and supplemental enhancement information (SEI) messages specified in HEVC and AVC applicable for HDR/WCG video.
- It covers conversion and coding chains using the IC_{TCp} colour representation, and the hybrid log-gamma (HLG) transfer functions.
- Examples of using colour remapping information (CRI) and tone mapping information (TMI) SEI messages for the support of SDR backward compatibility and display adaptation functionalities are described.
- A dual-layer coding approach using the Scalable Main 10 profile of HEVC for backward compatibility with SDR systems is also documented.

Information technology — High efficiency coding and media delivery in heterogeneous environments —

Part 15: Signalling, backward compatibility and display adaptation for HDR/WCG video

1 Scope

This document reviews approaches for processing and coding of HDR/WCG video content. The purpose of this document is to provide a set of publicly-referenceable methods for the operation of AVC or HEVC video coding systems adapted for compressing HDR/WCG video for consumer distribution applications.

This document first includes a review of the video usability information (VUI) indicators and supplemental enhancement information (SEI) messages applicable for HDR/WCG video. It provides a description of processing steps for converting from 4:4:4 RGB linear light representation video signals into video signals with IC_{TCp} colour representation and perceptual quantizer (PQ) transfer function, or with $Y'CbCr$ colour representation and HLG transfer function (IC_{TCp} , PQ and HLG are defined in Rec. ITU-R BT.2100-1). Some high-level approaches for compressing these signals using either Rec. ITU-T H.264 | ISO/IEC 14496-10 or Rec. ITU-T H.265 | ISO/IEC 23008-2 are provided. A description of post-decoding processing steps is also included for converting back to a linear light, 4:4:4 RGB representation. The document also addresses the standard dynamic range (SDR) backward compatibility, that is, the compatibility with legacy decoding systems that are not able to detect and properly display HDR/WCG video content. It describes example implementations of this feature using three different solutions: using HLG as a backward compatible transfer function, using CRI and TMI SEI messages, using dual-layer approach with the Scalable Main 10 profile of HEVC and an SDR compatible base layer. Finally, the document illustrates the usage of CRI SEI messages to convey metadata enabling the dynamic range and colour gamut adaptation at the display side of the decoded video to the display capabilities.

NOTE The document complements the material provided in ITU-T H.Supp15 | ISO/IEC TR 23008-14, which is focused on conversion and coding practices for non-constant luminance (NCL) $Y'CbCr$ video signals using the PQ transfer function.

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.

Recommendation ITU-T H.264 | ISO/IEC 14496-10: 2014, *Information technology — Coding of audio-visual objects — Part 10: Advanced Video Coding*

Recommendation ITU-T H.265 | ISO/IEC 23008-2: 2017, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding*