CTA Standard

Updates to Dynamic HDR Metadata Signaling

CTA-861.4

March 2019

Consumer Technology Association™

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(Formulated under the cognizance of the CTA **R4 Video Systems Committee**.)

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FOREWORD

This standard was developed by the Consumer Technology Association’s R4 Video Systems Committee.

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TABLES

Updates to Dynamic HDR Metadata Signaling

1 Scope

This standard specifies changes related to HDR Dynamic Metadata Types 0x0001, 0x0002, 0x0004, and adds support for a graphics overlay flag and for the ICtCp signal format to CTA-861-G [A].

The requirements of this standard are in addition to and complement CTA-861-G [A]. All devices compliant to CTA-861.4 shall also comply with CTA-861-G [A], except that this standard modifies Tables 14, 25, 47, 57, 63, 69 through 71, 88 through 90, 144, and 147 through 149 of CTA-861-G [A].

Any Errata and Extensions that apply to CTA-861-G [A], which were published after November 8th, 2016, also apply to this standard.

2 References

2.1 Normative References

The following standards contain provisions that, through reference in this text, constitute normative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed here.

2.1.1 Normative Reference List

A. CTA-861-G, A DTV Profile for Uncompressed High Speed Digital Interfaces, November 2016

2.1.2 Normative Reference Acquisition

ANSI/CTA Standards

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet: http://global.ihs.com;Email global@ihs.com

2.2 Compliance Notation

As used in this document, “shall” denotes mandatory provisions of the standard. “Should” denotes a provision that is recommended but not mandatory. “May” denotes a feature whose presence does not preclude compliance and implementation of which is optional. “Optional” denotes items that may or may not be present in a compliant device.

2.3 Hexadecimal Notation

The characters 0x preceding numbers or letters A through F designate the following values as hexadecimal notation. All other numerical values are to be assumed decimal.

2.4 Bit Naming Conventions

The names of the individual bits of multi-bit data values are composed using a value's mnemonic followed by a bit number. The significance of each bit is indicated by the bit number according to little-endian convention (i.e. bit number 0 is the least significant).

Future bits begin with the mnemonic 'F' followed by a bit number, where bit numbers indicate location - not significance. Future bits shall be set to zero and ignored.

2.5 Symbols and Abbreviations

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3 IC_TC_P

Normative Reference [50] of CTA-861-G [A] is modified, as shown below:

> 50. Recommendation ITU-R BT.2100-2 (07/2018) Image parameter values for high dynamic range television for use in production and international programme exchange

A new item is added to Section 2.2 Definitions of CTA-861-G [A]:

> **IC_TC_P** – A Constant Intensity video signal format, where the I component represents intensity, and the C_T and C_P components represent color opponents. This signal format can be sub-sampled in the same manner as YC_BC_R.

A new item is added to Section 2.3 Symbols and Abbreviations of CTA-861-G [A]:

> **PQ** Perceptual Quantization

Section 5.2 Color Component Samples of CTA-861-G [A] is modified:

> Color is communicated using one of three sets of components: RGB, YC_BC_R [3], and IC_TC_P. This interface shall be capable of supporting RGB (red, green, and blue), with encoding parameters based on the format. The interface may optionally support YC_BC_R or IC_TC_P.

The first paragraph of Section 5.2.1 RGB Conversion Matrices of CTA-861-G [A] is modified:

> A transformation from YC_BC_R or IC_TC_P to RGB generally occurs within the DTV after it receives a YC_BC_R or IC_TC_P encoded Picture. A transformation between YC_BC_R Color Component Samples and RGB Color Component Samples can be accomplished by applying one of four conversion matrices: ITU-R BT.601 [6], ITU-R BT.709 [7], ITU-R BT.2020 [39] non-constant luminance, or ITU-R BT.2020 [39] constant luminance. A transformation between IC_TC_P Color Component Samples and RGB Color Component Samples can be accomplished by applying one of two conversion matrices: ITU-R BT.2100 [50] constant intensity IC_TC_P color conversion matrix for PQ or HLG. The specific conversion matrix required depends on the Colorimetry and Extended Colorimetry fields in the AVI InfoFrame. The conversion matrix is either specified explicitly (e.g., the Colorimetry field is set to ITU-R BT.601 or ITU-R BT.709) or it is denoted in the subscript of the short name of the selected YC_BC_R colorimetry. For example, the ITU-R BT.601 conversion matrix applied to $sYCC_{601}$ or $opYCC_{601}$ Color Component Samples results in RGB Color Component Samples (both positive and negative).

New text, shown below, is added to the end of Section 5.2.1 RGB Conversion Matrices of CTA-861-G [A]:

> The ITU-R BT.2100 [50] constant intensity IC_TC_P color conversion matrix is shown below for convenience.

L= (1688 R + 2146 G + 262 B) / 4096
M = (683 R + 2951 G + 462 B) / 4096
S = (99 R + 309 G + 3688 B) / 4096

For PQ:

$L' = EOTF^{-1}(L)$
$M' = EOTF^{-1}(M)$
$S' = EOTF^{-1}(S)$
Note: L, M and S represent display light

I = 0.5 L' + 0.5 M'
C_T = (6610 L' – 13613 M' + 7003 S') / 4096
C_P = (17933 L' – 17390 M' – 543 S') / 4096
Note: The I, C_T and C_P symbols do not employ the prime symbols to simplify the notation.

For HLG:

L' = OETF(L)
M' = OETF(M)
S' = OETF(S)
Note: L, M and S represent scene light

I = 0.5 L' + 0.5 M'
C_T = (3625 L' – 7465 M' + 3840 S') / 4096
C_P = (9500 L' – 9212 M' – 288 S') / 4096
Note: The I, C_T and C_P symbols do not employ the prime symbols to simplify the notation.

Please refer to Section 5.3 Transfer Characteristic (e.g., gamma correction) for definitions of the electro-optical and opto-electronic transfer functions (EOTF, $EOTF^{-1}$ and OETF)

Section 5.2.2 Sample Lattice of CTA-861-G [A] is modified:

In order to improve color reproduction, the sample lattice for RGB, YC_BC_R, and IC_TC_P 4:2:2 Pixel Data should conform to the ITU-R BT.709 [7] sampling lattice. The sample lattice for these Pixel Data encodings are described below for convenience:

- R, G, B, Y, and I components are orthogonal, line- and picture-repetitive. R, G, and B components are co-sited with each other.

- C_B, C_R, C_T, and C_P are orthogonal, line- and picture-repetitive co-sited with each other and with alternate Y or I samples (starting with the first active Y or I sample in a line).

The sample lattice for YC_BC_R and IC_TC_P 4:4:4 Pixel Data should be the same as the sample lattice for RGB Pixel Data.

New text, shown below, is added to the end of Section 5.3 Transfer Characteristic (e.g., gamma correction) of CTA-861-G [A]:

The transfer characteristics for ITU-R BT.2100 [50] PQ encoded images are shown below for convenience.

$$F_D = \mathrm{EOTF}[E'] = 10000\,Y$$

$$Y = \left(\frac{\max\left[\left(E'^{1/m_2} - c_1\right), 0\right]}{c_2 - c_3 E'^{1/m_2}} \right)^{1/m_1}$$

$$\mathrm{EOTF}^{-1}[F_D] = \left(\frac{c_1 + c_2 Y^{m_1}}{1 + c_3 Y^{m_1}} \right)^{m_2}$$

$$Y = F_D / 10000$$

Where:

- E' denotes a non-linear color value {R', G', B'} or {L', M', S'} in PQ space [0,1]
- F_D is the luminance of a displayed linear component {R_D, G_D, B_D} or Y_D or I_D, in cd/m^2. NOTE: When referring to the luminance of a single color component (R_D, G_D, B_D), it means the luminance of an equivalent achromatic signal with all three color components having that same value.
- So that when R'=G'=B', the displayed pixel is achromatic.
- Y denotes the normalized linear color value, in the range [0:1]
- m_1 = 2610/16384 = 0.1593017578125
- m_2 = 2523/4096 * 128 = 78.84375
- c_1 = 3424/4096 = 0.8359375 = c_3 − c_2 + 1
- c_2 = 2413/4096 * 32 = 18.8515625
- c_3 = 2392/4096 * 32 = 18.6875

The transfer characteristics for Recommendation ITU-R BT.2100 [50] HLG encoded images are shown below for convenience.

$$E' = \mathrm{OETF}[E] = \begin{cases} \sqrt{3E} & 0 \le E \le 1/12 \\ a \cdot \ln(12E - b) + c & 1/12 < E \le 1 \end{cases}$$

Where:

- E is a signal for each color component {R_S, G_S, B_S} proportional to scene linear light normalized to the range [0:1].
- E' is the resulting non-linear signal {R', G', B'} in the range [0:1].
- a = 0.17883277, b = 0.28466892, c = 0.55991073

The four paragraphs, shown below, modify Section 5.4 Color Coding & Quantization of CTA-861-G [A]:

Range: Limited Range R, G, B, Y, and I signals shall have (219*2^(N-8))+1 quantization levels. Limited Range C_B, C_R, C_T, and C_P signals shall have (224*2^(N-8))+1 quantization levels. Full Range R, G, B, Y, I, C_B, C_R, C_T, and C_P signals shall have 2^N quantization levels.

Levels: Limited Range R, G, B, Y, and I signals shall have black level corresponding to code 16*2^(N-8) and peak white level corresponding to code 235*2^(N-8); Limited Range C_B, C_R, C_T, and C_P signals shall have a zero level corresponding to digital code 2^(N-1) and range spanning

codes 16*2^(N-8) to 240*2^(N-8). Full Range R, G, B, Y, and I signals shall have a black level corresponding to code 0 and peak white level corresponding to code (2^N)-1. Full Range C_B, C_R, C_T, and C_P signals shall have a zero level corresponding to digital code 2^(N-1) and range spanning codes 0 to (2^N)-1.

Overshoot/Undershoot Regions: If the N-bit digital video signal is converted to an analog signal in the Sink, it is recommended that for RGB or Y or I, the black level (i.e., sync level and blanking level) be aligned with the video portion of the signal at black and white digital levels 16*2^(N-8) and 235*2^(N-8), respectively, such that the Limited Range digital signal swing corresponds to the nominal analog video swing (e.g., 0 to 700mV per Sections 9.4, 10.5, and 10.6 of SMPTE 274M [2]). This means that zero analog level (0.0 IRE Units) should be associated with digital level 16*2^(N-8). Digital levels in an undershoot region 1 to (16*2^(N-8))-1 and overshoot region (235*2^(N-8))+1 to (2^N)-2 are recommended to be passed through the digital to analog converter; however, limited range of the analog signal should be aligned with the range 16*2^(N-8) to 235*2^(N-8) since it is expected that this range contains essential video. For the 640x480p format, it is recommended that the full 0-255 range be displayed for this format.

Forbidden Values: For Limited Range R, G, B, Y, I, C_B, C_R, C_T, C_P signals, codes outside the range 2^(N-8) to (255*2^(N-8))-1 are reserved and shall not be considered video.

Table 1, shown below, modifies Table 14 in Section 6.4 of CTA-861-G [A]:

	RGB or YC_BC_R (from Data Byte 1)			Colorimetry (from Data Byte 2)		Extended Colorimetry (from Data Byte 3)			Additional Colorimetry Extension (from Data Byte 14)				Colorimetry of Next Transmitted Picture	Notes
	Y2	Y1	Y0	C1	C0	EC2	EC1	EC0	ACE3	ACE2	ACE1	ACE0		
RGB 4:4:4	0	0	0	0	0	X	X	X	X	X	X	X	RGB	1
	0	0	0	0	1	X	X	X	X	X	X	X	Reserved	
	0	0	0	1	0	X	X	X	X	X	X	X	Reserved	
	0	0	0	1	1	0	X	X	X	X	X	X	Reserved	
	0	0	0	1	1	1	0	0	X	X	X	X	opRGB	2
	0	0	0	1	1	1	0	1	X	X	X	X	Reserved	
	0	0	0	1	1	1	1	0	X	X	X	X	ITU-R BT.2020 R'G'B' [39]	2,5
	0	0	0	1	1	1	1	1	0	0	0	0	DCI-P3 R'G'B' (D65)	
	0	0	0	1	1	1	1	1	0	0	0	1	DCI-P3 R'G'B' (theater)	
	0	0	0	1	1	1	1	1	0	X	1	X	Reserved	
	0	0	0	1	1	1	1	1	1	X	X	X	Reserved	

Table 1 Picture Colorimetry Indicated by the RGB or YC_BC_R (Y), Colorimetry (C), Extended Colorimetry (EC) and Additional Colorimetry Extension (ACE) Field Settings

	RGB or YC_BC_R (from Data Byte 1)			Colorimetry (from Data Byte 2)		Extended Colorimetry (from Data Byte 3)			Additional Colorimetry Extension (from Data Byte 14)				Colorimetry of Next Transmitted Picture	Notes
	Y2	Y1	Y0	C1	C0	EC2	EC1	EC0	ACE3	ACE2	ACE1	ACE0		
YC_BC_R 4:2:2	0	0	1	0	0	X	X	X	X	X	X	X	SMPTE 170M [1] or ITU-R BT.709 [7]	3,4
	0	0	1	0	1	X	X	X	X	X	X	X	SMPTE 170M [1]	4
	0	0	1	1	0	X	X	X	X	X	X	X	ITU-R BT.709 [7]	4
	0	0	1	1	1	0	0	0	X	X	X	X	$xvYCC_{601}$	2,4
	0	0	1	1	1	0	0	1	X	X	X	X	$xvYCC_{709}$	2,4
	0	0	1	1	1	0	1	0	X	X	X	X	$sYCC_{601}$	2,4
	0	0	1	1	1	0	1	1	X	X	X	X	$opYCC_{601}$	2,4
	0	0	1	1	1	1	0	0	X	X	X	X	Reserved	
	0	0	1	1	1	1	0	1	X	X	X	X	ITU-R BT.2020 $Y'_CC'_{BC}C'_{RC}$ [39]	2,5
	0	0	1	1	1	1	1	0	X	X	X	X	ITU-R BT.2020 $Y'C'_BC'_R$ [39]	2,5
	0	0	1	1	1	1	1	1	0	0	0	X	Reserved	
	0	0	1	1	1	1	1	1	0	0	1	0	ITU-R BT.2100 [50] IC_TC_P	
	0	0	1	1	1	1	1	1	0	0	1	1	Reserved	
	0	0	1	1	1	1	1	1	0	1	X	X	Reserved	
	0	0	1	1	1	1	1	1	1	X	X	X	Reserved	
YC_BC_R 4:4:4	0	1	0	0	0	X	X	X	X	X	X	X	SMPTE 170M [1] or ITU-R BT.709 [7]	3,4
	0	1	0	0	1	X	X	X	X	X	X	X	SMPTE 170M [1]	4
	0	1	0	1	0	X	X	X	X	X	X	X	ITU-R BT.709 [7]	4
	0	1	0	1	1	0	0	0	X	X	X	X	$xvYCC_{601}$	2,4
	0	1	0	1	1	0	0	1	X	X	X	X	$xvYCC_{709}$	2,4
	0	1	0	1	1	0	1	0	X	X	X	X	$sYCC_{601}$	2,4
	0	1	0	1	1	0	1	1	X	X	X	X	$opYCC_{601}$	2,4
	0	1	0	1	1	1	0	0	X	X	X	X	Reserved	
	0	1	0	1	1	1	0	1	X	X	X	X	ITU-R BT.2020 $Y'_CC'_{BC}C'_{RC}$ [39]	2,5,6
	0	1	0	1	1	1	1	0	X	X	X	X	ITU-R BT.2020 $Y'C'_BC'_R$ [39]	2,5
	0	1	0	1	1	1	1	1	0	0	0	X	Reserved	
	0	1	0	1	1	1	1	1	0	0	1	0	ITU-R BT.2100 [50] IC_TC_P	
	0	1	0	1	1	1	1	1	0	0	1	1	Reserved	
	0	1	0	1	1	1	1	1	0	1	X	X	Reserved	
	0	1	0	1	1	1	1	1	1	X	X	X	Reserved	
YC_BC_R 4:2:0	0	1	1	0	0	X	X	X	X	X	X	X	SMPTE 170M [1] or ITU-R BT.709 [7]	3,4
	0	1	1	0	1	X	X	X	X	X	X	X	SMPTE 170M [1]	4
	0	1	1	1	0	X	X	X	X	X	X	X	ITU-R BT.709 [7]	4
	0	1	1	1	1	0	0	0	X	X	X	X	$xvYCC_{601}$	2,4
	0	1	1	1	1	0	0	1	X	X	X	X	$xvYCC_{709}$	2,4
	0	1	1	1	1	0	1	0	X	X	X	X	$sYCC_{601}$	2,4
	0	1	1	1	1	0	1	1	X	X	X	X	$opYCC_{601}$	2,4
	0	1	1	1	1	1	0	0	X	X	X	X	Reserved	

	0	1	1	1	1	1	0	1	X	X	X	X	ITU-R BT.2020 $Y'_CC'_{BC}C'_{RC}$ [39]	2,5
	0	1	1	1	1	1	1	0	X	X	X	X	ITU-R BT.2020 $Y'C'_BC'_R$ [39]	2,5
	0	1	1	1	1	1	1	1	0	0	0	X	Reserved	
	0	1	1	1	1	1	1	1	0	0	1	0	ITU-R BT.2100 [50] IC_TC_P	
	0	1	1	1	1	1	1	1	0	0	1	1	Reserved	
	0	1	1	1	1	1	1	1	0	1	X	X	Reserved	
	0	1	1	1	1	1	1	1	1	X	X	X	Reserved	

Table 1 Picture Colorimetry Indicated by the RGB or YC_BC_R (Y), Colorimetry (C) and Extended Colorimetry (EC) Field Settings (continued)

	RGB or YC_BC_R (from Data Byte 1)			Colorimetry (from Data Byte 2)		Extended Colorimetry (from Data Byte 3)			Additional Colorimetry Extension (from Data Byte 14)				Colorimetry of Next Transmitted Picture	Notes
	Y2	Y1	Y0	C1	C0	EC2	EC1	EC0	ACE3	ACE2	ACE1	ACE0		
Reserved	1	0	X	X	X	X	X	X	X	X	X	X	Reserved	
Reserved	1	1	0	X	X	X	X	X	X	X	X	X	Reserved	
IDO-Defined	1	1	1	D	D	D	D	D	D	D	D	D	Defined by IDO	

Notes:

1. A DTV declares it is capable of displaying Pictures encoded in sRGB color space (as defined in IEC 61996-2-1 [33]) by setting bit 2 in the Feature Support byte (0x18) of the Basic Display Parameters and Feature Block in its EDID. A Sink that declares it is not capable of displaying Pictures encoded in RGB color space declares its colorimetry via the values set in bytes 0x19 through 0x22 of the Basic Display Parameters and Feature Block in its EDID. See Sections A.2.6 and A.2.7 for further information.

2. A DTV declares it is capable of displaying Pictures encoded in this colorimetry by setting the associated bit in Byte 3 of the Colorimetry Data Block in its EDID. See Section 7.5.5 for further information.

3. The Picture colorimetry is dependent on the value of Vactive for the Video Identification Code set in the AVI InfoFrame. See Section 5 for further information.

4. A DTV declares it is capable of displaying Pictures encoded in this colorimetry by setting bit 4 and/or bit 5 in Byte 3 of the CTA Extension Version 3 block in its EDID. See Section 7.5.

5. ITU-R BT.2020 [39] colorimetry is only defined for Component Depths of 10 & 12-bits/component and shall not be used at 8-bits/component.

6. In the case of 4:4:4 sampling, applying the constant luminance ($Y'_CC'_{BC}C'_{RC}$) transform of ITU-R BT.2020 [39] might be of little benefit.

Table 1 Picture Colorimetry Indicated by the RGB or YC_BC_R (Y), Colorimetry (C) and Extended Colorimetry (EC) Field Settings (continued)

Table 2, shown below, modifies Table 25 in Section 6.4 of CTA-861-G [A]:

ACE3	ACE3	ACE1	ACE0	Additional Colorimetry Extension
0	0	0	0	DCI-P3 R'G'B' (D65)
0	0	0	1	DCI-P3 R'G'B' (theater)
0	0	1	0	ITU-R BT.2100 [50] IC_TC_P
0x03-0x0F				Reserved

Table 2 AVI InfoFrame Data Byte 14 Additional Colorimetry Extension (ACE) Bits

Table 3, Table 4 and the paragraph, all shown below, are modifying Tables 70 and 71 and the paragraph below Table 71 in Section 7.5.5 of CTA-861-G [A]:

	bits							
Byte#	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	Tag Code (0x07)			Length of following data block (in bytes) (0x03)				
2	Extended Tag Code (0x05)							
3	$BT2020_{RGB}$	$BT2020_{YCC}$	$BT2020_{cYCC}$	opRGB	$opYCC_{601}$	$sYCC_{601}$	$xvYCC_{709}$	$xvYCC_{601}$
4	DCI-P3	IC_TC_P	F45=0	F44=0	MD3	MD2	MD1	MD0

Table 3 Colorimetry Data Block

Flag	Colorimetry
$xvYCC_{601}$	Standard Definition Colorimetry based on IEC 61966-2-4 [5]
$xvYCC_{709}$	High Definition Colorimetry based on IEC 61966-2-4 [5]
$sYCC_{601}$	Colorimetry based on IEC 61966-2-1/Amendment 1 [34]
$opYCC_{601}$	Colorimetry based on IEC 61966-2-5 [32], Annex A
opRGB	Colorimetry based on IEC 61966-2-5 [32]
$BT2020_{cYCC}$	Colorimetry based on ITU-R BT.2020 [39] $Y'cC'_{BC}C'_{RC}$
$BT2020_{YCC}$	Colorimetry based on ITU-R BT.2020 [39] $Y'C'_BC'_R$
$BT2020_{RGB}$	Colorimetry based on ITU-R BT.2020 [39] R'G'B'
DCI-P3	Colorimetry based on DCI-P3 [51] [52] [1]
IC_TC_P	Colorimetry based on ITU-R BT.2100 [50] IC_TC_P

Table 4 Data Byte 3 Colorimetry Support Flags

Byte 4, bits 0 through 3 are listed in Table 72 and designated for future gamut-related metadata. As yet undefined, this metadata is carried in an interface-specific way. The flag for bit 6 is defined for colorimetry based upon the ITU-R BT.2100 standard. The flag for bit 7 is defined for colorimetry based upon the RP431-2 and EG432-1 standards.

4 HDR Dynamic Metadata Type 0x0001

Section R.1 Scope of CTA-861-G [A] is modified:

A display management (DM) message contains metadata in order to provide dynamic information that can be employed by the display to adapt the delivered HDR imagery to the capability of the display device. The information conveyed in this DM message corresponds to the metadata specified in SMPTE ST 2094-1 [56], SMPTE ST 2094-10 [57] and SMPTE ST 2086 [41].

This annex specifies a syntax for the carriage of ST 2094-10 [57] Application #1 metadata for type_1_hdr_metadata_version value 0x0. This syntax is used for carriage of this metadata over the CTA-861 interface. It may also be used in an SEI message. Future versions of CTA-861 may specify the data format for future versions of type 1 HDR metadata.

Section R.2 Definitions of CTA-861-G [A] is modified:

Refer to ITU-T H.265 [55], Sections 5.2 "Arithmetic operators", 5.8 "Mathematical functions" and 7.2 “Specification of syntax functions and descriptors”.

For this annex, "sequence" refers to one or more frames with identical metadata values. A sequence may consist of continuous pictorial content, starting and ending at an editorial cut point, or of a single frame.

Table 5 and the paragraphs, shown below, modify Table 144 and the paragraph below Table 144 in Section R.3 of CTA-861-G [A]:

DM_data() {	Descriptor
reserved_1	ue(v)
reserved_2	ue(v)
reserved_3	ue(v)
reserved_4	u(16)
display_primaries_x[0]	u(16)
display_primaries_y[0]	u(16)
display_primaries_x[1]	u(16)
display_primaries_y[1]	u(16)
display_primaries_x[2]	u(16)
display_primaries_y[2]	u(16)
white_point_x	u(16)
white_point_y	u(16)
max_display_mastering_luminance	u(32)
min_display_mastering_luminance	u(32)
reserved_15	u(32)
reserved_16	i(16)
reserved_17	i(16)
reserved_18	i(16)
reserved_19	i(16)
reserved_20	i(16)
reserved_21	i(16)
reserved_22	i(16)
reserved_23	i(16)
reserved_24	i(16)
reserved_25	u(16)
reserved_26	u(16)
reserved_27	u(16)
reserved_28	u(32)
reserved_29	u(5)
reserved_30	u(2)
reserved_31	u(2)
reserved_32	u(2)
reserved_33	u(12)
reserved_34	u(12)
reserved_35	u(10)
num_ext_blocks	ue(v)
if(num_ext_blocks) {	
while(!byte_aligned())	

dm_alignment_zero_bit	f(1)
for(i = 0; i < num_ext_blocks; i ++) {	
ext_dm_data_block()	
}	
}	
}	

Table 5 DM_data()

reserved_1 - reserved_4 and **reserved_15 - reserved_35** are not used. Sources shall set **reserved_1 - reserved_4** and **reserved_15 - reserved_35** to zero. Sinks shall ignore **reserved_1 - reserved_4** and **reserved_15 - reserved_35.**

display_primaries_x[0], display_primaries_y[0], display_primaries_x[1], display_primaries_y[1], display_primaries_x[2], display_primaries_y[2], white_point_x, white_point_y, max_display_mastering_luminance, min_display_mastering_luminance are defined in ITU-T H.265 [55], Section D.3.28, "Mastering display colour volume SEI message syntax". Sinks shall ignore **max_display_mastering_luminance, min_display_mastering_luminance** when **max_display_mastering_luminance** is zero.

A new paragraph, shown below, is added below Table 146 in Section R.3 of CTA-861-G [A]:

The parameter values used in this document are independent of the input pixel bit depth and represent units in absolute luminance or intensity. All 12-bit PQ encoded parameters included in this document are used to process pixels with up to 12-bit components. These PQ encoded parameters are computed as shown in Annex A.2 of ST 2084 [40].

Two paragraphs and Table 6, shown below, are modifying Table 147 and the two paragraphs above Table 147 in Section R.3 of CTA-861-G [A]:

ext_block_length[i] is used to derive the size of the i-th extended metadata block payload in bytes. The value shall be in the range of 0 to 1023, inclusive. ext_block_length is not present if num_ext_blocks is equal to 0.

ext_block_level[i] specifies the level of payload contained in the current extended metadata block. The value shall be in the range of 0 to 255, inclusive. The corresponding extended display mapping metadata block types are defined in Table 6 below. If ext_block_level is not present, it shall be inferred to be 0.

ext_block_level	extended display mapping metadata block type
0	Reserved
1	Level 1 Metadata – Content Range
2	Level 2 Metadata – Trim Pass
3	Level 3 Metadata – Content Range Offsets
4	Reserved
5	Level 5 Metadata – Active Area
6…255	Reserved

Table 6 Definition of extended metadata block type

The paragraphs, shown below, are modifying the paragraphs of Section R.3 of CTA-861-G [A], starting at the paragraph defining min_PQ, up to the end of the Section:

min_PQ specifies the minimum luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If min_PQ is not present, it shall be inferred to be equal to the value of source_min_PQ. Note that the 12-bit min_PQ value is calculated as follows:

$$\text{min\_PQ} = \text{Clip3}(0, 4095, \text{Round}(\text{Min} * 4095)),$$

where Min is MinimumPqencodedMaxrgb as defined in section 6.1.3 of ST 2094-10 [57]

max_PQ specifies the maximum luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If max_PQ is not present, it shall be inferred to be equal to the value of source_max_PQ. Note that the 12-bit max_PQ value is calculated as follows:

$$\text{max\_PQ} = \text{Clip3}(0, 4095, \text{Round}(\text{Max} * 4095)),$$

where Max is MaximumPqencodedMaxrgb as defined in section 6.1.5 of ST 2094-10 [57]

avg_PQ specifies the midpoint luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If avg_PQ is not present, it shall be inferred to be equal to the value of (source_min_PQ + source_max_PQ) / 2. Note that the 12-bit avg_PQ value is calculated as follows:

$$\text{avg\_PQ} = \text{Clip3}(0, 4095, \text{Round}(\text{Avg} * 4095)),$$

where Avg is AveragePqencodedMaxrgb as defined in section 6.1.4 of ST 2094-10 [57]

target_max_PQ specifies the maximum luminance value of a target display in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If target_max_PQ is not present, it shall be inferred to be equal to the value of source_max_PQ. target_max_PQ is the PQ encoded value of TargetedSystemDisplayMaximumLuminance as defined in section 10.4 of ST 2094-1 [56].
Note: If there is more than one extension block with ext_block_level equal to 2, those blocks shall have no duplicated target_max_PQ.

trim_slope specifies the slope metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_slope is not present, it shall be inferred to be 2048. Note that the 12-bit slope value is calculated as follows:

$$trim\_slope = \text{Clip3}(0, 4095, \text{Round}((S - 0.5) * 4096)),$$

where *S* is the ToneMappingGain as defined in section 6.2.3 of ST 2094-10 [57].

trim_offset specifies the offset metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_offset is not present, it shall be inferred to be 2048. Note that the 12-bit offset value is calculated as follows:

$$trim\_offset = \text{Clip3}(0, 4095, \text{Round}((O + 0.5) * 4096)),$$

where *O* is the ToneMappingOffset as defined in section 6.2.2 of ST 2094-10 [57].

trim_power specifies the power metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_power is not present, it shall be inferred to be 2048. Note that the 12-bit power value is calculated as follows:

$$trim\_power = \text{Clip3}(0, 4095, \text{Round}((P - 0.5) * 4096)),$$

where *P* is the ToneMappingGamma as defined in section 6.2.4 of ST 2094-10 [57].

trim_chroma_weight specifies the chroma weight metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_chroma_weight is not present, it shall be inferred to be 2048. Note that the 12-bit chroma weight value is calculated as follows:

$$trim\_chroma\_weight = \text{Clip3}(0, 4095, \text{Round}((CW + 0.5) * 4096)),$$

where *CW* is the ChromaCompensationWeight as defined in section 6.3.1 of ST 2094-10 [57].

trim_saturation_gain specifies the saturation gain metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_saturatioin_gain is not present, it shall be inferred to be 2048. Note that the 12-bit saturation gain value is calculated as follows:

$$trim\_saturation\_gain = \text{Clip3}(0, 4095, \text{Round}((SG + 0.5) * 4096)),$$

where *SG* is the SaturationGain as defined in section 6.3.2 of ST 2094-10 [57].

ms_weight specifies the multiscale weight metadata. The value shall be in the range of -1 to 4095, inclusive. If ms_weight is not present, it shall be inferred to be 2048. Where ms_weight is equal to -1, the bit stream indicates ms_weight is unspecified. The 13-bit multiscale weight value is calculated as follows:

$$ms\_weight = \text{-1 OR Clip3}(0, 4095, \text{Round}(MS * 4096)),$$

where *MS* is the ToneDetailFactor as defined in section 6.4.2 of ST 2094-10 [57].

min_PQ_offset specifies the offset to the minimum luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If min_PQ_offset is not present, it shall be inferred to be equal to the default value 2048. Note that the 12-bit min_PQ_offset value is calculated as follows:

$$\text{min\_PQ\_offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Min\_Offset} + 0.5) * 4096)),$$

where Min_Offset is MinimumPqencodedMaxrgbOffset as defined in section 6.1.6 of ST 2094-10 [57].

max_PQ_offset specifies the offset to the maximum luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If max_PQ_offset is not present, it shall be inferred to be equal to the default value 2048. Note that the 12-bit max_PQ_offset value is calculated as follows:

$$\text{max\_PQ\_offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Max\_Offset} + 0.5) * 4096)),$$

where Max_Offset is MaximumPqencodedMaxrgbOffset as defined in section 6.1.8 of ST 2094-10 [57].

avg_PQ_offset specifies the offset to the midpoint luminance value of the current frame sequence in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. If avg_PQ_offset is not present, it shall be inferred to be equal to the default value 2048. Note that the 12-bit avg_PQ_offset value is calculated as follows:

$$\text{avg\_PQ\_offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Avg\_Offset} + 0.5) * 4096)),$$

where Avg_Offset is AveragePqencodedMaxrgbOffset as defined in section 6.1.7 of ST 2094-10 [57].

active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset specify the active area of the current frame, in terms of a rectangular region specified in frame coordinates for active area. The values shall be in the range of 0 to 8191, inclusive. See also UpperLeftCorner and LowerRightCorner definitions in ST 2094-1 [56].

If active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset are not present, they shall be inferred to be 0.

The coordinates of top left active pixel are derived as follows:

$$X_{top\_left} = \text{active\_area\_left\_offset}$$

$$Y_{top\_left} = \text{active\_area\_top\_offset}$$

The coordinates of top left active pixel are defined as the UpperLeftCorner in section 9.2 of ST 2094-1 [56].

The coordinates of bottom right active pixel are derived as follows:

$$X_{bottom\_right} = \text{XSize} - 1 - \text{active\_area\_right\_offset}$$

$$Y_{bottom\_right} = \text{YSize} - 1 - \text{active\_area\_bottom\_offset}$$

where Xsize is the horizontal resolution of the current frame and Ysize is the vertical resolution of the current frame. X_{bottom_right} is greater than X_{top_left} and Y_{bottom_right} is greater than Y_{top_left}.
The coordinates of bottom right active pixel are defined as the LowerRightCorner in section 9.3 of ST 2094-1 [56].

ext_dm_alignment_zero_bit shall be equal to 0.

5 HDR Dynamic Metadata Type 0x0002

Normative Reference 49 of CTA-861-G [A] is replaced by the text shown below:

49. ETSI TS 103 433-1 v1.2.1 (2017-05), High-Performance Single Layer Directly Standard Dynamic Range (SDR) Compatible High Dynamic Range (HDR) System for use in Consumer Electronics devices (SL-HDR1)

Normative Reference 53 of CTA-861-G [A] is modified, as shown below:

> 53. ETSI TS 103 433 v1.1.1 (2016-08), High-Performance Single Layer Directly Standard Dynamic Range (SDR) Compatible High Dynamic Range (HDR) System for use in Consumer Electronics devices (SL-HDR1)

Reference 49 is added to entry 0x0002 in Table 47 in Section 6.10 of CTA-861-G [A], as shown below:

> HDR Dynamic Metadata carried in Supplemental Enhancement Information (SEI) messages according to ETSI TS 103 433 [53][49]

The second paragraph below Table 48 in Section 6.10.1 of CTA-861-G [A] is modified:

> When Extended InfoFrame Type Code is set to 0x0002, the Application-specific Data in Data Bytes 1-*n* is a concatenation of the Supplemental Enhancement Information (SEI) messages described in the Annexes of ETSI TS 103 433 [53] in any order. The data bytes defining payloadType and payloadSize as defined in ITU-T H.264 [54] and ITU-T H.265 [55] are included in the Application-specific Data. The processing mode to be used by the Sink with the HDR Dynamic Metadata is indicated by sl_hdr_mode_value_minus1 as described in ETSI TS 103 433-1 [49] sections G.3, A.2.2 and A.2.3.

Table 7 and the paragraphs, shown below, are modifying Table 89 and the paragraph below Table 89 in Section 7.5.14 of CTA-861-G [A]:

bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
F17=0	sl_hdr_mode_support			ts_103_433_spec_version			

Table 7 Support Flags for Supported HDR Dynamic Metadata Type 0x0002

> In this case, a Sink supporting the HDR Dynamic Metadata Data Block shall indicate which ts_103_433_spec_version it supports. If ts_103_433_spec_version is equal to 0, this indicates the Sink supports TS 103 433 v1.1.1 (2016-08) [53] and the sl_hdr_mode_support bits are ignored by the Source.
>
> If ts_103_433_spec_version is equal to 1 or higher, this indicates the SL-HDR specification version supported by the Sink and the sl_hdr_mode_support bits indicate the ETSI TS 103 433 processing mode(s) supported by the Sink as specified in ETSI TS 103 433-1 [49]. In this case, it is not necessary to also support ETSI TS 103 433 V1.1.1 [53].

6 HDR Dynamic Metadata Type 0x0004

A new definition is added to Section 2.2 of CTA-861-G [A] as follows:

linearized maxRGB – maxRGB values as defined in SMPTE ST 2094-1 [56], normalized to the range [0, 1], representing linear light level with 0 representing 0 cd/m^2 and 1 representing 10000 cd/m^2 when the three normalized color components have the same value.

> Note: This is the same definition as in SMPTE ST 2094-40:2016 [58]. In addition, the normalized RGB value {1, 1, 1} is defined to be 10000 cd/m2.

The paragraph, shown below, modifies the third paragraph of Section S.1 of CTA-861-G [A]:

> This annex specifies the syntax and semantics for the carriage of SMPTE ST 2094-40 Application #4 [58] metadata. For type_4_hdr_metadata_version value 0x0, the syntax and semantics are as defined below without the constraints described in Section S.4. For type_4_hdr_metadata_version value 0x1, the syntax and semantics are as shown below and are constrained as described in Section S.4. The syntax specified in Table 148, with the semantics specified in Section S.3, is used for carriage of this metadata over the CTA-861 interface, and may also be used in an SEI message. Future versions of CTA-861 may specify the syntax for future versions of type 4 metadata.

Table 8 and the paragraph, shown below, modify Table 148 and the paragraph above Table 148 in Section S.2 of CTA-861-G [A]:

> Table 148 defines the message syntax for the full set of features specified by ST 2094-40. Additional constraints are specified in Section S.4.

user_data_registered_itu_t_t35 () {	Descriptor
itu_t_t35_country_code	u(8)
itu_t_t35_terminal_provider_code	u(16)
itu_t_t35_terminal_provider_oriented_code	u(16)
application_identifier	u(8)
application_mode	u(8)
num_windows	u(2)
for(w = 1; w < num_windows; w++) {	
window_upper_left_corner_x[w]	u(16)
window_upper_left_corner_y[w]	u(16)
window_lower_right_corner_x[w]	u(16)
window_lower_right_corner_y[w]	u(16)
center_of_ellipse_x[w]	u(16)
center_of_ellipse_y[w]	u(16)
rotation_angle[w]	u(8)
semimajor_axis_internal_ellipse[w]	u(16)
semimajor_axis_external_ellipse[w]	u(16)
semiminor_axis_external_ellipse[w]	u(16)
overlap_process_option[w]	u(1)
}	
targeted_system_display_maximum_luminance	u(27)
targeted_system_display_actual_peak_luminance_flag	u(1)
if(targeted_system_display_actual_peak_luminance_flag) {	
num_rows_targeted_system_display_actual_peak_luminance	u(5)
num_cols_targeted_system_display_actual_peak_luminance	u(5)
for(i = 0; i < num_rows_targeted_system_display_actual_peak_luminance; i++)	
for(j = 0; j < num_cols_targeted_system_display_actual_peak_luminance; j++)	
targeted_system_display_actual_peak_luminance[i][j]	u(4)
}	
for(w = 0; w < num_windows; w++) {	
for(i = 0; i < 3; i++)	
maxscl[w][i]	u(17)
average_maxrgb[w]	u(17)
num_distributions[w]	u(4)
for(i = 0; i < num_distributions[w]; i++) {	
distribution_index[w][i]	u(7)
distribution_values[w][i]	u(17)
}	
fraction_bright_pixels[w]	u(10)
}	
mastering_display_actual_peak_luminance_flag	u(1)
if(mastering_display_actual_peak_luminance_flag) {	
num_rows_mastering_display_actual_peak_luminance	u(5)
num_cols_mastering_display_actual_peak_luminance	u(5)
for(i = 0; i < num_rows_mastering_display_actual_peak_luminance; i++)	
for(j = 0; j < num_cols_mastering_display_actual_peak_luminance; j++)	
mastering_display_actual_peak_luminance[i][j]	u(4)
}	
for(w = 0; w < num_windows; w++) {	
tone_mapping_flag[w]	u(1)
if(tone_mapping_flag[w]) {	
knee_point_x[w]	u(12)

knee_point_y[w]	u(12)
num_bezier_curve_anchors[w]	u(4)
for(i = 0; i < num_bezier_curve_anchors[w]; i++)	
bezier_curve_anchors[w][i]	u(10)
}	
color_saturation_mapping_flag[w]	u(1)
if(color_saturation_mapping_flag[w]) {	
color_saturation_weight[w]	u(6)
}	
}	
}	

Table 8 user_data_registered_itu_t_t35

The Section, including Table 9, shown below, is modifying Section S.3 and Table 149 of CTA-861-G [A]:

S.3 User_data_registered_itu_t_t35 SEI message semantics for ST 2094-40 [58]

This SEI message provides information to enable color volume transformation of the reconstructed color samples of the output pictures. The input to the indicated color volume transform process is the linearized RGB color components of the source content.

The information conveyed in this SEI message is intended to be adequate for purposes corresponding to the use of SMPTE ST 2094-40 [58]. Additional constraints are specified in S.4.

itu_t_t35_country_code shall be a byte having a value specified as a country code by Rec. ITU-T T.35 Annex A [59]. The value shall be 0xB5.

itu_t_t35_terminal_provider_code shall be a fixed 16-bit field. The value shall be 0x003C.

itu_t_t35_terminal_provider_oriented_code shall be a 16-bit code. The value shall be as specified in Table 149.

itu_t_t35_terminal_provider_oriented_code	Indicated value
0x0000	Unspecified
0x0001	ST 2094-40 [58]
0x0002 - 0xFFFF	Reserved

Table 9 Interpretation of the itu_t_t35_terminal_provider_oriented_code

application_identifier identifies an application and its defining document in ST-2094 suite. Application_identifier shall be set to 4.

application_mode shall be set to a value of 0. All other values are reserved.

num_windows indicates the number of processing windows. The first processing window shall be for the entire picture. (See S.4 Additional Constraints.)

window_upper_left_corner_x[w] specifies the x coordinate of the top left pixel of the w-th processing window. The value of window_upper_left_corner_x[w] shall not exceed 65535. (See S.4 Additional Constraints.)

window_upper_left_corner_y[w] specifies the y coordinate of the top left pixel of the w-th processing window. The value of window_upper_left_corner_y[w] shall not exceed 65535. (See S.4 Additional Constraints.)

window_lower_right_corner_x[w] specifies the x coordinate of the bottom right pixel of the w-th processing window. The value of window_lower_right_corner_x[w] shall not exceed 65535. (See S.4 Additional Constraints.)

window_lower_right_corner_y[w] specifies the y coordinate of the bottom pixel of the w-th processing window. The value of window_lower_right_corner_y[w] shall not exceed 65535. (See S.4 Additional Constraints.)

center_of_ellipse_x[w] specifies the x coordinate of the center position of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of center_of_ellipse_x[w] shall be in the range of 0 to (width of Picture – 1), inclusive, and in multiples of 1 pixel. (See S.4 Additional Constraints.)

center_of_ellipse_y[w] specifies the y coordinate of the center position of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of center_of_ellipse_y[w] shall be in the range of 0 to (height of Picture – 1), inclusive, and in multiples of 1 pixel. (See S.4 Additional Constraints.)

rotation_angle[w] specifies the clockwise rotation angle in degree of arc with respect to the positive direction of the x-axis of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of rotation_angle[w] shall be in the range of 0 to 180, inclusive, and in multiples of 1. (See S.4 Additional Constraints.)

semimajor_axis_internal_ellipse[w] specifies the semi-major axis value of the internal ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of semimajor_axis_internal_ellipse[w] shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. (See S.4 Additional Constraints.)

semimajor_axis_external_ellipse[w] specifies the semi-major axis value of the external ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of semimajor_axis_external_ellipse[w] shall not be less than semimajor_axis_internal_ellipse[w]. The value of semimajor_axis_external_ellipse[w] shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. (See S.4 Additional Constraints.)

semiminor_axis_external_ellipse[w] specifies the semi-minor axis value of the external ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of semiminor_axis_external_ellipse[w] shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. (See S.4 Additional Constraints.)

overlap_process_option[w] is an enumerator that indicates one of the two methods of combining rendered pixels in the w-th processing window in an image with at least one elliptical pixel selector. For overlapping elliptical pixel selectors in an image, overlap_process_option[w] shall have the same value. overlap_process_option[w] = 0 shall indicate the Weighted Averaging method and overlap_process_option[w] = 1 shall indicate the Layering method as described in Annex B of reference [59]. (See S.4 Additional Constraints.)

targeted_system_display_maximum_luminance specifies the nominal maximum display luminance of the targeted system display in units of 1 candela per square meter. The value of targeted_system_display_maximum_luminance shall be in the range of 0 to 10000 candelas per square meter, inclusive.

targeted_system_display_actual_peak_luminance_flag enables the targeted system display actual peak luminance feature of ST 2094-40. (See S.4 Additional Constraints.)

num_rows_targeted_system_display_actual_peak_luminance specifies the number of rows in the targeted_system_display_actual_peak_luminance array. The value of num_rows_targeted_system_display_actual_peak_luminance shall be in the range of 2 to 25, inclusive. (See S.4 Additional Constraints.)

num_cols_targeted_system_display_actual_peak_luminance specifies the number of columns in the targeted_system_display_actual_peak_luminance array. The value of num_cols_targeted_system_display_actual_peak_luminance shall be in the range of 2 to 25, inclusive. (See S.4 Additional Constraints.)

targeted_system_display_actual_peak_luminance[i][j] specifies the normalized actual peak luminance of the targeted system display. The value of targeted_system_display_actual_peak_luminance[i][j] shall be in the range of 0 to 15, inclusive, representing a range of 0 cd/m^2 to the value of TargetedSystemDisplayMaximumLuminance as defined in clause 7.2 of SMPTE ST 2094-40 [58]. (See S.4 Additional Constraints.)

maxscl[w][i] specifies the maximum of the i-th color component of linearized RGB values in the w-th processing window in the scene (as defined in clause 4.6 of SMPTE ST 2094-40 [58]). The value of maxscl[w][i] shall be in the range of 0 to 100,000, inclusive, representing 0 to 10,000.0 cd/m^2. maxscl[w][0], maxscl[w][1], and maxscl[w][2] shall correspond to the R, G, and B color components, respectively.

average_maxrgb[w] specifies the average of linearized maxRGB values in the w-th processing window in the scene. The value of average_maxrgb[w] shall be in the range of 0 to 100,000, inclusive, representing 0 to 10,000.0 cd/m^2.

num_distributions[w] indicates the number of linearized maxRGB values at given percentiles in the w-th processing window in the scene. (See S.4 Additional Constraints.)

distribution_index[w][i] specifies the interpretation of the corresponding distribution_values[w][i] value. Values of 0 through 98 indicate that distribution_values[w][i] contains the value below which distribution_index[w][i] percent of the linearized maxRGB values in the scene for the w-th processing window fall. A value of 99 indicates that distribution_values[w][i] contains the value below which 99.98% of the linearized maxRGB values in the scene for the w-th processing window fall.The value of distribution_index[w][i] shall be in the range of 0 to 99, inclusive. (See S.4 Additional Constraints.)

distribution_values[w][i] specifies the linearized maxRGB value at the percentile specified by distribution_index[w][i] in the w-th processing window in the scene. The value of distribution_values[w][i] shall be in the range of 0 to 100,000, inclusive, representing 0 to 10,000.0 cd/m^2. (See S.4 Additional Constraints.)

fraction_bright_pixels[w] is unused and constrained to a value of 0. (See S.4 Additional Constraints.)

mastering_display_actual_peak_luminance_flag enables the mastering display actual peak luminance feature of ST 2094-40. (See S.4 Additional Constraints.)

num_rows_mastering_display_actual_peak_luminance specifies the number of rows in the mastering_display_actual_peak_luminance array. The value of mastering_display_actual_peak_luminance[i][j] shall be in the range of 0 to 15, inclusive, representing a range of 0 cd/m^2 to the value of Maximum Display Mastering Luminance (as defined in SMPTE ST 2086 [41]). (See S.4 Additional Constraints.)

num_cols_mastering_display_actual_peak_luminance specifies the number of columns in the mastering_display_actual_peak_luminance array. The value of num_cols_mastering_display_actual_peak_luminance shall be in the range of 2 to 25, inclusive. (See S.4 Additional Constraints.)

mastering_display_actual_peak_luminance[i][j] specifies the normalized actual peak luminance of the mastering display used for mastering the image essence. The value of mastering_display_actual_peak_luminance[i][j] shall be in the range of 0 to 1, inclusive, and in multiples of 1/15. (See S.4 Additional Constraints.)

tone_mapping_flag[w], when set to 1, indicates that the metadata for the tone mapping function in the w-th processing window is present. When set to 0, it indicates that the metadata for the tone mapping function in the w-th processing window is not present.

knee_point_x[w] specifies the x coordinate of the separation point between the linear part and the curved part of the tone mapping function. The value of knee_point_x[w] shall be in the range of 0 to 4,095, inclusive, where 0 maps to 0 cd/m^2 and the full range of 4,095 maps to the maximum of the scene maximum luminance and the target peak luminance in cd/m^2.

knee_point_y[w] specifies the y coordinate of the separation point between the linear part and the curved part of the tone mapping function. The value of knee_point_y[w] shall be in the range of 0 to 4,095, inclusive, where 0 maps to 0 cd/m^2 and the full range of 4,095 maps to the target peak luminance in cd/m^2.

num_bezier_curve_anchors[w] indicates the number of the intermediate anchor parameters of the tone mapping function in the w-th processing window. (See S.4 Additional Constraints.)

bezier_curve_anchors[w][i] specifies the i-th intermediate anchor parameter of the tone mapping function in the w-th processing window in the scene. The value of bezier_curve_anchors[w][i] shall be in the range of 0 to 1,023, inclusive, where 1,023 corresponds to an intermediate anchor parameter value of 1.0.

color_saturation_mapping_flag[w] enables the color saturation mapping feature of ST 2094-40. (See S.4 Additional Constraints.)

color_saturation_weight[w] specifies a number that shall adjust the color saturation gain in the w-th processing window in the scene. The value of color_saturation_weight[w] shall be in the

range of 0 to 63/8, inclusive, and in multiples of 1/8. The default value shall be 1. (See S.4 Additional Constraints.)

Note: Definitions of the metadata items and terms used in this section of the document are provided in reference [56] and [58]. A color volume transform method using this message is described in Annex B of reference [58].

A new Section S.4, including 3 new Tables, shown below, is added after Section S.3 of CTA-861-G [A]:

S.4 Additional Constraints

For type_4_hdr_metadata_version value 0x1, the following additional constraints shall apply:

Index	**Value**
num_windows	1
window_upper_left_corner_x[w]	Not used.
window_upper_left_corner_y[w]	Not used.
window_lower_right_corner_x[w]	Not used.
window_lower_right_corner_y[w]	Not used.
center_of_ellipse_x[w]	Not used.
center_of_ellipse_y[w]	Not used.
rotation_angle[w]	Not used.
semimajor_axis_internal_ellipse[w]	Not used.
semimajor_axis_external_ellipse[w]	Not used.
semiminor_axis_external_ellipse[w]	Not used.
overlap_process_option[w]	Not used.
targeted_system_display_actual_peak_luminance_flag	0
num_rows_targeted_system_display_actual_peak_luminance	Not used.
num_cols_targeted_system_display_actual_peak_luminance	Not used.
targeted_system_display_actual_peak_luminance[i][j]	Not used.
num_distributions[w]	9
distribution_index[0][i]	See Table 11.
distribution_values[0][i]	See Table 12.
fraction_bright_pixels[w]	0
mastering_display_actual_peak_luminance_flag	0
num_rows_mastering_display_actual_peak_luminance	Not used.
num_cols_mastering_display_actual_peak_luminance	Not used.
mastering_display_actual_peak_luminance[i][j]	Not used.
num_bezier_curve_anchors[w]	0 to 9, inclusive.
color_saturation_mapping_flag[w]	0
color_saturation_weight[w]	Not used.

Table 10 Additional constraints

The value of distribution_index[0][i] shall be fixed as shown in Table 11:

Index	Value
distribution_index[0][0]	1
distribution_index[0][1]	5
distribution_index[0][2]	10
distribution_index[0][3]	25
distribution_index[0][4]	50
distribution_index[0][5]	75
distribution_index[0][6]	90
distribution_index[0][7]	95
distribution_index[0][8]	99

Table 11 Values of distribution_index[0][i]

The value of distribution_values[0][i] shall be as shown in Table 12:

Index	Value
distribution_values[0][0]	as measured
distribution_values[0][1]	as measured
distribution_values[0][2]	as measured
distribution_values[0][3]	as measured
distribution_values[0][4]	as measured
distribution_values[0][5]	as measured
distribution_values[0][6]	as measured
distribution_values[0][7]	as measured
distribution_values[0][8]	as measured

Table 12 Values of distribution_values[0][i]

7 Graphics Overlay Flag and Updates to Extended InfoFrame Section

Introduction of the graphics overlay flag results in a number of updates to the Extended InfoFrame sections 6.10 and 6.10.1 of CTA-861-G [A].

A new definition is added to Section 2.2 of CTA-861-G [A]:

> **Graphics Overlay** – Content, possibly semi-transparent, that is superimposed over and/or around the original video, typically by a set-top-box or video playback device.

A new entry, 0x0100, is added to Table 47 in Section 6.10 of CTA-861-G [A]. The modified table, Table 13, is shown below, including the change specified in Section 5:

Value	Extended InfoFrame Type
0x0000	Reserved
0x0001	HDR Dynamic Metadata according to the syntax specified in Annex R

0x0002	HDR Dynamic Metadata carried in Supplemental Enhancement Information (SEI) messages according to ETSI TS 103 433 [53][49]
0x0003	HDR Dynamic Metadata carried in Colour Remapping Information SEI message according to ITU-T H.265 [55]
0x0004	HDR Dynamic Metadata carried according to the syntax specified in Annex S
0x0005-0x00FF	Reserved
0x0100	Graphics Overlay Flag carried according to the syntax specified in Annex T
All other values	Reserved

Table 13 Extended InfoFrame Type Codes

The second paragraph of Section 6.10.1 HDR Dynamic Metadata Extended InfoFrame and Figure 7 HDR Dynamic Metadata Transmission Window and Metadata Applicability of CTA-861-G [A] are moved to the end of Section 6.10 and modified, as shown below:

Figure 7 depicts the transfer timing and applicability of the Extended InfoFrame data relative to the video lines. The Metadata Transmission Window (MTW) is defined as the period of time beginning with the first Active Pixel of a Video Frame and ending with the final Blank Pixel of the final Blanking Line in a Vblank period. As shown by the arrow in Figure 7, an Extended InfoFrame transmitted during the MTW applies to the Active Pixels that immediately follow the MTW. Standards and specifications that incorporate CTA-861 may reduce the period of the MTW by delaying the start of the MTW and/or ending the MTW on an earlier Blanking Line.

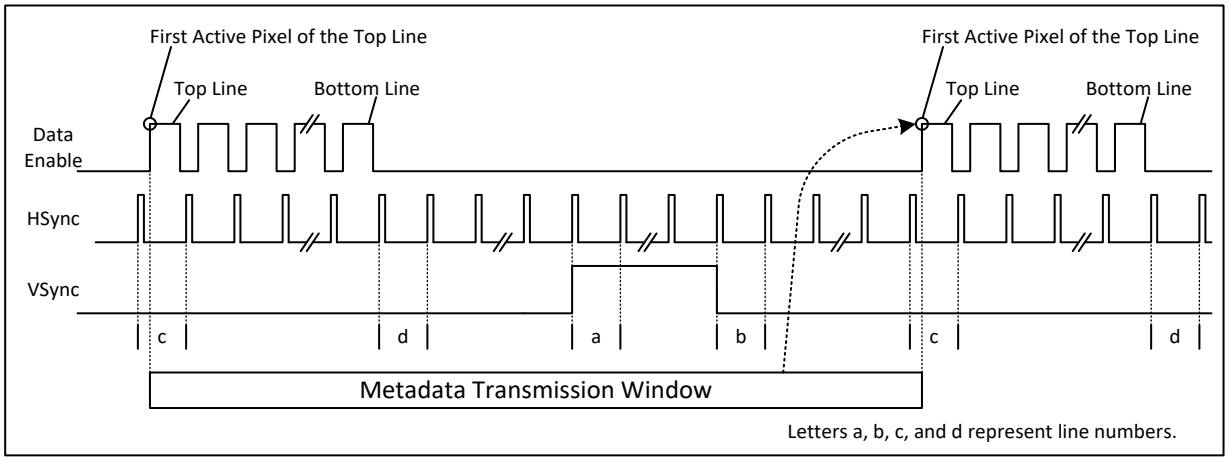

Figure 1 Extended InfoFrame Transmission Window and Metadata Applicability

A new sentence is added to the end of Section 6.10 Extended InfoFrame of CTA-861-G [A], as shown below:

A Source shall not send the same Extended InfoFrame Type more than once within an MTW.

The first paragraph of Section 6.10.1 HDR Dynamic Metadata Extended InfoFrame of CTA-861-G [A] is modified:

> When the Extended InfoFrame Type Code is set to 0x0001, 0x0002, 0x0003, or 0x0004, the Extended InfoFrame carries HDR Dynamic Metadata. The HDR Dynamic Metadata Extended InfoFrame contains the HDR Dynamic Metadata that might typically be carried in Supplemental Enhancement Information (SEI) messages.
>
> When the Extended InfoFrame Type Code is set to 0x0100, the Extended InfoFrame carries the Graphics Overlay Flag, which applies to the HDR Dynamic Metadata as specified in Annex T.

A new paragraph is added after the fourth paragraph below Table 48 in Section 6.10.1 of CTA-861-G [A], as shown below:

> When Extended InfoFrame Type Code is set to 0x0100, the Application-specific Data in Data Bytes 1-n is the Graphics Overlay Flag carried according to the syntax specified in Annex T.

The fifth and sixth paragraphs below Table 48 in Section 6.10.1 of CTA-861-G [A] are moved to the end of Section 6.10 and modified, as shown below:

> The data contained in the Extended InfoFrame applies to the Active Pixels that follow the MTW.
>
> If the Source supports transmission of a type of Extended InfoFrame (as indicated by the relevant Extended InfoFrame Type) and if it determines that the Sink is capable of receiving that information, the Source may send the Extended InfoFrame in conjunction with the video encoded according to the rules of the Extended InfoFrame Type.

The seventh paragraph below Table 48 in Section 6.10.1 of CTA-861-G [A] is modified, as shown below:

> A Source shall not send an Extended InfoFrame Type 0x0001, 0x0002, 0x0003, 0x0004, or 0x0100 to a Sink that does not indicate support for that Extended InfoFrame Type in the Sink's HDR Dynamic Metadata Data Block. A Source shall not send more than one type of HDR Dynamic Metadata Extended InfoFrame Types 0x0001, 0x0002, 0x0003, 0x0004 within the same MTW. A Source may send a Graphics Overlay Flag Extended InfoFrame when an HDR Dynamic Metadata Extended InfoFrame Type 0x0001, 0x0002, 0x0003, or 0x0004 is present. A Source shall not send a Graphics Overlay Flag Extended InfoFrame containing Extended InfoFrame Type 0x0100 unless it is also sending an HDR Dynamic Metadata Extended InfoFrame containing an Extended InfoFrame Type 0x0001, 0x0002, 0x0003, or 0x0004 that applies to the same frame.

New paragraphs and a Table, shown below, are added below the first paragraph below Table 90 in Section 7.5.14 of CTA-861-G [A]:

> When Supported Extended InfoFrame Type has a value of 0x0100, Support Flags is as shown in Table 14:

Bits							
7	6	5	4	3	2	1	0
F17=0	F16=0	F15=0	F14=0	graphics_overlay_flag_version			

Table 14 Support Flags for Graphics Overlay Flag Extended InfoFrame Type 0x0100

In this case, a Sink supporting the Extended InfoFrame Type 0x0100 shall indicate which graphics_overlay_flag_version it supports.

A new Annex, shown below, is added as Annex T to CTA-861-G [A]. This includes a new Table, shown below as Table 15:

Annex T Graphics Overlay Flag (Normative)

T.1 Scope

The Graphics Overlay Flag indicates that the video picture to which the current HDR Dynamic Metadata applies has been significantly changed. This typically occurs when a set-top-box or video playback device has added a Graphics Overlay or has presented content related to an interactive application. When this occurs, a display that applies the transmitted HDR Dynamic Metadata to the video picture might cause clipping or other improper reproduction of the image. When the HDR Dynamic Metadata varies and a large Graphics Overlay has a fixed value, this can cause the overlay to change appearance over time, which can be perceived as an unintended “breathing” of the image. The Graphics Overlay Flag indicates to the Sink device that the HDR Dynamic Metadata does not necessarily represent the characteristics of the delivered video images. This annex specifies a syntax for the carriage of the Graphics Overlay Flag for graphics_flag_overlay_version value 0x0.

T.2 Graphics Overlay Flag Syntax

The syntax of the Graphics Overlay Flag shall be as specified in Table 15:

bits							
7	6	5	4	3	2	1	0
F17=0	F16=0	F15=0	F14=0	F13=0	F12=0	F11=0	graphics_ overlay_ flag

Table 15 Overlay Flag Syntax

graphics_overlay_flag identifies when the video picture has been altered such that the HDR Dynamic Metadata is unlikely to represent the characteristics of the delivered video images. A value of 0 shall indicate that the HDR Dynamic Metadata represents the characteristics of the delivered video images. A value of 1 shall indicate that the HDR Dynamic Metadata does not necessarily represent the characteristics of the delivered video images. The default value shall be 0.

A Sink shall not use HDR Dynamic Metadata for tone mapping when the value of the Graphics Overlay Flag is equal to 1, except for during a period immediately following the transition of the

value of the Graphics Overlay Flag from 0 to 1, during which the Sink may apply a smooth transition from the use of HDR Dynamic Metadata for tone mapping to a static method of tone mapping.

A Sink may use HDR Dynamic Metadata, when available, for tone mapping when the value of the Graphics Overlay Flag is equal to 0. When the value of the Graphics Overlay Flag transitions from 1 to 0, the Sink may apply a smooth transition from its current tone mapping basis to the use of HDR Dynamic Metadata for tone mapping.

When sending a Graphics Overlay Flag Extended InfoFrame, a Source shall set the Graphics Overlay Flag to 0 when no graphics overlay has been added to the frame to which the InfoFrame applies and may set the Graphics Overlay Flag to 1 when a Graphics Overlay has been added.

The Source continues sending HDR Dynamic Metadata whenever the Graphics Overlay Flag is being sent (regardless of whether it is set to 0 or 1) in order for smooth transitions to be supported.

8 HDMI Forum Data Blocks

Table 16, shown below, modifies Table 57 in Section 7.5 of CTA-861-G [A], adding a range of Extended Tag Codes for future use by HDMI:

Extended Tag Codes	Type of Data Block
0	Video Capability Data Block
1	Vendor-Specific Video Data Block
2	VESA Display Device Data Block [100]
3	VESA Video Timing Block Extension [101]
4	Reserved for HDMI Video Data Block
5	Colorimetry Data Block
6	HDR Static Metadata Data Block
7	HDR Dynamic Metadata Data Block
8…12	Reserved for video-related blocks
13	Video Format Preference Data Block
14	YC_BC_R 4:2:0 Video Data Block
15	YC_BC_R 4:2:0 Capability Map Data Block
16	Reserved for CTA Miscellaneous Audio Fields
17	Vendor-Specific Audio Data Block
18	Reserved for HDMI Audio Data Block
19	Room Configuration Data Block
20	Speaker Location Data Block
21…31	Reserved for audio-related blocks
32	InfoFrame Data Block (includes one or more Short InfoFrame Descriptors)
33…119	Reserved
120…127	Reserved for HDMI
128…255	Reserved

Table 16 CTA Data Block Extended Tag Codes

9 Errata

Table 17, shown below, modifies Table 63 in Section 7.5.2 of CTA-861-G [A]:

	bits							
Byte#	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	F17=0	Audio Format Code=1110				Max Number of channels - 1		
2	F27=0	192 kHz	176.4 kHz	96 kHz	88.2 kHz	48 kHz	44.1 kHz	32 kHz
3	F37=0	F36=0	F35=0	F34=0	F33=0	Profile		

Table 17 CTA Short Audio Descriptor for Audio Format Code 14 (WMA Pro)

The second paragraph of Section 7.5.3 Speaker Allocation Data Block of CTA-861-G [A] is modified:

> The payload of the Speaker Allocation Data Block is shown in Table 69. This payload is preceded by a Tag Code Byte that includes a tag equal to 4 and a length of 3 (see Table 53 and Table 55). The Sink signifies that a speaker, or pair of speakers, is present by setting the bit associated with that speaker or pair of speakers to one. The speaker designations are the same as is used in the Audio InfoFrame (see Figure 6 and Table 34). In many cases, a single flag represents a channel pair (2 channels). Using the Speaker Allocation Data Block, these paired configurations cannot be represented independently. If independent representation of these channels is desired, then all channels must be represented with a Speaker Location Descriptor which is contained in a Speaker Location Data Block, (see section 7.5.16).

Table 18, shown below, modifies Table 69 in Section 7.5.3 of CTA-861-G [A]:

	bits							
Byte#	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	FLw/ FRw	F16=0[1]	FLc/FRc	BC	BL/BR	FC	LFE1	FL/FR
2	TpSiL/ TpSiR	SiL/SiR	TpBC	LFE2	LS/RS	TpFC	TpC	TpFL/ TpFR
3	F37=0	F36=0	F35=0	F34=0	F33=0[2]	BtFL/ BtFR	BtFC	TpBL/ TpBR

Table 18 Speaker Allocation Data Block Payload[16]

[1] Use of F16 for RLC/RRC has been deprecated. RLC/RRC are considered to be logically the same speaker positions as BL/BC. Legacy Sinks might use RLC/RRC instead of BL/BR; Sources shall route audio intended for RLC/RRC to BL/BR. See Table 29 and Table 35. Future use of F16 for other speaker positions is reserved.

[2] Use of F33 for TpLS/TpRS has been deprecated. Future use of F33 for other speaker positions is reserved.

Table 19, shown below, modifies Table 88 in Section 7.5.14 of CTA-861-G [A]:

bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
F17=0	F16=0	F15=0	F14=0	type_1_hdr_metadata_version			

Table 19 Support Flags for Supported HDR Dynamic Metadata Type 0x0001

Table 20, shown below, modifies Table 90 in Section 7.5.14 of CTA-861-G [A]:

bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
F17=0	F16=0	F15=0	F14=0	type_4_hdr_metadata_version			

Table 20 Support Flags for Supported HDR Dynamic Metadata Type 0x0004

The second to last paragraph of Section 7.5.14 HDR Dynamic Metadata Data Block of CTA-861-G [A] is modified:

> Each Supported HDR Dynamic Metadata Extended InfoFrame Type may also indicate support for other optional fields relevant to that Type. No such Optional Fields are included in this specification. Therefore, the length of following data for each Supported HDR Dynamic Metadata Type is either 2 or 3, depending on the presence of Support Flags (indicating that no Optional Fields are present).

Table 21, shown below, modifies Table 43 in Section 6.9 of CTA-861-G [A]:

EOTF	**EOTF of stream**
0	Traditional gamma - SDR Luminance Range
1	Traditional gamma - HDR Luminance Range
2	SMPTE ST 2084 [40]
3	Hybrid Log-Gamma (HLG) based on ITU-R BT.2100 [50]
4- 7	Reserved for future use

Table 21 Data Byte 1 - Electro-Optical Transfer Function

Table 22, shown below, modifies Table 85 in Section 7.5.13 of CTA-861-G [A]:

ET_*n*	Supported EOTF
ET_0	Traditional gamma - SDR Luminance Range
ET_1	Traditional gamma - HDR Luminance Range
ET_2	SMPTE ST 2084 [40]
ET_3	Hybrid Log-Gamma (HLG) based on Recommendation ITU-R BT.2100 [50]
ET_4 to ET_5	Reserved for future use (0)

Table 22 Supported Electro-Optical Transfer Function

The fourth paragraph after Table 85 of Section 7.5.13 HDR Dynamic Metadata Data Block of CTA-861-G [A] is modified:

> When ET_3 is set to '1', the Sink indicates support for the Hybrid Log-Gamma (HLG) EOTF defined in Recommendation ITU-R BT.2100 [50].

Consumer Technology Association Document Improvement Proposal

If in the review or use of this document a potential change is made evident for safety, health or technical reasons, please email your reason/rationale for the recommended change to standards@CTA.tech.

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