

CTA Standard

HDR Static Metadata Extensions

CTA-861.3-A

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**Consumer
Technology
Association**

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(Formulated under the cognizance of the CTA **R4.8 DTV Interface Subcommittee.**)

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FOREWORD

This standard was developed by the Consumer Technology Association's R4.8 DTV Interface Subcommittee.

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HDR Static Metadata Extensions

1 Scope

This standard specifies static High Dynamic Range (HDR) metadata extensions using an additional InfoFrame and EDID CTA data block, replacing previously reserved codes in Table 5 and Table 46 of CTA-861-F [1]. Recommendations regarding the usage of static HDR metadata are also provided.

These data structures allow signaling of SMPTE ST 2084 HDR EOTF [2] and SMPTE ST 2086 Mastering Display Metadata [3], while containing provisions for future HDR EOTFs and metadata. It is anticipated that these data structures will be extended to include additional EOTF and HDR metadata capabilities in future versions of CTA-861-F [1].

The requirements of this standard are in addition to and complement CTA-861-F [1]. All devices compliant to CTA-861.3 shall also comply with CTA-861-F [1], except that this standard deprecates and replaces Table 5 and Table 46 of CTA-861-F [1].

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

1. CTA-861-F, A DTV Profile for Uncompressed High Speed Digital Interfaces, May 2014
2. SMPTE ST 2084:2014, High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays
3. SMPTE ST 2086:2014, Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images

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

SMPTE Standards

- Society of Motion Picture and Television Engineers, 3 Barker Ave., 5th Floor, White Plains, NY 10601; Phone 914-761-1100; Fax 914-761-3115; Internet: <http://www.smpte.org>

2.2 Informative References

The following references contain provisions that, through reference in this text, constitute informative 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 indicated below.

2.2.1 Informative Reference List

4. Blu-ray Disc Association, "System Description Blu-ray Disc Read-Only Format Part 3, Audio Visual Basic Specifications Version 3.1", December 2015

2.2.2 Informative Reference Acquisition

Blu-ray Disc Association

- Blu-ray Disc Association, License Office, 4444 Riverside Dr. Suite #103, Burbank, CA 91505, USA. Web Site: <http://www.blu-raydisc.com/en/index.aspx>; E-mail: license@bdemail.com; Fax.: +1-818-557-1674.

2.3 Definitions

For the purposes of CTA-861.3, the following definitions apply.

Electro-Optical Transfer Function (EOTF) - A mathematical function that describes the relationship between the luminance values input to a display device and the values output by the display.

High Dynamic Range (HDR)- In a display device, the range of luminance levels that exceed conventional display system capabilities.

Sink - A device which receives an uncompressed A/V signal.

Source - A device which generates an uncompressed A/V signal.

2.4 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.

2.5 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.

2.6 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.

2.7 Symbols and Abbreviations

BDA	Blu-ray Disc Association
CTA	Consumer Technology Association
EOTF	Electro-optical Transfer Function
HDR	High Dynamic Range
LSB	Least Significant Byte

MaxCLL	Maximum Content Light Level
MaxFALL	Maximum Frame-average Light Level
MSB	Most Significant Byte
SMPTE	Society of Motion Picture and Television Engineers

3 Auxiliary Information Carried from Source to Sink for HDR

This section extends the information in Section 6 of CTA-861-F [1].

3.1 InfoFrame Type Code

This document defines a new Dynamic Range and Mastering InfoFrame. This InfoFrame is signaled using a new InfoFrame Type Code of 0x07 in Table 5 of CTA-861-F [1], with a corresponding update to the “Reserved for future use” range.

The updated Table 5 of CTA-861-F [1] is shown below:

Info Frame Type Code	Type of InfoFrame
0x00	Reserved
0x01	Vendor-Specific (defined in Section 6.1 of CTA 861-F [1])
0x02	Auxiliary Video Information (defined in Section 6.4 of CTA 861-F [1])
0x03	Source Product Description (defined in Section 6.5 of CTA 861-F [1])
0x04	Audio (defined in Section 6.6 of CTA 861-F [1])
0x05	MPEG Source (defined in Section 6.7 of CTA 861-F [1])
0x06	NTSC VBI (defined in Section 6.8 of CTA 861-F [1])
0x07	Dynamic Range and Mastering (defined in Section 3.2 below)
0x08-0x1F	Reserved for future use
0x20-0xFF	Forbidden

Table 1 List of InfoFrame Type Codes (Table 5)

3.2 Dynamic Range and Mastering InfoFrame

The Dynamic Range and Mastering InfoFrame carries data such as the EOTF and the Static Metadata associated with the dynamic range of the video stream.

If the Source supports the transmission of the Dynamic Range and Mastering InfoFrame and if it determines that the Sink is capable of receiving that information, the Source shall send the Dynamic Range and Mastering InfoFrame once per Video Field while it is sending data associated with the dynamic range of the video stream. The Source shall not send a Dynamic Range and Mastering InfoFrame to a Sink that does not have at least one of the ET_{*n*} bits set to ‘1’.

The Dynamic Range and Mastering InfoFrame is defined in Table 2:

InfoFrame Type Code	InfoFrame Type = 0x07					
InfoFrame Version number	Version=0x01					
Length of InfoFrame	Length of following HDR Metadata and Mastering InfoFrame (=n)					
Data Byte 1	F17=0	F16=0	F15=0	F14=0	F13=0	EOTF (3 bits)
Data Byte 2	F27=0	F26=0	F25=0	F24=0	F23=0	Static_Metadata_Descriptor_ID (3 bits)
Data Byte 3	Static_Metadata_Descriptor					
...	...					
Data Byte n	...					

Table 2 Dynamic Range and Mastering InfoFrame

Data Byte 1 EOTF identifies the Electro-Optical Transfer Function (EOTF) used in the stream.

EOTF	EOTF of stream
0	Traditional gamma - SDR Luminance Range
1	Traditional gamma - HDR Luminance Range
2	SMPTE ST 2084 [2]
3	Future EOTF
4- 7	Reserved for future use

Table 3 Data Byte 1 - Electro-Optical Transfer Function

“Traditional Gamma” indicates that the EOTF used in the video stream is consistent with the requirements of CTA-861-F [1]. If the Colorimetry bits C0 and C1 in the AVI InfoFrame are both zero (indicating “No Data”), then the transfer function shall be consistent with the requirements of CTA-861-F [1], section 5.1, “Default Encoding Parameters”. If either of bits C0 and C1 in the AVI Info Frame are non-zero, then the transfer function shall be consistent with the colorimetry standard indicated by the Colorimetry (C0 and C1) and Extended Colorimetry (EC0 to EC2) bits in the AVI InfoFrame. See CTA-861-F [1], section 5.3, “Transfer Characteristic (e.g., gamma correction)” for more information on transfer functions for supported colorimetry standards. The SMPTE ST 2086 [3] metadata contained in Bytes 3-22 of Table 5 may be used by the Source to provide information about the mastering display color volume characteristics associated with the video stream.

If “Traditional Gamma - SDR Luminance Range” is indicated, then the maximum encoded luminance is typically mastered to 100 cd/m².

If “Traditional Gamma – HDR Luminance Range” is indicated, then the maximum encoded luminance is understood to be the maximum luminance of the Sink device.

Data Byte 2 Static_Metadata_Descriptor_ID identifies the structure used in Data Byte 3 and higher.

Static_Metadata_Descriptor_ID	Metadata Descriptor
0	Static Metadata Type 1
1 - 7	Reserved for future use

Table 4 Data Byte 2 - Static_Metadata_Descriptor_ID

3.2.1 Static Metadata Type 1

When Static_Metadata_Descriptor_ID = 0, Static_Metadata_Descriptor uses the structure defined in Table 5 that was defined at the request of the Blu-ray Disc Association, see [4].

Data Byte number	Contents	Group
Data Byte 3	display primaries_x[0], LSB	1
Data Byte 4	display primaries_x[0], MSB	
Data Byte 5	display primaries_y[0], LSB	
Data Byte 6	display primaries_y[0], MSB	
Data Byte 7	display primaries_x[1], LSB	
Data Byte 8	display primaries_x[1], MSB	
Data Byte 9	display primaries_y[1], LSB	
Data Byte 10	display primaries_y[1], MSB	
Data Byte 11	display primaries_x[2], LSB	
Data Byte 12	display primaries_x[2], MSB	
Data Byte 13	display primaries_y[2], LSB	
Data Byte 14	display primaries_y[2], MSB	
Data Byte 15	white_point_x, LSB	2
Data Byte 16	white_point_x, MSB	
Data Byte 17	white_point_y, LSB	
Data Byte 18	white_point_y, MSB	
Data Byte 19	max_display_mastering_luminance, LSB	3
Data Byte 20	max_display_mastering_luminance, MSB	
Data Byte 21	min_display_mastering_luminance, LSB	4
Data Byte 22	min_display_mastering_luminance, MSB	
Data Byte 23	Maximum Content Light Level, LSB	5
Data Byte 24	Maximum Content Light Level, MSB	
Data Byte 25	Maximum Frame-average Light Level, LSB	6
Data Byte 26	Maximum Frame-average Light Level, MSB	

Table 5 Static Metadata Descriptor Type 1

Data Bytes 3 – 22 contain the Display Mastering data defined in SMPTE ST 2086 [3].

Data Bytes 3 – 18 are coded as unsigned 16-bit values in units of 0.00002, where 0x0000 represents zero and 0xC350 represents 1.0000.

Data Bytes 3-14 describes the chromaticity of the Red, Green and Blue color primaries of the mastering display,

All possible mappings of the chromaticity of Red, Green and Blue color primaries to indices 0,1 and 2 are allowed and shall be supported by the sink.

The correspondence between Red, Green and Blue color primaries and indices 0, 1, or 2 is determined by the following relationship:

The Red color primary corresponds to the index of the largest display_primaries_x[] value.

The Green color primary corresponds to the index of the largest display_primaries_y[] value.

The Blue color primary corresponds to the index with neither the largest display_primaries_y[] value nor the largest display_primaries_x[] value.

Data Bytes 19 – 20 specify a value for the `max_display_mastering_luminance`. This value is coded as an unsigned 16-bit value in units of 1 cd/m^2 , where 0x0001 represents 1 cd/m^2 and 0xFFFF represents 65535 cd/m^2 .

Data Bytes 21 – 22 specify a value for the `min_display_mastering_luminance`. This value is coded as an unsigned 16-bit value in units of 0.0001 cd/m^2 , where 0x0001 represents 0.0001 cd/m^2 and 0xFFFF represents 6.5535 cd/m^2 .

Data Bytes 23 – 24 contain the Maximum Content Light Level (MaxCLL). This value is coded as an unsigned 16-bit value in units of 1 cd/m^2 , where 0x0001 represents 1 cd/m^2 and 0xFFFF represents 65535 cd/m^2 .¹ The algorithm used to calculate MaxCLL is defined in Annex A.

Data Bytes 25 – 26 contain the Maximum Frame-Average Light Level (MaxFALL). This value is coded as an unsigned 16-bit value in units of 1 cd/m^2 , where 0x0001 represents 1 cd/m^2 and 0xFFFF represents 65535 cd/m^2 .² The algorithm used to calculate MaxFALL is defined in Annex A.

The data in Data Bytes 3 – 26 are arranged into groups, as indicated in Table 5 above. When all of the Data Bytes in a group are set to zero, then the Sink shall interpret the data for that group as unknown³.

4 EDID Data Structure for Dynamic Range and Mastering Information

This section extends the information in Section 7 of CTA-861-F [1].

4.1 CTA Data Block Tag Code

This document defines a new HDR Static Metadata Data Block. This is identified with a new Extended Tag Code of 0x06 in Table 46 of CTA-861-F [1], with a corresponding update to the “Reserved for video-related blocks” range.

The updated Table 46 of CTA-861-F [1] is shown below:

¹ For MaxCLL, the unit is equivalent to cd/m^2 when the brightest pixel in the entire video stream has the chromaticity of the white point of the encoding system used to represent the video stream. Since the value of MaxCLL is computed with a `max()` mathematical operator, it is possible that the true CIE Y Luminance value is less than the MaxCLL value. This situation may occur when there are very bright blue saturated pixels in the stream, which may dominate the `max(R,G,B)` calculation, but since the blue channel is an approximately 10% contributor to the true CIE Y Luminance, the true CIE Y Luminance value of the example blue pixel would be only approximately 10% of the MaxCLL value.

² For MaxFALL, the unit is equivalent to cd/m^2 when the maximum frame average of the entire stream corresponds to a full-screen of pixels that has the chromaticity of the white point of the encoding system used to represent the video stream. The frame-average computation used to compute the MaxFALL value is performed only on the active image area of the image data. If the video stream is a “letterbox” format (e.g. where a 2.40:1 aspect ratio is put inside a 16:9 image container with black bars on the top and bottom of the image), the black bar areas are not part of the active image area and therefore are not included in the frame-average computation. This allows the MaxFALL value to remain an upper bound on the maximum frame-average light level even if image zooming or pan/scan is performed as a post-processing operation.

³ For MaxCLL and MaxFALL, this may occur when information about the content light level has not been, or cannot be, provided - for example, content that is rendered or broadcast in real-time, or pre-processed content that was delivered without information about the content light level.

Extended Tag Codes	Type of Data Block
0	Video Capability Data Block
1	Vendor-Specific Video Data Block
2	VESA Display Device Data Block
3	VESA Video Timing Block Extension
4	Reserved for HDMI Video Data Block
5	Colorimetry Data Block
6	HDR Static Metadata Data Block
7...12	Reserved for video-related blocks
13	Video Format Preference Data Block
14	YCbCr 4:2:0 Video Data Block
15	YCbCr 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...31	Reserved for audio-related blocks
32	InfoFrame Data Block (includes one or more Short InfoFrame Descriptors)
33...255	Reserved

Table 6 CTA Data Block Tag Codes (Table 46)

4.2 HDR Static Metadata Data Block

The HDR Data Block indicates the HDR capabilities of the Sink and is defined below:

	bits							
Byte#	7	6	5	4	3	2	1	0
1	Tag Code (0x07)			Length of following data block = n bytes				
2	Extended Tag Code (0x06)							
3	F37=0	F36=0	ET_5	ET_4	ET_3	ET_2	ET_1	ET_0
4	SM_7	SM_6	SM_5	SM_4	SM_3	SM_2	SM_1	SM_0
5	Desired Content Max Luminance data (8 bits)							
6	Desired Content Max Frame-average Luminance data (8 bits)							
7	Desired Content Min Luminance data (8 bits)							

Table 7 HDR Static Metadata Data Block

Byte 1 indicates the length of the following data in the Data Block. This document defines a structure up to and including Byte 7. Future versions may have a different number of bytes in the Data Block: Source implementations shall parse this Data Block according to the length specified in Byte 1.

Byte 3, bits 0 to 5, identify the Electro-Optical Transfer Functions supported by the Sink:

ET_n	Supported EOTF
ET_0	Traditional gamma - SDR Luminance Range
ET_1	Traditional gamma - HDR Luminance Range
ET_2	SMPTE ST 2084 [2]
ET_3	Future EOTF
ET_4 to ET_5	Reserved for future use (0)

Table 8 Supported Electro-Optical Transfer Function

When ET_0 is set to '1', the Sink indicates support for the Traditional Gamma – SDR Luminance Range as described in section 3.2.

When ET_1 is set to '1', the Sink indicates support for the Traditional Gamma - HDR Luminance Range as described in section 3.2. This is intended to support Sources without SMPTE ST 2084 [2] hardware capability.

When ET_2 is set to '1', the Sink indicates support for the EOTF defined in SMPTE ST 2084 [2].

ET_4 to ET_5 shall be set to '0'. Future Specifications may define other EOTFs.

Byte 4 indicates which Static Metadata Descriptors are supported.

SM <i>n</i>	Supported Static Metadata Descriptor
SM_0	Static Metadata Type 1
SM_1 to SM_7	Reserved for future use (0)

Table 9 Supported Static Metadata Descriptor

When SM_0 is set to '1', the Sink indicates support for Static Metadata Type 1 (see section 3.2.1).

The length of the data block, *n*, in Byte 1 indicates which of the Bytes 5 to 7 are present. Bytes 5 to 7 are optional to declare. When *n* = 3, Bytes 5 to 7 are not present. When *n* = 4, Byte 5 is present; when *n* = 5, Bytes 5 and 6 are present; and when *n* = 6, Bytes 5 to 7 are present. When *n* > 3, each of Bytes 5 to 7 which are indicated to be present in the HDR Static Metadata Data Block may be set to zero. This value indicates that the data for the relevant Desired Max Content Luminance, Desired Content Max Frame-average Luminance or Desired Content Min Luminance is not indicated.

Byte 5 indicates the Desired Content Max Luminance Data. This is the content's absolute peak luminance (in cd/m²) (likely only in a small area of the screen) that the display prefers for optimal content rendering. Byte 5 contains an 8-bit value representing a perceptually coded value of the Desired Content Maximum Luminance.

Byte 6 indicates the Desired Content Max Frame-average Luminance. This is the content's max frame-average luminance (in cd/m²) that the display prefers for optimal content rendering. Byte 6 contains an 8-bit value representing a perceptually coded value of the Desired Content Max Frame-average Luminance.

The luminance values represented by Bytes 5 and 6 are calculated from:

$$\text{Luminance value} = 50 \cdot 2^{(\text{CV}/32)}$$

where CV (code value) is the decimal equivalent of the value of the byte.

Byte 7 indicates the Desired Content Min Luminance. This is the minimum value of the content (in cd/m²) that the display prefers for optimal content rendering. Byte 7 contains an 8-bit value representing a perceptually coded value of the Desired Content Min Luminance and is calculated from:

$$\text{Desired Content Min Luminance} = \text{Desired Content Max Luminance} \cdot (\text{CV}/255)^2 / 100$$

where CV (code value) is the decimal equivalent of the value of Byte 7.

Annex A Calculation of MaxCLL and MaxFALL (Normative)

The values of MaxCLL and MaxFALL shall be calculated as follows:

A.1 MaxCLL

CalculateMaxCLL()

```
{
    set MaxCLL = 0
    for each ( frame in the sequence )
    {
        set frameMaxLightLevel = 0
        for each ( pixel in the active image area of the frame )
        {
            convert the pixel's non-linear (R',G',B') values to linear values (R,G,B) calibrated
            to cd/m2
            set maxRGB = max(R,G,B)
            if(maxRGB>frameMaxLightLevel )
                set frameMaxLightLevel = maxRGB
        }
        if(frameMaxLightLevel>MaxCLL )
            set MaxCLL = frameMaxLightLevel
    }
    return MaxCLL
}
```

A.2 MaxFALL

CalculateMaxFALL()

```
{
    set MaxFALL = 0
    for each ( frame in the sequence )
    {
        set runningSum = 0
        for each ( pixel in the active image area of the frame )
        {
            convert the pixel's non-linear (R',G',B') values to linear values (R,G,B) calibrated
            to cd/m2
            set maxRGB = max(R,G,B)
            set runningSum = runningSum + maxRGB
        }
        set frameAverageLightLevel = runningSum / numberOfPixelsInActiveImageArea
        if(frameAverageLightLevel>MaxFALL )
            set MaxFALL = frameAverageLightLevel
    }
    return MaxFALL
}
```

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@ce.org.

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