UHD World Association
世界超高清视频产业联盟

HDR Video Technology Part 2-1

Application Guide to System Integration

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Contents

1 Scope 1
2 Normative References 1
3 Terms and Definitions 2
3.1 AVC/H.264 2
Video encoding technology specified by ITU-T H.264 2
3.2 AVS2 2
Video encoding technology specified by GB/T 33475.2-2024 2
3.3 AVS3 2
Video encoding technology specified by GY/T 368—2023 2
3.4 HDR Vivd 2
3.5 HDR Vivid Playback Device 2
3.6 HDR Vivid Display Device 2
3.7 HEVC/H.265 2
Video encoding technology specified by ITU-T H.265 2
3.8 VVC/H.266 2
Video encoding technology specified by ITU-T H.266 2
3.9 general purpose multimedia interface；GPMI 2
Interface specified by T/SUCA 001.1 2
4 Abbreviations 2
5 Overview 3
6 HDR Vivid metadata generation 3
6.1 Input and output 3
6.2 Image Quality Monitoring 4
6.3 Dynamic Metadata Generation Mode 4
6.3.1 Auto Mode 4
6.3.2 Director Mode 4
7 HDR Vivid metadata Encapsulation 8
7.1 ES encapsulation of HDR Vivid 8
7.1.1 AVC/H.264,HEVC/H.265 and VVC/H.266 ES Encapsulation 8
7.1.2 AVS2 and AVS3 ES Encapsulation 11
7.1.3 Metadata transmission 14
7.1.4 Backward Compatibility 15
7.2 MP4 file encapsulation 15
7.3 HDR Vivid HLS Stream Encapsulation 17
7.3.1 General Requirements 17
7.3.2 HLS Stream Encapsulation 17
7.4 HDR Vivid DASH Encapsulation 18
7.4.1 General Requirements 18
7.4.2 DASH Encapsulation 18
7.5 HDR Vivid DVB Transport Stream (TS) Encapsulation 20
7.5.1 General Requirements 20
7.5.2 TS Encapsulation 20
7.5.3 Strategy for TS packet loss 21

7.6 MXF encapsulation requirements 21
7.6.1 Static metadata 21
7.6.2 Dynamic metadata 21
7.7 IMF encapsulation requirements 22
7.7.1 Static metadata encapsulation requirements 22
7.7.2 Dynamic metadata encapsulation requirements 22
Figure 4 IMF Package Structure 23
8 Explanation of Terminal Application 23
8.1 Composition of the Terminal System 23
8.1.1 Functional Modules 23
8.1.2 Application Methods 24
8.2 Decoding and Presentation of HDR Vivid Signals in the Device 24
8.2.1 Basic Requirements 24
8.2.2 Adaptation Modes under the Playback Device Method 25
8.2.3 Adaptation for Interworking with PQ HDR Signals 25
8.2.4 Adaptation for Interworking with HLG HDR Signals 26
8.3 Dynamic Metadata Transfer over HDMI 26
8.3.1 Overview 26
8.3.2 Define VS-VDB 27
8.3.3 Define VS-IF 29
8.3.4 Define VS-EMDS 29
8.3.5 Graph processing for display device adaptation in receiving end adaptation mode 32
8.4 GPMI metadata transmission requirements 34
8.4.1 General Provisions 34
8.4.2 HDR Vivid Capability Description 35
8.4.3 Static Metadata Transmission 36
8.4.4 Dynamic Metadata Transmission 37
8.4.5 CRC32 Calculation for GPMI DIP Packets 41
9 Content Protection 42
Annex A 43
A.1 XML encapsulation example of HDR static metadata 43
A.2 XML encapsulation example of HDR dynamic metadata 44
References 51

High Dynamic Range Video Technology

Part 2-1: Application Guide to System Integration

1 Scope

This document stipulates HDR System Integration specified in T/UWA 005.1-2022, including production, transmission, reception and decoding.

2 Normative References

The following documents are indispensable to the application 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.

GY/T 368—2023," Advanced and efficient video coding".

GB/T 33475.2-2024: "Information technology — High efficiency multimedia coding — Part 2: Video"

ISO/IEC 14496-12:2020 Information technology — Coding of audio-visual objects, part 12: ISO base media file format.

ISO/IEC 23009-1: "Information technology - Dynamic adaptive streaming over HTTP (DASH) - Part 1: Media presentation description and segment formats".

Recommendation ITU-R BT.2020: "Parameter values for ultra-high definition television systems for production and international programme exchange".

Recommendation ITU-R BT.709: "Parameter values for the HDTV standards for production and international programme exchange".

Recommendation ITU-R BT.601-7 (2011): "Studio encoding parameters of digital television for standard 4:3 and wide screen 16:9 aspect ratios".

Recommendation ITU-T H.264 / ISO/IEC 14496-10: "Information technology -- Coding of audiovisual objects -- Part 10: Advanced Video Coding".

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

Recommendation ITU-T H.266 / ISO/IEC 23090-3: "Information technology -- Coded representation of immersive media -- Part 3: Versatile Video Coding".

Recommendation ITU-T H.274 / ISO/IEC 23002-7:2022: "Information technology -- MPEG Video Technologies -- Part 7: Versatile supplemental enhancement information messages for coded video bitstreams".

ETSI EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

ETSI TS 103 285: "Digital Video Broadcasting (DVB); MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks".

RFC 8216: HTTP Live Streaming.

SMPTE ST 2067-202:2023 Interoperable Master Format – Isochronous Stream of XML Documents (ISXD) Plug-in.

SMPTE RP 2057: Text-Based Metadata Carriage in MXF.

SCTE 214-1 2022: MPEG DASH for IP-Based Cable Services Part 1: MPD Constraints and Extensions.

ITU-T Rec. T.35:2000 SERIES T: Terminals for Telematic Services Procedure for the allocation of ITU-T defined codes for non-standard facilities.

T/UWA 005.1-2022 High Dynamic Range Video Technology – Part 1: Metadata and Tone Mapping.

3 Terms and Definitions

The terms and definitions below apply to this document.

3.1 AVC/H.264

Video encoding technology specified by ITU-T H.264

3.2 AVS2

Video encoding technology specified by GB/T 33475.2-2024

3.3 AVS3

Video encoding technology specified by GY/T 368−2023

3.4 HDR Vivd

HDR Vivid refers to an HDR technical standard provided in T/UWA 005.1-2022. It is the generic term for derivative technologies of the kind.

3.5 HDR Vivid Playback Device

A device that decodes video, processes metadata and images in accordance with T/UWA 005.1-2022, and outputs the result through a digital video interface.

3.6 HDR Vivid Display Device

A device that processes metadata and images in accordance with T/UWA 005.1-2022 and displays the images.

3.7 HEVC/H.265

Video encoding technology specified by ITU-T H.265

3.8 VVC/H.266

Video encoding technology specified by ITU-T H.266

3.9 general purpose multimedia interface；GPMI

Interface specified by T/SUCA 001.1

4 Abbreviations

For the purpose of this document, the abbreviations below apply.

DCCD	Device Comprehensive Capability Description
DIP	Descriptive Information Packet
ES	Elemental Stream
HDMI	High Definition Multimedia Interface
HDR	High Dynamic Range
SDR	Standard Dynamic Range

EOTF	Electro-Optical Transfer Function
OETF	Opto-Electrical Transfer Function
PQ	Perceptual Quantizer
HLG	Hybrid Log-Gamma
DASH	Dynamic Adaptive Streaming over HTTP
HLS	HTTP Live Streaming
PMT	Program Mapping Table
TS	Transport Stream
XAVC	Extended Advanced Video coding

5 Overview

The application of HDR video stream metadata comprises three stages: metadata generation, encapsulation and terminal application, as shown in Figure 1. In the HDR metadata generation stage, metadata conforming to the provisions of T/UWA 005.1 is generated based on the analysis of the video picture and the relevant adjustment conditions. In the HDR metadata encapsulation stage, the metadata is encapsulated into a video stream or file suitable for distribution at both the program stream and transport stream levels. In the terminal application stage, the metadata is extracted and transmitted from the program, and the corresponding processing is performed in accordance with T/UWA 005.1. The process is shown in the Figure below.

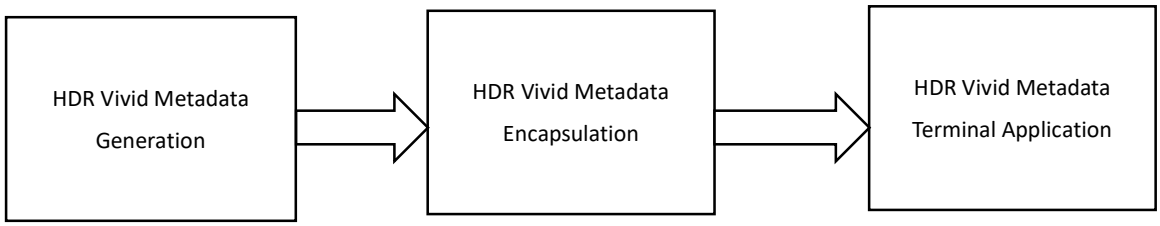


Figure 1 HDR Vivid Video Stream Processing Flow Diagram

6 HDR Vivid metadata generation

6.1 Input and output

The main tasks of post-production are: extracting and adjusting dynamic metadata and encapsulating files.

The basic requirement for post-production input is BT.2020 color gamut. It could be an RGB signal in a linear gamut, an RGB signal in a PQ gamut, or a YUV signal in a PQ gamut. It is recommended that the bit width of the linear gamut be at least 16 bits and that of the PQ gamut be at least 12 bits. YUV444 sampling format or YUV422 sampling format is recommended.

The output must be the 10-bit video data of YUV420, YUV422, or YUV444 format in the PQ gamut and dynamic metadata. If the output content is to be distributed directly, it is recommended that the ES file in the specified encoding format be output and dynamic metadata be embedded in the SEI header. If the output content is to be archived, it is recommended that an MXF file be output. Video content is stored in single frames in a high-bitrate format, such as XAVC. Dynamic metadata is embedded in the SEI data of each frame in a XAVC file.

6.2 Image Quality Monitoring

Post-production needs to output two channels for display. The first channel is output to a professional display monitor, as a high-quality reference. The second channel is processed using HDR Vivid dynamic metadata (tone mapping) and output to a consumer display device, such as a 500-nit HDR Vivid TV, as a consumer device reference.

6.3 Dynamic Metadata Generation Mode

Dynamic metadata can be generated in two modes: Auto Mode and Director Mode.

6.3.1 Auto Mode

In Auto Mode, the HDR Vivid dynamic metadata is extracted from each frame of the video, processed in real time using HDR Vivid, and output to the display device for playback. Auto Mode needs to integrate the automatic dynamic metadata extraction algorithm and post-processing algorithm specified in T/UWA 005.1-2024.

The Auto Mode UI should support the video read-in and playback, dynamic metadata extraction, HDR Vivid post-production, and display output of processed video content.

6.3.2 Director Mode

6.3.2.1 Overview

Director Mode is for colorists to adjust the dynamic metadata of each scene or frame manually, to achieve their desired effect. The basic requirements are to provide the HDR Vivid tone mapping curve adjustment controls, display the current tone mapping curve during adjustment, and support real-time post-processing based on the current dynamic metadata or curve and output to display.

Director Mode needs to integrate the dynamic metadata extraction algorithm, the post-processing algorithm and the Director Mode curve adjustment algorithm.

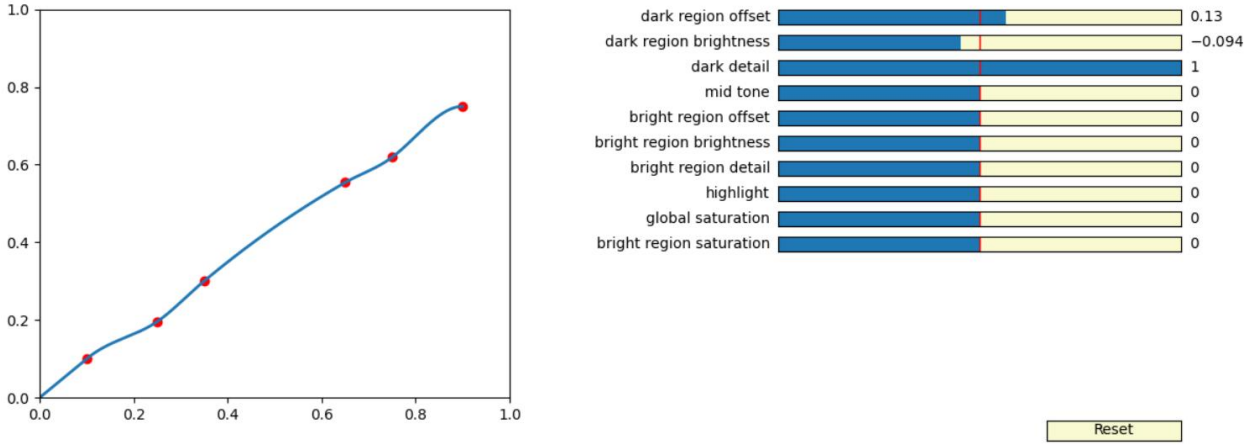


Figure 2 UI reference in HDR Vivid Director Mode

6.3.2.2 Director Mode Composition

The specifications of Director Mode consist of two parts. First, one must run Auto Mode before running Director Mode. The dynamic metadata extracted and the corresponding tone mapping curve in Auto Mode shall be used as a reference in Director Mode. If the colorist does not make any adjustments, the Director Mode output

shall be equivalent to Auto Mode output. Alternatively, if the colorist restores the default settings, the dynamic metadata and tone mapping curves shall be what they were in Auto Mode. After the adjustment, the dynamic metadata adjusted by the colorist replaces the dynamic metadata in Auto Mode and is written into the output file. Second, the number of controls, the adjustment range and the adjustment function shall comply with HDR Vivid specifications. HDR Vivid recommends 10 sliding controls, each with an adjustment range between -1.0 and 1.0, and a default value of 0, same as in Auto Mode. When the values of all controls are 0, the dynamic metadata and tone mapping curves in Director Mode shall be the same as those in Auto Mode.

6.3.2.3 Curve Anchor Point

The HDR Vivid curve is determined by six anchor points. It is recommended that the six anchor points be shown in the UI. The controls in Director Mode can directly adjust the locations of these six anchor points, and the HDR Vivid curve is calculated and the corresponding dynamic metadata is generated according to the adjustment made on the controls. The x values of the six anchor points in ascending order are TH1, TH2, TH3, TH1_HIGH, TH2_HIGH, and TH3_HIGH, as defined in the HDR Vivid dynamic metadata. The y coordinates are the y values of the HDR Vivid curve on these six locations, and are expressed as TH1_Y, TH2_Y, TH3_Y, TH1_HIGH_Y, TH2_HIGH_Y, and TH3_HIGH_Y. Auto Mode is the basis for Director Mode. The anchor values in Auto Mode are TH1_ref, TH2_ref, TH3_ref, TH1_HIGH_ref, TH2_HIGH_ref, TH3_HIGH_ref, TH1_Y_ref, TH2_Y_ref, TH3_Y_ref, TH1_HIGH_Y_ref, TH2_HIGH_Y_ref, TH3_HIGH_Y_ref.

The curve adjustment algorithm is responsible for mapping the control values to the locations of the anchor points, and calculating the curve parameters and dynamic metadata. The locations of the six anchors are interdependent, and the curve adjustment algorithm strives to coordinate them to generate curves that conform to the HDR Vivid standards. However, in some extreme cases, if by adjusting the six anchor points, no curve that meets the HDR Vivid standards can be generated, the algorithm will return fitting failed. In this case, the controls, curve, and dynamic metadata shall return to their last normal states.

6.3.2.4 Controls

The controls functions and the corresponding anchor locations and dynamic metadata are described in Table 1.

Table 1 − Control Description

No.	Control	Description
1	Dark region offset	The value of TH3 is adjusted, which corresponds to TH3 defined in the dynamic metadata. When the value of the control is 0, the value of TH3 is equal to the value of TH3_ref in Auto Mode. When the value of the control is -1, TH3 takes the minimum value of the adjustment range. When the value of the control is +1, TH3 takes the maximum value of the adjustment range. [TH2_ref, 0.45] is the recommended adjustment range. The region whose value is smaller than TH3 is defined as dark region. The three anchor points TH1, TH2, and TH3 determine the cubic spline of the dark region. Adjusting the value of TH3 changes the coverage of the cubic spline of the dark region. In addition, the main curve is determined by two anchor points: TH3 and TH1_HIGH. Therefore, when the value of TH3 is changed, parameters of the main curve shall be re-calculated, including m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata.

No.	Control	Description
2	Dark region brightness	The value of TH1_Y is adjusted, which corresponds to the value of MB defined in the dynamic metadata, that is, the slope of the linear spline at the beginning of the curve, which affects the brightness of the darkest part of the image. When the value of the control is 0, TH1_Y takes the value of MB_ref in Auto Mode. When the value of the control is -1, TH1_Y takes the minimum value of the adjustment range. When the value of the control is +1, TH1_Y takes the maximum value of the adjustment range. [0, 1] is the recommended adjustment range.
3	Dark detail	The value of TH2_Y is adjusted, which corresponds to the strength defined in the dynamic metadata. It affects the shape of the cubic spline in the dark region and thus affects the detail performance of the dark region. When the value of the control is 0, TH2_Y takes the value strength_ref in Auto Mode. When the value of the control is -1, TH2_Y takes the minimum value of the adjustment range. When the value of the control is +1, TH2_Y takes the maximum value of the adjustment range. [-0.5, 0.5] is the recommended adjustment range.
4	Mid tone	The value of TH3_Y is adjusted. TH3_Y is defined as the mid tone. It does not directly correspond to any dynamic meta-parameter, but affects m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata. When the value of the control is 0, TH3_Y takes the value TH3_Y_ref in Auto Mode. When the value of the control is -1, TH3_Y takes the minimum value of the adjustment range. When the value of the control is +1, TH3_Y takes the maximum value of the adjustment range. [TH2_Y_ref, TH1_HIGH_Y_ref] is the recommended adjustment range. When the value of TH3_Y is changed, parameters of the main curve shall be re-calculated, including m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata. If a HDR Vivid-compliant curve cannot be obtained after TH3_Y is adjusted to a certain location, the coordination mechanism is triggered – that is, a new TH1_HIGH_Y value is searched in the same direction of TH3_Y adjustment until a HDR Vivid-compliant curve can be calculated. If the adjustment fails, the current adjusted location is invalid and the system returns to the last valid status and control values.
5	Bright region offset	The value of TH1_HIGH is adjusted, which corresponds to the TH1_HIGH defined in the dynamic metadata. When the value of the control is 0, the value of TH1_HIGH is equal to the value of TH1_HIGH_ref in Auto Mode. When the value of the control is -1, TH1_HIGH takes the minimum value of the adjustment range. When the value of the control is +1, TH1_HIGH takes the maximum value of the adjustment range. [0.48, TH2_HIGH_ref] is the recommended adjustment range. The region whose value is greater than TH1_HIGH is defined as the bright region. The three anchor points TH1_HIGH, TH2_HIGH, and TH3_HIGH determine the cubic spline of the bright region. Adjusting the value of TH1_HIGH changes the coverage of the cubic splines in the bright region. In addition, the main curve is determined by two anchor points: TH3 and TH1_HIGH. Therefore, when the value of TH1_HIGH is changed, parameters

No.	Control	Description
		of the main curve shall be re-calculated, including m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata.
6	Bright region brightness	The value of TH1_HIGH_Y is adjusted. It does not directly correspond to any dynamic meta-parameter, but affects m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata. When the value of the control is 0, TH1_HIGH_Y takes the value TH1_HIGH_Y_ref in Auto Mode. When the value of the control is -1, TH1_HIGH_Y takes the minimum value of the adjustment range. When the value of the control is +1, TH1_HIGH_Y takes the maximum value of the adjustment range. [TH3_Y_ref, TH2_HIGH_Y_ref] is the recommended adjustment range. When the value of TH1_HIGH_Y is changed, parameters of the main curve shall be re-calculated, including m_p, m_a, m_b, m_m, m_n, K1, K2, and K3 defined in the dynamic metadata. If a compliant HDR Vivid curve cannot be obtained after TH1_HIGH_Y is adjusted to a certain location, the coordination mechanism is triggered, that is, a new TH3_Y value is searched in the same direction of TH1_HIGH_Y adjustment until a HDR Vivid-compliant curve can be calculated. If the adjustment fails, the current adjusted location is invalid and the system returns to the last valid status and control values.
7	Bright region detail	The value of TH2_HIGH_Y is adjusted, which corresponds to strength_HIGH defined in dynamic metadata. It affects the shape of the cubic spline of the bright region and thus affects the detail performance of the bright region. When the value of the control is 0, strength_HIGH takes the value of strength_HIGH_ref in Auto Mode. When the value of the control is -1, strength_HIGH takes the minimum value of the adjustment range. When the value of the control is +1, strength_HIGH takes the maximum value of the adjustment range. [-0.5, 0.5] is the recommended adjustment range.
8	Highlight	The value of TH3_HIGH is adjusted, which corresponds to the TH3_HIGH defined in the dynamic metadata. When the value of the control is 0, TH3_HIGH takes the value of TH3_HIGH_ref in Auto Mode. When the value of the control is -1, TH3_HIGH takes the minimum value of the adjustment range. When the value of the control is +1, TH3_HIGH takes the maximum value of the adjustment range. [TH2_HIGH, max_source] is the recommended adjustment range, with max_source indicating the PQ value of the maximum luminance of the current frame. In Director Mode, the value of TH3_HIGH_Y must be equal to the maximum luminance of the reference display device. Therefore, the region whose value is greater than TH3_HIGH is the overexposed region. This control is used to adjust the range of overexposed region to control the effect of highlight.
9	Global saturation	The saturation of the global luminance range is adjusted, which corresponds to color_saturation_gain[0] defined in the dynamic meta parameter. When the value of the control is 0, it takes the value of color_saturation_gain[0] in Auto Mode. When the value of the control is -1, it takes the minimum value 0. When the value of the control is +1, it takes the maximum value 255.

No.	Control	Description
10	Bright region saturation	The saturation for the bright region is adjusted, which corresponds to color_saturation_gain[1] defined in the dynamic meta parameter. When the value of the control is 0, it takes the value of color_saturation_gain[1] in Auto Mode. When the value of the control is -1, it takes the minimum value 0. When the value of the control is +1, it takes the maximum value 255.

7 HDR Vivid metadata Encapsulation

7.1 ES encapsulation of HDR Vivid

7.1.1 AVC/H.264,HEVC/H.265 and VVC/H.266 ES Encapsulation

When HDR static metadata is encapsulated in AVC/H.264, HEVC/H.265 and VVC/H.266 streams, each IDR frame shall contain the static metadata corresponding to that video sequence. Among them, the static metadata shall be encapsulated in the SEI messages (content_light_level_info and mastering_display_colour_volume) defined in AVC/H.264, HEVC/H.265 and VVC/H.266, and their syntax and semantics are described in ITU-T H.274.

When HDR dynamic metadata is encapsulated in AVC/H.264, HEVC/H.265 and VVC/H.266 streams, the dynamic metadata of each frame shall be encapsulated in the SEI message (user_data_registered_itu_t_t35) defined in AVC/H.264, HEVC/H.265 and VVC/H.266. Its syntax description shall comply with the provisions of ITU-T H.274, and the specific syntax structure is shown in Table 2.

Table 2 Syntax structure of ES dynamic metadata encapsulation

Pseudocode	Descriptor
user_data_registered_itu_t_t35(payloadSize) {	
itu_t_t35_country_code	0x26
if(itu_t_t35_country_code != 0xFF){	
i = 1	
}	
else {	
itu_t_t35_country_code_extension_byte	b(8)
i = 2	
}	
do {	
itu_t_t35_payload_byte	b(8)
i++	
} while(i < payloadSize)	
}	

itu_t_t35_country_code indicates the country code and shall be 0x26, indicating China.
itu_t_t35_payload_byte is one byte in the **itu_t_t35_payload** syntax structure.
Data in **itu_t_t35_payload** is represented as below Table 3.

Table 3 Syntax structure of **itu_t_t35_payload**

itu_t_t35_payload(){	**descriptor**
terminal_provide_code	u(16)
terminal_provide_oriented_code	u(16)
system_start_code	u(8)
if(system_start_code==0x01||system_start_code==0x02|| system_start_code==0x03||system_start_code== 0x04||system_start_code==0x05||system_start_code==0x06||system_start_code==0x07){	
num_windows=1	
for(w = 0； w < num_windows； w++) {	
minimum_maxrgb_pq[w]	u(12)
average_maxrgb_pq[w]	u(12)
variance_maxrgb_pq[w]	u(12)
maximum_maxrgb_pq[w]	u(12)
}	
for(w = 0； w < num_windows； w++) {	
tone_mapping_enable_mode_flag[w]	u(1)

if(tone_mapping_enable_mode_flag [w]==1){	
tone_mapping_param_enable_num [w]	u(1)
tone_mapping_param_num [w]++	
for(i=0； i< tone_mapping_param_num [w]； i++){	
targeted_system_display_maximum_luminance_ pq[i][w]	u(12)
base _enable_flag[i][w]	u(1)
if(base _enable_flag[i][w]){	
base_param_m_p[i][w]	u(14)
base_param_m_m[i][w]	u(6)
base_param_m_a[i][w]	u(10)
base_param_m_b[i][w]	u(10)
base_param_m_n[i][w]	u(6)
base_param_K1[i][w]	u(2)
base_param_K2[i][w]	u(2)
base_param_K3[i][w]	u(4)
base_param_Delta_enable_mode[i][w]	u(3)
base_param_enable_Delta[i][w]	u(7)
}	
3Spline _enable_flag[i][w]	u(1)
if(3Spline_enable_flag[i][w]){	
3Spline_enable_num[i][w]	u(1)
3Spline _num++；	
for(j = 0； j < 3Spline _num； j ++) {	
3Spline_TH_enable_mode[j] [i][w]	u(2)
if((3Spline_TH_mode[j][i] [w]==0)||(3Spline_TH_mode[j][i][w]==2)){	
3Spline_TH_enable_MB [j][i][w]	f(8)
}	
3Spline_TH_enable[j][i][w]	f(12)
3Spline_TH_enable_Delta1 [j][i][w]	f(10)
3Spline_TH_enable_Delta2 [j][i][w]	f(10)
3Spline_enable_Strength[j][i][w]	f(8)
}	
}	
}// for(i=0； i< tone_mapping_param_num [w]； i++){	
}// if(tone_mapping_enable_mode_flag [w]==1){	
color_saturation_mapping_ enable_flag[w]	u(1)
if(color_saturation_mapping_flag[w]) {	
color_saturation_ enable_num[w]	u(3)
for(i = 0； i< color_saturation_num [w]； i++) {	
color_saturation_ enable_gain[i][w]	u(8)

}	
}	
} //for(w = 0； w < num_windows； w++) {	
}// if(system_start_code…){	
while(!byte_aligned())	
stuffing_bit	u(1)
}	

terminal_provide_code: indicates the organization or institution code, which shall be 0x0004, indicating UWA.

terminal_provide_oriented_code: indicates the self-defined code of the organization or institution, which shall comply with the provisions of Table 5 of this document, indicating the version number of HDR Vivid.

stuffing_bit: indicates the stuffing bit, which shall be 0.

The semantics of the other syntax elements in **itu_t_t35_payload** are as specified in T/UWA 005.1-2024

7.1.2 AVS2 and AVS3 ES Encapsulation

When HDR dynamic metadata is encapsulated in AVS2 and AVS3 streams, the dynamic metadata is encapsulated in the extension data (hdr_dynamic_metadata_extension) after the picture header defined in GB/T 33475.2 and GY/T 368—2023. Its syntax description shall comply with the provisions of GB/T 33475.2 and GY/T 368—2023, and the specific syntax structure is shown in Table 4.

Table 4 Syntax structure of **hdr_dynamic_metadata_extension**

Definition	Descriptor
hdr_dynamic_metadata_extension( ) {	
extension_id	0x5
hdr_dynamic_metadata_type	0x5
while (next_bits(24) ! '0000 0000 0000 0000 0000 0001') {	
extension_data_byte	u(8)
}	
next_start_code()	
}	

extension_id: indicates the identifier of the extension data, which shall be 0x5, indicating the HDR Vivid metadata extension.

hdr_dynamic_metadata_type: indicates the extension type of the HDR Vivid metadata, which shall be 0x5.

extension_data_byte: is one byte in the **extension_data** syntax structure. The syntax structure of extension_data is shown in Table5.

Table 5 Syntax structure of **extension_data_byte**

Definition	Descriptor
extension_data_byte ( ) {	
itu_t_t35_country_code	0x26
terminal_provide_code	0x0004
terminal_provide_oriented_code	0x0005 (v1.0)
system_start_code	u(8)
if(system_start_code==0x01){	
num_windows=1	
for(w = 0; w < num_windows; w++) {	
minimum_maxrgb_pq[w]	u(12)
marker_bit	f(1)
average_maxrgb_pq[w]	u(12)
marker_bit	f(1)
variance_maxrgb_pq[w]	u(12)
marker_bit	f(1)
maximum_maxrgb_pq[w]	u(12)
marker_bit	f(1)
}	
for(w = 0; w < num_windows; w++) {	
tone_mapping_enable_mode_flag[w]	u(1)
if(tone_mapping_enable_mode_flag [w]==1){	
tone_mapping_param_enable_num [w]	u(1)

tone_mapping_param_enable_num [w]++	
for(i=0; i< tone_mapping_param_enable_num [w]; i++){	
targeted_system_display_maximum_luminance_ pq[i][w]	u(12)
base _enable_flag[i][w]	u(1)
marker_bit	f(1)

Table 4 Data Table of extension_data_byte (continued)

Definition of Dynamic Metadata	Descriptor
if(base _enable_flag[i][w]){	
base_param_m_p[i][w]	u(14)
base_param_m_m[i][w]	u(6)
marker_bit	f(1)
base_param_m_a[i][w]	u(10)
base_param_m_b[i][w]	u(10)
marker_bit	f(1)
base_param_m_n[i][w]	u(6)
base_param_K1[i][w]	u(2)
base_param_K2[i][w]	u(2)
base_param_K3[i][w]	u(4)
base_param_Delta_enable_mode[i][w]	u(3)
marker_bit	f(1)
base_param_enable_Delta[i][w]	u(7)
}	
3Spline _enable_flag[i][w]	u(1)
if(3Spline_enable_flag[i][w]){	
3Spline_enable_num[i][w]	u(1)
3Spline_enable_num[i][w]++;	
for(j = 0; j < 3Spline_enable_num[i][w]; j ++) {	
3Spline_TH_enable_mode[j] [i][w]	u(2)
if((3Spline_TH_mode[j][i] [w]==0)|| (3Spline_TH_mode[j][i] [w]==2)){	
3Spline_TH_enable_MB [j][i][w]	f(8)
}	
marker_bit	f(1)
3Spline_TH_enable[j][i][w]	f(12)
marker_bit	f(1)
3Spline_TH_enable_Delta1 [j][i][w]	f(10)
3Spline_TH_enable_Delta2 [j][i][w]	f(10)
marker_bit	f(1)
3Spline_enable_Strength[j][i][w]	f(8)
}	
}	
}	

}	
}	
color_saturation_mapping_enable_flag[w]	u(1)
if(color_saturation_mapping_enable_flag[w]) {	
color_saturation_enable_num[w]	u(3)
for(i = 0; i< color_saturation_enable_num [w]; i++) {	

Table 4 Data Table of extension_data_byte (continued)

Definition of Dynamic Metadata	Descriptor
color_saturation_enable_gain[i][w]	u(8)
marker_bit	f(1)
}	
}	
}	
}	
stuffing_bit	'1'
while(!byte_aligned())	
stuffing_bit	'0'
}	

itu_t_t35_country_code: indicates the country code, which shall be 0x26, indicating China.

terminal_provide_code: indicates the organization or institution code, which shall be 0x0004, indicating UWA.

terminal_provide_oriented_code: indicates the self-defined code of the organization or institution, which shall comply with the provisions of Table 5 of this document, indicating the version number of HDR Vivid.

stuffing_bit: indicates the stuffing bit, which shall be 0.

marker_bit: indicates the marker bit, which shall be 1, used to avoid the appearance of more than 21 consecutive bit 0s after any byte-aligned position in the bitstream.

The semantics of the other syntax elements in **extension_data** are as specified in T/UWA 005.1-2024.

7.1.3 Metadata transmission

Each frame in the video shall carry dynamic metadata, and the dynamic metadata of that frame shall be used for the display adaptation of that frame.

If the loss of dynamic metadata occurs, it is advisable to use the last valid dynamic metadata before the loss until valid dynamic metadata is obtained again.

The transmission of dynamic metadata includes two modes, namely the statistical information mode and the curve parameter mode.

When the tone mapping enable flag (tone_mapping_enable_mode_flag) is 0, the tone mapping curve parameters in the dynamic metadata are not transmitted, i.e., the metadata defined in 7.4.7 to 7.4.27 of T/UWA 005.1-2024 is not transmitted. This metadata transmission mode is called the statistical information mode.

When the tone mapping enable flag is 1, both the metadata defined in 7.4.1 to 7.4.6 of T/UWA 005.1-2024 and the metadata defined in 7.4.7 to 7.4.27 of T/UWA 005.1-2024 are transmitted. This dynamic metadata transmission mode is called the curve parameter mode.

7.1.4 Backward Compatibility

There are 4 versions of HDR Vivid. Each version generates an independent set of dynamic metadata, encapsulated in one ES, meaning each ES can carry dynamic metadata of multiple, not necessarily continuous versions. For instance, one ES can carry the dynamic metadata of both versions 1 and 2; or it can carry the metadata of versions 1, 3 and 4. terminal_provide_oriented_code in itu_t_t35_payload() indicates version number. It is recommended that terminal devices extract the dynamic metadata of the highest version number for post-processing. See the table below for the mapping between version numbers and code words.

Table 6 Mapping Table of Version Numbers and Code Words

HDR Vivid Version Numbers	Code Words of terminal_provide_oriented_code in itu_t_t35_payload()
1.0	0x0005
2.0	0x0006
3.0	0x0007
4.0	0x0008

Note: If the terminal device cannot identify a version of HDR Vivid, then neglect that version. If it cannot identify any of the versions, then skip HDR Vivid processing.

7.2 MP4 file encapsulation

The HDR Vivid MP4 file structure shall comply with ISO/IEC 14496-12:2022. The method for adding the HDR Vivid video bitstream format syntax Box is as follows:

a) On the basis of retaining all the original MP4 structures, a Box describing the HDR Vivid video bitstream format, i.e., the CUVV Configuration Box, shall be added by extension within the VisualSampleEntry Box in the Sample Description Box (stsd) of the video track.

b) The compressorname description field in the VisualSampleEntry Box may be modified to "HDR Vivid video".

Note: The application mainly uses the cuvv box to identify whether it is an HDR Vivid video.

The syntax structure of the CUVV Configuration Box is shown in Table 7.

Table 7 Syntax structure of CUVV Configuration Box

class CUVVConfigurationBox extends Box('cuvv')	Descriptor
{	
unsigned int (16) cuva_version_map;	0x0009 (Version number information)
unsigned int (16) terminal_provide_code;	0x0004

unsigned int (16) terminal_provide_oriented_code;	0x0008 (Highest version number)
const unsigned int (32)[4] reserved = 0;	
}	

The four-character code of the newly-added box is CUVV. The internal structure specifies the version number information of HDR Vivid video. The 16-bit cuva_version_map can represent up to 16 version numbers, with each bit representing one. The highest bit indicates the highest version number, and the lowest bit the lowest version number. For instance, if cuva_version_map is 0x0009, the ES contains versions 4 and 1 (binary number 1001 being 9 in decimal).

The other two descriptors correspond to terminal_provide_code and terminal_provide_oriented_code described in the itu_t_t35_payload() structure in 6.2. terminal_provide_code (16 bits) is 0x0004, and terminal_provide_oriented_code (16 bits) is the value representing the highest version contained in the current ES. For instance, if cuva_version_map is 0x0009, the highest version in the current ES is 4; and according to Table 6 in section 6.4, terminal_provide_oriented_code for version 4 is 0x0008.

To add cuvv in a MP4 file, find moov->trak(video)->mdia->minf->stbl->stsd, and add a CUVV Box in VisualSampleEntry Box.

In accordance with ISO/IEC 14496-12(2015-12-15), VisualSampleEntry is described below.

Table 8 VisualSampleEntry Description

class VisualSampleEntry(codingname) extends SampleEntry (codingname){	Descriptor
unsigned int(16) pre_defined = 0;	
const unsigned int(16) reserved = 0;	
unsigned int(32)[3] pre_defined = 0;	
unsigned int(16) width;	
unsigned int(16) height;	
template unsigned int(32) horizresolution = 0x00480000; // 72 dpi	
template unsigned int(32) vertresolution = 0x00480000; // 72 dpi	
const unsigned int(32) reserved = 0;	
template unsigned int(16) frame_count = 1;	
string[32] compressorname;	
template unsigned int(16) depth = 0x0018;	
int(16) pre_defined = -1;	
// other boxes from derived specifications	
CleanApertureBox clap; // optional	
PixelAspectRatioBox pasp; // optional	
}	

The newly-added CUVV Box is placed in "other boxes from derived specifications", and added after other extension Boxes.

For instance, in a H.265 MP4 file, VisualSampleEntry is "hvc1" or "hev1". hvcC Box describes video coded ES. In a HDR Vivid MP4 file, a new Box is added after hvcC Box – CUVV Box, and the description of "Compression name" is changed to "CUVA HDR Video". The rest of the structure remains unchanged.

A sample HDR Vivid MP4 file:

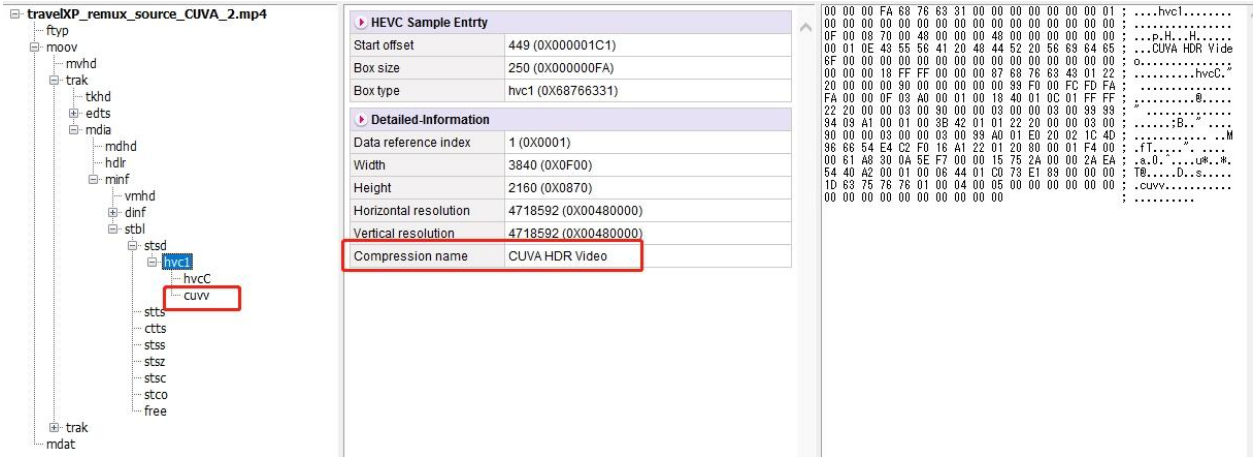


Figure 3 HDR Vivid MP4 File Description

7.3 HDR Vivid HLS Stream Encapsulation

7.3.1 General Requirements

Other than the playlist file of HDR Vivid HLS stream being an m3u8 file with added HDR Vivid video information, it is compliant with the HLS stream standard IETF RFC 8216.

7.3.2 HLS Stream Encapsulation

EXT-X-STREAM-INF and EXT-I-STREAM-INF tags are used to specify video or audio attributes in HLS streams. In additional to the m3u8 description, CUVA HLS encapsulation puts in a SUPPLEMENTAL-CODECS descriptor field for each video stream, with the content being a CUVA descriptor. The format of the CUVA descriptor is defined as: [CUVAHDR_video].[CUVA_Version_map], where the CUVAHDR_video identifier indicates an HDR Vivid stream.

Note: The SUPPLEMENTAL-CODECS attribute is formally defined in HLS protocol version 12 (v12), which is a new feature introduced in the second edition of the IETF's HLS specification (draft-pantos-hls-rfc8216bis-12).

When an HLS stream is packaged in MP4 or TS format, the value of CUVAHDR_video is 'cuvv' in both cases. CUVA_Version_map represents the version number information of CUVA. CUVA_Version_map specifies CUVA version number, and each bit represents one version. The highest bit indicates the highest version number, and the lowest bit the lowest version number. For example, CUVA_Version_map of 1101 indicates that the stream includes Version 4, 3 and 1. Other audio and video attributes remain unchanged.

Add the VIDEO-RANGE attribute to the #EXT-X-STREAM-INF tag in the m3u8 file. The value of this attribute is an enumerated string, and the valid strings are SDR, HLG, and PQ.

Note: The VIDEO-RANGE descriptor refers to HTTP Live Streaming 2nd Edition draft-pantos-hls-rfc8216bis-16.

Different coding points may use the same transfer function. The definition of the Opto-Electronic Transfer Function (OETF) is specified in ISO/IEC 23091-2.

If the video is encoded using the reference OETF specified by the transfer_characteristics value of 18, the VIDEO-RANGE value must be HLG.

If the video is encoded using the reference OETF specified by the transfer_characteristics value of 16, the VIDEO-RANGE value must be PQ.

Examples of HLS m3u8 description:

```
#EXT-X-STREAM-INF:BANDWIDTH=5120000,VIDEO-RANGE=PQ,
CODECS="hvc1.2.4.L153.b0,mp4a.40.29",SUPPLEMENTAL-CODECS="cuvv.1101",
FRAME-RATE=50.000,RESOLUTION=3840x2160,AUDIO="aac"
low/video.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=7680000,VIDEO-
RANGE=PQ,CODECS="hvc1.2.4.L153.b0,mp4a.40.29",SUPPLEMENTAL-CODECS="cuvv.1101",
FRAME-RATE=50.000,RESOLUTION=3840x2160,AUDIO="aac"
high/video.m3u8
```

7.4 HDR Vivid DASH Encapsulation

7.4.1 General Requirements

The media presentation description (MPD) file of HDR Vivid DASH (Dynamic Adaptive Streaming over HTTP) is in line with the requirements in ISO/IEC FDIS 23009, the international standard for MPEG-DASH, except for additional Representation information about HDR Vivid videos.

7.4.2 DASH Encapsulation

The media presentation description (MPD) file of HDR Vivid DASH (Dynamic Adaptive Streaming over HTTP) is in line with the requirements in ISO/IEC FDIS 23009, except for the additional HDR Vivid videos information in the codecs tag within the *Representation* field.

In a DASH MPD file, the *Representation* field specifies attributes of the video or audio, including the frame rate, resolution, bit rate, encoder, and bandwidth.

The HDR Vivid DASH encapsulation, on the basis of retaining the original *Representation* description, a new *scte214:supplementalCodecs* descriptor option (defined in SCTE 214-1 2022 section 10.1.6) is added for each video stream, with the content being an HDR Vivid descriptor. The format of the HDR Vivid descriptor is defined as: [*CUVAHDR_video*].[*CUVA_Version*], where the *CUVAHDR_video* tag indicates an HDR Vivid stream.

The value of *CUVAHDR_video* is 'cuvv' in MP4 and TS encapsulations of the DASH streams. *CUVA_Version_map* specifies the HDR Vivid version numbers, and each bit represents one version. The highest bit indicates the highest version number, and the lowest bit the lowest version number. For example, *CUVA_Version_map* of 1101 indicates the ES contains versions 4, 3, and 1. DASH audios and videos have their own descriptions respectively, and therefore the codecs here only describes video information, and the newly added *scte214:supplementalCodecs* only needs to be added to each video descriptor. Meanwhile, a *SupplementalProperty* auxiliary information description must be added, whose *schemeIdUri* is "urn:dvb:dash:hdr-dmi" and value is "T/UWA 005".

- If HLG is used, according to ETSI TS 103 285 V1.4.1 5.2.6, the following descriptions need to be added:

1) Add urn:dvb:dash:profile:dvbdash:2017 to the DVB DASH profile
2) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp:ColourPrimaries" and @value="9"
3) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp: MatrixCoefficients" and @value="9"
4) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics " and @value="14"
5) SupplementalProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics " and @value="18"

An example of the MPD file description for the HDR Vivid HLG DASH stream is as follows:

```
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp:ColourPrimaries"    value="9">
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp: MatrixCoefficients"    value="9">
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics"    value="14">
<SupplementalProperty schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics"    value="18">
<SupplementalProperty schemeIdUri="urn:dvb:dash:hdr-dmi" value="T/UWA 005"/>
<Representation id=”bbb_30fps_1024x576_2500k” codecs=” hvc1.2.4.L153.b0” bandwidth=”3134488”
scte214:supplementalCodecs="cuvv.1101" />
<Representation id=”bbb_30fps_1280x720_4000k” codecs=” hvc1.2.4.L153.b0” bandwidth=”4952892”
scte214:supplementalCodecs="cuvv.1101" />
```

- If HDR10 is used, according to ETSI TS 103 285 V1.4.1 5.2.7, the following descriptions need to be added:

1) Add urn:dvb:dash:profile:dvbdash:2017 to DVB DASH profile
2) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp:ColourPrimaries" and @value="9"
3) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp: MatrixCoefficients" and @value="9"
4) EssentialProperty descriptor: @schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics" and @value="16"

An example of the MPD file description for the HDR Vivid HDR10 DASH stream is as follows:

```
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp:ColourPrimaries"    value="9">
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp: MatrixCoefficients"    value="9">
<EssentialProperty schemeIdUri="urn:mpeg:mpegB:cicp: TransferCharacteristics"    value="16">
<SupplementalProperty schemeIdUri="urn:dvb:dash:hdr-dmi" value="T/UWA 005"/>
<Representation id=”bbb_30fps_1024x576_2500k” codecs=” hvc1.2.4.L153.b0” bandwidth=”3134488”
scte214:supplementalCodecs="cuvv.1101" />
<Representation id=”bbb_30fps_1280x720_4000k” codecs=” hvc1.2.4.L153.b0” bandwidth=”4952892”
scte214:supplementalCodecs="cuvv.1101" />
```

7.5 HDR Vivid DVB Transport Stream (TS) Encapsulation

7.5.1 General Requirements

The syntax of HDR Vivid DVB TS streams is in line with ETSI EN 300 468 V1.16.1 (2019-08) except for an additional description of component_descriptor regarding the HDR Vivid elementary streams. To be specific, the Program Mapping Table (PMT) is modified.

Fault tolerance strategies are applied to HDR programs with missing metadata.

7.5.2 TS Encapsulation

7.5.2.1 Overview

Based on the syntax of the original component_descriptor, the following fields are added to specify the HDR Vivid dynamic metadata in use. Except for the two additional descriptors, registration_descriptor () and CUVV_video_stream_descriptor(), the rest remains the same.

7.5.2.2 registration_descriptor ()

registration_descriptor () is added to the video description in the PMT. Its built-in field is defined as follows:

Table 9 Registration Descriptor

registration_descriptor ()	descriptor
{	
unsigned int (8) descriptor_tag;	**0x05**
unsigned int (8) descriptor_length;	**0x04**
unsigned int (32) Format_identifier;	**'cuvv'**
}	

descriptor_tag is 0x05, specifying it as a registration descriptor.

descriptor_length is 0x04, specifying the length of the descriptor "cuvv".

Format_identifier must be 0x63757676("cuvv") which is used to instantly decide if the TS is an HDR Vivid ES.

7.5.2.3 CUVV_video_stream_descriptor()

A user-defined descriptor is added to the video description in the PMT to indicate information such as the HDV Vivid version. This descriptor is defined as follows:

Table 10 User-Defined Descriptor

CUVV_video_stream_descriptor()	Descriptor
{	
unsigned int (8) descriptor_tag;	0xF3
unsigned int (8) descriptor_length;	0x0A
unsigned int (32) cuvv_tag ;	'cuvv'

unsigned int (16) cuva_version_map;	0x0005 (version numbers)
unsigned int (16) terminal_provide_code;	0x0004
unsigned int (16) terminal_provide_oriented_code;	0x0007 (the highest version number)
}	

descriptor_tag is 0xF3 defined by the user.

descriptor_length is 10.

cuvv_tag is 0x63757676 ("cuvv"). It is used to further specify that the content of this descriptor is CUVV information when there is a conflict due to the user-defined descriptor_tag 0xF3.

CUVA_Version_map specifies the HDR Vivid version numbers. It has 16 bits and each bit represents one version. The highest bit indicates the highest version number, and the lowest bit the lowest version number. For example, when CUVA_Version_map is 0x0005 (5 in decimal is 0101 in binary), it means that there are versions 3 and 1 in the ES.

terminal_provide_code

The last two descriptors are corresponding to "**terminal_provide_code**" and "**terminal_provide_oriented_code**" in the "itu_t_t35_payload ()" statement mentioned in Section 7.1. terminal_provide_code is 0x0004 (16 bits). terminal_provide_oriented_code (16 bits) is the value specifying the highest version number of the bit stream. For example, when CUVA_Version_map is 0x0005, it means the highest version of the ES is version 3. From Table 6 in Section 7.1.4 we can see that terminal_provide_oriented_code corresponding to version 4 is 0x0007.

7.5.3 Strategy for TS packet loss

If the HDR Vivid DVB streams in TS encapsulation cannot synchronize or there are over three lost packets, the synchronization should be restarted.

7.6 MXF encapsulation requirements

7.6.1 Static metadata

The Generic Stream Partition dedicated to text metadata shall be placed within the Body Partition of the MXF file, and adjacent to the Foot Partition. The specific technical specification shall comply with the requirements of the SMPTE RP 2057 standard. The XML encapsulation example of the static metadata is detailed in A.1 of Annex A, and the detailed description is given in 7.7.1.

7.6.2 Dynamic metadata

In MXF encapsulation the corresponding HDR Vivid metadata can be appended to the data in the Body Partition where it is interleaved on a frame-by-frame basis immediately following each video frame. This ensures that during replay, the decoder can accurately apply the metadata of each frame in synchronously with the corresponding video frame. An XML example of the dynamic metadata is provided in Annex A.2.

For JPEG 2000 encoding, extensions may be made based on SMPTE RDD 56:2021, and the relevant keys can be modified as follows:

- Changing the key corresponding to PHDR Universal Labels in Table 1 to urn:smpte:ul:060e2b34.04010105.0e230607.01010101;
- Changing the key corresponding to PHDRMetadataTrackSubDescriptor in Table 2 to urn:smpte:ul:060e2b34.02530105.0e230607.01010103;
- Changing the keys corresponding to PHDRMetadataTrackSubDescriptor Element Labels in Table 3 to urn:smpte:ul:060e2b34.01010105.0e230607.01010104,
  urn:smpte:ul:060e2b34.01010105.0e230607.01010105,
  urn:smpte:ul:060e2b34.01010105.0e230607.01010106

Note: The above keys have been registered at https://smpte-ra.org/class-1314-registrations.

7.7 IMF encapsulation requirements

For IMF encapsulation, HDR Vivid dynamic metadata can be wrapped as a separate Isochronous Stream of XML Documents (ISXD) file (see Figure 4), extending the XML description based on SMPTE ST2067-202:2023.

7.7.1 Static metadata encapsulation requirements

In the case of static metadata, the Generic Stream Partition dedicated to text metadata in the Body Partition of the MXF file is placed immediately adjacent to the Foot Partition. The location of static metadata within the ISXD file is illustrated in Figure 4. A sample XML file of static metadata is provided in Annex A.1.

Included is: xmlns="http://www.theuwa.com/hdrvivid-static/1_0_0": the middle segment *hdrvivid-static* indicates that this is HDR Vivid static metadata, which can also be extended to accommodate other metadata definitions; "1_0_0" denotes the metadata version number, which is subject to future expansion. The namespace can be aligned with the Text Data Description in the Generic Stream Text-based Set.

The XML can define two elements: *BasicInfo* and *OutputStructure*.

1) *BasicInfo* is used to describe the version, creator and software version. It can also specify the adjustment mode for tone mapping. The *TrimMode* can be either *Curve* or *Statistical*.
2) *OutputStructure* is used to define the output name, resolution and related information. Track specifies the frame rate, master peak brightness and ideal player environment, as well as the video encoding parameters such as colour space and transfer curve. *Cut* describes the start time and duration of each scene, where the dynamic metadata remains essentially consistent across each the *cuts*.

7.7.2 Dynamic metadata encapsulation requirements

The dynamic metadata is encapsulated in the body partition of the MXF file. The XML encapsulation example of the dynamic metadata is shown in Annex A.2.

Among them, xmlns="http://www.theuwa.com/hdrvivid-dynamic/1_0_0". The Namespace is consistent with Table 5 of ST2067-202:2023, and is a key identifier ensuring that the ISXD data can be correctly recognized and parsed. Different metadata types correspond to different NamespaceURI.

Annex A.2 describes two dynamic metadata description modes: the statistical information mode XML encapsulation example and the *curve* parameter mode XML encapsulation example.

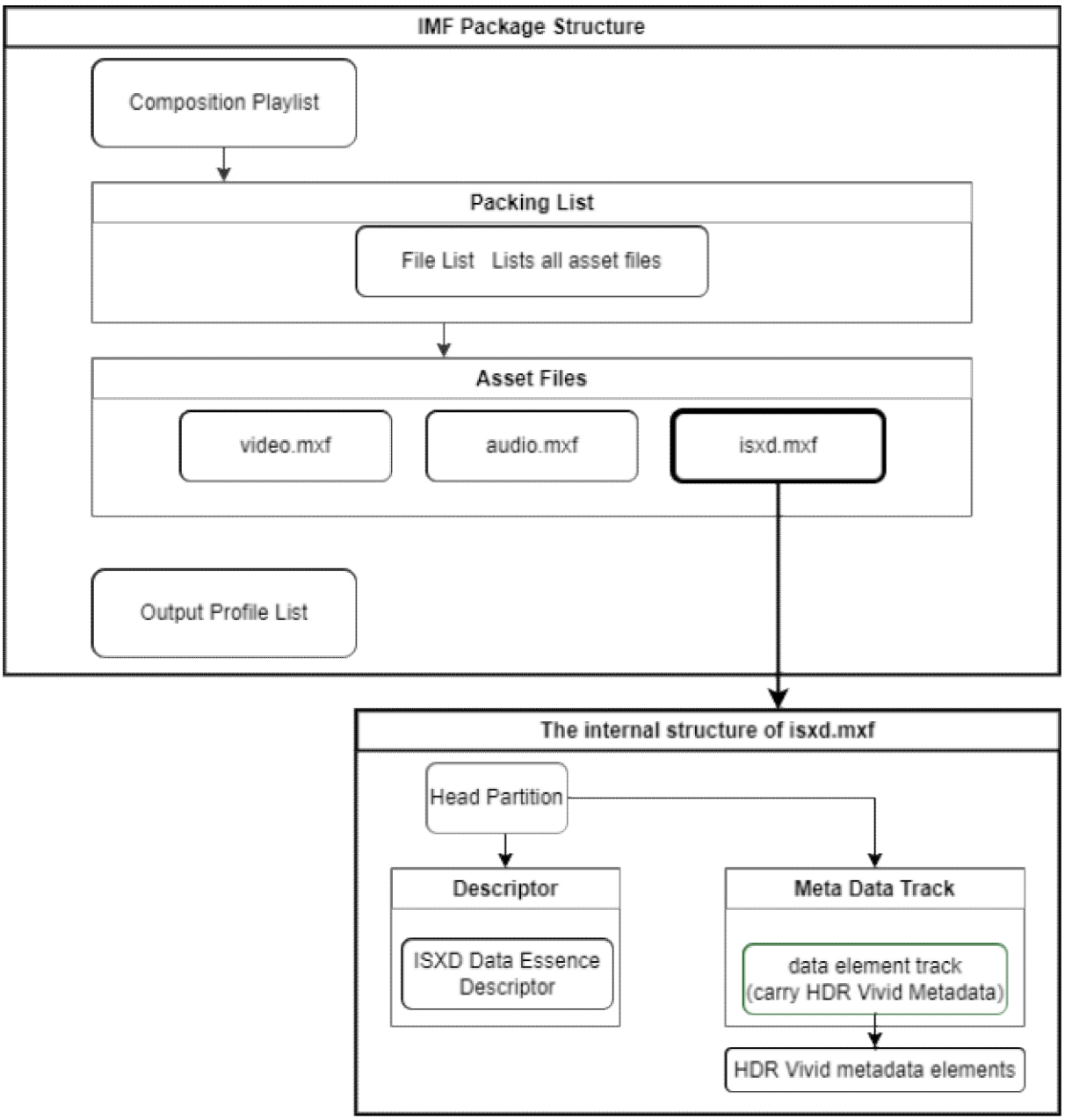


Figure 4 IMF Package Structure

8 Explanation of Terminal Application

8.1 Composition of the Terminal System

8.1.1 Functional Modules

The HDR Vivid terminal system has two functions, video receiving and decoding, and video display. The process is shown in the following figure.

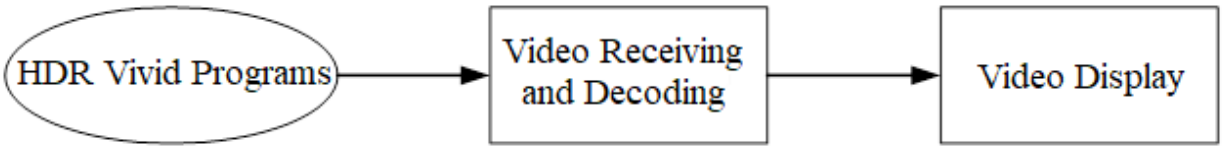


Figure 5 Functions of HDR Vivid Terminal System

Video receiving and decoding is done in playback devices which have network ports, coaxial connectors, USB ports, and video decoding abilities, mainly set-top-boxes, media players, and display devices with decoding abilities. HDR Vivid playback devices refers to those that receive, decode, and output HDR Vivid video content and metadata.

Display devices are used to present the content of videos, mainly televisions, projectors, monitors, laptops, mobile phones and other devices that can present images. Display devices can be put into the following categories based on their ability to support HDR Vivid.

Table 11 Display Device Categories

Category	HDR Vivid Display Device	HDR Display Device	SDR Display Device
Description	In line with HDR Vivid specification, can receive and process the HDR Vivid metadata, and display the video signals	Can only receive, decode, and display PQ-HDR or HLG_HDR video signals and static metadata defined under BT.2100	Do not support HDR signals defined by BT.2100, can only receive, decode, and display SDR video signals under BT.2020, BT.709, and BT.601

8.1.2 Application Methods

There are two application methods for the terminal system:

(1) All-in-one method

The display device receives HDR Vivid signals directly from the video distribution network, and then decodes, plays, and displays video on its own.

(2) Playback device method

The display device is connected via the digital visual interface to a playback device which receives HDR Vivid signals from the video distribution network and decodes the signals. Then the display device receives the decoded video signals from the playback device and displays the video content.

A playback device only needs to support the playback device method. A display device should support either one of the methods.

8.2 Decoding and Presentation of HDR Vivid Signals in the Device

8.2.1 Basic Requirements

A playback device should provide at least one adaptation mode, under which it performs only the processing required under this standard and other necessary image processing, to ensure that the output image and information meet the requirement of this standard.

A display device should provide at least one adaptation mode, under which it performs image processing based on the requirements of the authentication mode defined in this standard, ensuring the presentation of HDR Vivid videos is in line with this standard.

8.2.2 Adaptation Modes under the Playback Device Method

Under the playback device method where the playback device and the display device work together for the decoding and presentation of HDR Vivid videos, there are two adaptation modes.

(1) Receiving end adaptation mode

Under this mode, the playback device sends HDR Vivid signals and the dynamic metadata to the display device. Then, the display device performs color signal dynamic range conversion and color correction based on the requirements specified in T/UWA 005.1-2022. Here, when the display device receives video images with varying information inputs such as different transfer character curves, color gamuts, or color space conversion matrices, the display should remain stable with no visible flickering or black screen.

(2) Monitor adaptation mode

Under this mode, the playback device performs color signal dynamic range conversion and color correction based on the requirements specified in T/UWA 005.1-2022 with the dynamic range information in the Extended Display Identification Data (EDID) provided by the display device. Here, when the display device receives image signals sent by the playback device, it does not perform color dynamic range conversion or color correction. It performs signal conversion based on the transfer character curve and other necessary processing, and then present the video.

An HDR Vivid playback device should fully support both adaptation modes mentioned above. If an HDR Vivid display device has a digital visual interface which supports the HDR Vivid format, it needs to support at least one of the above modes. The HDR Vivid playback device should prioritize the receiving end adaptation mode when connecting with the HDR Vivid display device, and only use the monitor adaptation mode when the HDR Vivid display device only supports this mode.

8.2.3 Adaptation for Interworking with PQ HDR Signals

When the HDR Vivid playback device receives HDR Vivid signals in PQ HDR format, it needs to convert the signal format based on the type of display device it connects with. Details are in the following table:

Table 12 PQ Signal Format Conversion for Display Device

Type of Display Device	HDR Vivid Display Device		HDR Display Device	SDR Display Device
	Mastering Display Adaptation Mode	Receiving End Adaptation Mode		
Output Signal from Playback Device	Processed PQ HDR signals and HDR Vivid VS-IF information frames	PQ HDR signals and VS-EMDS information frames of HDR Vivid dynamic metadata	(1) PQ HDR signals and static metadata (if the video signals contain static metadata); (2) Or processed PQ HDR signals	SDR signals after conversion (the most preferable output color gamut is that defined in BT2020, followed by BT709 and lastly BT601)

8.2.4 Adaptation for Interworking with HLG HDR Signals

When the HDR Vivid playback device receives HDR Vivid signals in HLG HDR format, it needs to convert the signal format based on the type of display device it connects with. Details are in the following table:

Table 13 HLG Signal Format Conversion for Display Device

Type of Display Device	HDR Vivid Display Device		HDR Display Device	SDR Display Device
	Mastering Display Adaptation Mode	Receiving End Adaptation Mode		
Output Signal from Playback Device	Processed PQ HDR signals and HDR Vivid VS-IF information frames	HLG HDR signals and VS-EMDS information frames of HDR Vivid dynamic metadata ([1] if the video signals contain HDR Vivid dynamic metadata)	(1) HLG HDR ([2]PQ HDR) signals and static metadata (if the video signals contain static metadata) (2) Or processed PQ HDR signals	SDR signals after conversion (the most preferable color gamut is that defined in BT2020, followed by BT709 and lastly BT601)

[1] HDR Vivid does not mandatorily require HLG HDR signals to carry dynamic metadata.

[2] Some HDR display devices support only the PQ HDR format and not the HLG HDR format. In this case, the playback device need to convert the HLG HDR signals to PQ HDR signals before sending them to the display device.

8.3 Dynamic Metadata Transfer over HDMI

8.3.1 Overview

When an HDR Vivid playback device and an HDR Vivid display device are connected via HDMI to transfer image data, dynamic metadata must be transferred as is required in this chapter.

HDR Vivid signal over HDMI has its optical-electric transfer feature defined in transfer_character field of VS-IF or VS-EMDS with BT. 2020 as its color gamut. The playback device does not have to transmit HDR static metadata frames specified under CTA-861.3.

When an HDR Vivid playback device is connected to an HDR Vivid display device, the playback device would query EDID of the display device for VS-VDB data defined in 8.3.2 to know how well the display device supports HDR Vivid. If VS-VDB indicates that HDR Vivid receiving end adaptation mode is supported, the playback device would encapsulate the HDR Vivid dynamic metadata in information frames as per 8.3.3, and send them along with HDR Vivid video image to the display device. If VS-VDB indicates that HDR Vivid monitor mode is supported, the playback device would refer to VS-VDB for maximum luminance and minimum luminance of the display device, and adjust video content accordingly as per Chapter 9 and Appendix B.3 of T/UWA 005.1-2022 before sending to the display device. The playback device would also send to the display device VS-IF information as per 8.3.2.

8.3.2 Define VS-VDB

HDR Vivid display device uses the VS-VDB data block in HDMI EDID to indicate its ability to receive HDR Vivid dynamic metadata.

8.3.2.1 Syntax

Below is the syntax of the HDR Vivid VS-VDB data block:

Table 15 Syntax of VS-VDB data block

Byte\Bit	7	6	5	4	3	2	1	0
0	Tag Code= (0x07)			Length=(14)				
1	Extended Tag Code=0x01 (VSVDB)							
2	IEEE OUI/CID (0x03）							
3	IEEE OUI/CID (0x75)							
4	IEEE OUI/CID (0x04）							
5	system_start_code[7…0]							
6	version_code[3…0]				0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)
7	display_maximum_luminance [31…0]							
8								
9								
10								
11	display_minimum_luminance [15…0]							
12								
13	monitor_mode_support	rx_mode_support	0 (Reserved)					
14	0 (Reserved)							

8.3.2.2 Semantics

system_start_code

8-bit unsigned integer. It indicates the HDR Vivid version supported by a device. If the device supports the current version, the value is 1.

If the adopted version is higher than what is represented in system_start_code of dynamic metadata data in the stream, dynamic metadata will be packed in HDR Vivid VS-EMDS package structure. Or, in current transmitting device, display adaptation is performed according to HDR Vivid metadata criteria before the metadata is sent to the receiving device.

version_code

4-bit unsigned integer. It indicates the HDR Vivid version number of a device. If it is current version, the value is 1. The transmitting device refers to the version information of the receiving device and then sends the dynamic metadata in the corresponding format.

display_maximum_luminance

32-bit unsigned integer. It indicates maximum luminance of a display device under D65. The unit of measurement is 0.0001 nit (cd/m^2).Code word 0x00000001 represents 0.0001 nit. The value of MaxDisplay is display_maximum_luminance/10000. If the display device supports monitor mode, value of display_maximum_luminance in the display device must be set properly for playback device to refer to when it does imaging processing. If not, the value of display_maximum_luminance is set as 0.

display_minimum_luminance

16-bit unsigned integer. It indicates the minimum luminance of a display device under D65. The unit of measurement is 0.0001 nit (cd/m^2). Code word 0x0001 represents 0.0001 nit. The value of MinDisplay is

display_minmum_luminance/1000. If the display device supports monitor mode, the value of display_minimum_luminance in the display device must be set properly for playback device to refer to when it does imaging processing. If not, the value of display_minimum_luminance is set as 0.

monitor_mode_support

1 bit unsigned integer. It indicates if the display device supports monitor mode. If monitor_mode_support=1, the display device supports monitor mode. If monitor_mode_support=0, the display device does not support the monitor mode.

rx_mode_support

1 bit unsigned integer. It indicates whether a display device supports the receiving end adaptation mode. If rx_mode_support=1, the display device supports receiving end adaptation mode; if rx_mode_support=0, the device does not support the receiving end adaptation mode.

8.3.3 Define VS-IF

8.3.3.1 Syntax

In HDR Vivid monitor mode, static metadata is transferred from playback device to display device using a VS-IF information frame of HDMI. Below is the syntax of VS-IF information frames:

Table 15 Syntax of VS-IF information frames

Byte\Bit	7	6	5	4	3	2	1	0
HB0	VSIF Type Code =0x81							
HB1	VSIF Version=0x01							
HB2	0	0	0	0	0	Payload Length=27		
PB00	checksum							
PB01	IEEE OUI/CID (0x03)							
PB02	IEEE OUI/CID (0x75)							
PB03	IEEE OUI/CID (0x04)							
PB04	system_start_code [7…0]							
PB05	version_code [3…0]				Monitor_mode_enable =0x01	transfer_ character=0	0 (Rsvd)	0 (Rsvd)
PB06~PB27	0 (Reserved)							

8.3.3.2 Syntax

monitor_mode_enable

1 bit unsigned integer. In this guideline, monitor_mode_enable has a fixed value of 1. It indicates that current HDR Vivid signals are connected and processed in monitor mode.

transfer_character

1 bit unsigned integer. It represents transfer character of graphs. In this guideline, transfer_character has a fixed value of 0, meaning that under monitor mode, the graph transfer character is a ST2084 EOTF curve.

8.3.4 Define VS-EMDS

In HDR Vivid receiving end adaptation mode, dynamic metadata are transferred from playback device to display device through VS-EMDS information frames of HDMI.

8.3.4.1 Syntax

Below is the syntax of HDR Vivid VS-EMDS:

Table 16 Syntax of VS-EMDS

Byte\ Bit	7	6	5	4	3	2	1	0
HB0	0	1	1	1	1	1	1	1
HB1	1 (First)	0 (Last)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)
HB2	0 (Sequence_Index)							
PB0	1 (New)	0 (End)	1 (DS_Type)		0 (AFR)	1 (VFR)	1 (Sync)	0 (Rsvd)
PB01	0 (Rsvd)							
PB02	0 (Organization_ID)							
PB03	0x00 (Data_Set_Tag_MSB)							
PB04	0x02 (Data_Set_Tag_LSB)							
PB05	0x00 (Data_Set_Length_MSB)							
PB06	0x38 (Data_Set_Length_LSB)							
PB07	IEEE OUI/CID (03)							
PB08	IEEE OUI/CID (75)							
PB09	IEEE OUI/CID (04)							
PB10	system_start_code [7…0]							
PB11	version_code [3…0]				minimum_maxrgb_pq [11…8]			
PB12	minimum_maxrgb_pq [7…0]							
PB13	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	average_maxrgb_pq [11…8]			
PB14	average_maxrgb_pq [7…0]							
PB15	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	variance_maxrgb_pq [11…8]			
PB16	variance_maxrgb_pq [7…0]							
PB17	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	maximum_maxrgb_pq [11…8]			
PB18	maximum_maxrgb_pq [7…0]							
PB19	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	targeted_system_display_maximum_luminance_ pq [11…8]			
PB20	targeted_system_display_maximum_luminance_ pq [7…0]							
PB21	Transfer _Character	base_ enable flag[0]	base_param_m_p [13…8]					
PB22	base_param_m_p [7…0]							
PB23	0(Rsvd)	0(Rsvd)	base_param_m_m [5…0]					
PB24	0(Rsvd)	0(Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	base_param_m_a[9,8]	

Byte\ Bit	7	6	5	4	3	2	1	0
PB25	base_param_m_a[7…0]							
PB26	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	base_param_m_b[9…8]	
PB27	base_param_m_b [7…0]							
HB0	0	1	1	1	1	1	1	1
HB1	0 (First)	0 (Last)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)
HB2		1(Sequence_Index)						
PB0	0 (Rsvd)	0 (Rsvd)	base_param_m_n [5…0]					
PB1	0 (Rsvd)	0 (Rsvd)	base_param_K1 [1..0]		base_param_K2[1..0]		base_param_K3[1..0]	
PB2	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0(Rsvd)	base_param_Delta_enable_mode[2..0]		
PB3	0 (Rsvd)	base_param_enable_Delta[6…0]						
PB4	0(Rsvd)	0(Rsvd)	0(Rsvd)	3Spline_enable_num		3Spline _enable_flag[0]	3Spline_TH_enable_mode0[1, 0]	
PB5	3Spline_TH_enable_MB0[7…0]							
PB6	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	3Spline_TH_enable0[11…8]			
PB7	3Spline_TH_enable0[7…0]							
PB8	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	3Spline_TH_enable_0Delta1[9,8]	
PB9	3Spline_TH_enable_0Delta1[7…0]							
PB10	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	3Spline_TH_enable_0Delta2[9,8]	
PB11	3Spline_TH_enable_0Delta2[7…0]							
PB12	3Spline_enable_Strength0[7…0]							
PB13	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	3Spline_TH_enable_mode1[1, 0]	
PB14	3Spline_TH_enable_MB1[7…0]							
PB15	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	3Spline_TH_enable1[11…8]			
PB16	3Spline_TH_enable1[7…0]							
PB17	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	3Spline_TH_enable_1Delta1[9,8]	
PB18	3Spline_TH_enable_1Delta1[7…0]							
PB19	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	0 (Rsvd)	3Spline_TH_enable_1Delta2[9,8]	
PB20	3Spline_TH_enable_1Delta2[7…0]							
PB21	3Spline_enable_Strength1[7…0]							
PB22	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	color_saturation_enable_num[2…0]		

Byte\ Bit	7	6	5	4	3	2	1	0
PB23	color_saturation_enable_gain0 [7…0]							
PB24	color_saturation_enable_gain1 [7…0]							
PB25	color_saturation_enable_gain2 [7…0]							
PB26	color_saturation_enable_gain3 [7…0]							
PB27	color_saturation_enable_gain4 [7…0]							
HB0	0	1	1	1	1	1	1	1
HB1	0(First)	1(Last)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)	0(Rsvd)
HB2		2(Sequence_Index)						
PB0	color_saturation_enable_gain5 [7…0]							
PB1	color_saturation_enable_gain6 [7…0]							
PB2	color_saturation_enable_gain7 [7…0]							
PB3	graphic_ source_display_value [7…0]							
PB4	0 (Reserved)							
PB5	max_display_mastering_luminance,MSB							
PB6	max_display_mastering_luminance,LSB							
PB7~PB27	0 (Reserved)							

8.3.4.2 Syntax

version_code

4 bit unsigned integer. It indicates the system version. If it is current version, the value is 1.

transfer_character

1 bit unsigned integer. It indicates the graph transfer character. If the value of transfer_character is 0, the transfer character is a ST2084 EOTF curve. If transfer_character is 1, the transfer character is a Hybrid Log-Gamma(HLG) OETF curve.

graphic_source_display_value_pq

8 bit unsigned integer. It indicates the display luminance code values of PQ nonlinear normalized content of the image that is transferred from a playback device to a display device. Graph content's color gamut and transfer character are consistent with those of the video. The transfer character is determined by transfer_character field of the image. If graphic_source_value_pq is 0, there is no graph transfer. Graph's fixed curve source luminance parameter graphic_source_value_pq takes graphic_source_display_value_pq/255 as its value. See 11.3.4 graph processing for the display device adaptation under receiving end adaptation mode.

max_display_mastering_luminance

16-bit unsigned integer. It is generated by combining max_display_mastering_luminance, LSB and max_display_mastering_luminance, MSB. If the code value is 0x0001, the max_display_mastering_luminance value is 1 nit, and if the code value is 0xFFF, the max_display_mastering_luminance value is 65535 nits.

For the rest parameters, see grammar related to dynamic metadata in T/UWA 005.1-2022.

8.3.5 Graph processing for display device adaptation in receiving end adaptation mode

a) When the receiving end receives VS-EMDS packages, it extracts from them HDR Vivid metadata and graphic fixed curve range parameters.

b) See Chapter 9 of T/UWA 005.1-2022 to generate medium tone mapping curve P, including base curve parameter $P_{tone_mapping}$, which includes m_p, m_m, m_n, m_a, m_b, K1, K2, and K3, one dimensional spline curve parameter $P_{1spline}$, which includes MB[0][0] and TH3[0], and cubic spline $P_{3spline}$, which includes TH1[3Spline_num], TH2[3Spline_num], TH3[3Spline_num], MA[2][3Spline_num], MB[2][3Spline_num], MC[2][3Spline_num], and MD[2][3Spline_num].

c) If graphic_source_value_pq = 0, set the final tone mapping curve S as P;

d) If graphic_source_value_pq > 0, graph's target display luminance is

$$graphic_target_value_pq = \max(\min(graphic_source_value_pq, MaxDisplayPQ \times 0.9), 0.5081)$$

Set the one dimensional spline curve $S_{1spline}$ including MB[0][0] and TH3[0] of S as follows:

MB[0][0] = graphic_target_value_pq /graphic_source_value_pq

TH3[0] = graphic_source_value_pq

base_offset = 0

Set the base curve parameter $S_{tone_mapping}$, including s_m_p, s_m_m, s_m_n, s_m_a, s_m_b, s_K1, s_K2 and s_K3 of S as base curve $P_{tone\text{-}mapping}$, including m_p, m_m, m_n, m_a, m_b, K1, K2 and K3.

See 9.3 of T/UWA 005.1-2022 and generate cubic spline parameter $S_{3spline}$ following steps below.

1) Set TH1[1] = TH3[0], and calculate TH2[1] = TH1[1] + B, TH3[1] = TH2[1] + C, where B has a default value of 0.15, and C takes B/2 as its value; if TH3[1] > MaxSource, then TH3[1] = MaxSource. TH2[1] = TH1[1] + 2* (TH3[1] - TH1[1])/3. Generate cubic spline parameter $S_{3spline}$ as per 9.3.3.1 or 9.3.3.2 of T/UWA 005.1-2022, and check if this cubic spline curve is monotonically increasing (see 11.3.4.1). If yes, go to step 2; otherwise, go to step 3.
2) If TH1[3Spline_num] is greater than TH3[1], pass this cubic spline's parameter $P_{3spline}$, including TH1[3Spline_num], TH2[3Spline_num], TH3[3Spline_num], MA[2][3Spline_num], MB[2][3Spline_num], MC[2][3Spline_num] and MD[2][3Spline_num] to cubic spline parameter $S_{3spline}$; otherwise, values of TH1[2], TH2[2], TH3[2], and the latter cubic spline parameter are all set as 0, and the value of 3spline_num of metadata is set as 1. Terminate the cubic spline parameter generation process.
3) Set TH3[1] = MaxSource, TH2[1] = TH1[1] + 2*(TH3[1] - TH1[1])/3, and generate cubic spline parameter $S_{3spline}$, and check if the curve is monotonically increasing (see 11.3.4.1). If yes, go to step 4. Otherwise, go to step 5.
4) Find minimum TH3 in [TH1[1]+B+C, MaxSource] using binary search, and generate cubic spline parameter $S_{3spline}$ as per 9.3.3.1 or 9.3.3.2 of T/UWA 005.1-2022, and make it monotonically increasing (see 11.3.4.1). Search 10 times at most, and then terminate the curve parameter generation process.
5) TH3[1] = MaxSource, TH2[1] = TH3[1], MA[0][1] = graphic_target_value_pq, MB[0][1] = (VA2-MA[0][1])/(TH2[1]-TH1[1]), MC[0][1], MD[0][1], MA[1][1], MB[1][1], MC[1][1], and MD[1][1] all have a value of 0. Terminate the cubic spline parameter generation process.

8.3.5.1 Check if the Cubic Spline is Monotonically Increasing

In a cubic spline range, there are two cubic splines, and the equations are as follows:

$$F(L) = MD[0][n] \times (L - TH1[n])^3 + MC[0][n] \times (L - TH1[n])^2 + MB[0][n] \times (L - TH1[n])^1 + MA[0][n]$$

where L is an independent variable of range [TH1[n], TH2[n]];

$$F(L) = MD[1][n] \times (L - TH2[n])^3 + MC[1][n] \times (L - TH2[n])^2 + MB[1][n] \times (L - TH2[n])^1 + MA[1][n]$$

where L is an independent variable of range [TH2[n], TH3[n]], and 0 < n <= 3Spline_num.

Both cubic splines have to be monotonically increasing. Check with the following conditions.

a) Conditions to be met for the first cubic spline curve to increasing monotonically are:

If $\mathrm{TH1[n]} \le (\mathrm{TH1[n]} - \frac{MC[0][n]}{3 \times MD[0][n]}) \le TH2[n]$, then

$$MB[0][n] - \frac{MC[0][n]^2}{3 \times MD[0][n]} \ge 0$$

.

If $\mathrm{TH1[n]} > \left(\mathrm{TH1[n]} - \frac{MC[0][n]}{3 \times MD[0][n]}\right) \quad \left(\mathrm{TH1[n]} - \frac{MC[0][n]}{3 \times MD[0][n]}\right) > TH2[n]$, then

$$\begin{cases} MB[0][n] \ge 0 \\ 3 \times MD[0][n] \times (DTH2)^2 + 2 \times MC[0][n] \times (DTH2)^1 + MB[0][n] \ge 0 \end{cases}$$

where $DTH2 = (TH2[n] - TH1[n])$

b) Conditions to be met for the second cubic spline curve to increase monotonically are:

If $\mathrm{TH2[n]} \le (\mathrm{TH2[n]} - \frac{MC[1][n]}{3 \times MD[1][n]}) \le TH3[n]$, then

$$MB[1][n] - \frac{MC[1][n]^2}{3 \times MD[1][n]} \ge 0$$

.

If $\mathrm{TH2[n]} > \left(\mathrm{TH2[n]} - \frac{MC[1][n]}{3 \times MD[1][n]}\right) \quad \left(\mathrm{TH2[n]} - \frac{MC[1][n]}{3 \times MD[1][n]}\right) > TH3[n]$, then:

$$\begin{cases} MB[1][n] \ge 0 \\ 3 \times MD[1][n] \times (DTH3)^2 + 2 \times MC[1][n] \times (DTH3)^1 + MB[1][n] \ge 0 \end{cases}$$

Where $DTH3 = (TH3[n] - TH2[n])$.

8.4 GPMI metadata transmission requirements

8.4.1 General Provisions

When an HDR Vivid player device connects to an HDR Vivid display device via GPMI for image data transmission, metadata transmission shall comply with the requirements of Clause 8.4.

For HDR Vivid signals transmitted over GPMI, the electro-optical transfer characteristic of the signal is determined by the transfer_character field in the GPMI video metadata descriptive information packet DIP. The colour gamut of the signal is ITU-R BT.2020.

After the HDR Vivid player establishes a connection with the HDR Vivid display device, the player shall query the data block specified in 8.4.2 within the display device's DCCD information to obtain the HDR Vivid support capability of the display device.

If the display device's DCCD indicates support for the HDR Vivid monitor-adaptation mode, the player shall perform adaptation processing on HDR Vivid video content in accordance with Clause 9 of T/UWA 005.1-2024 based on the maximum display luminance and minimum display luminance provided in the display device's DCCD, and then send the processed content to the display device. Meanwhile, the player shall transmit DIP information specified in 8.4.3 to the display device.

If the display device's DCCD indicates support for the HDR Vivid receiver-side adaptation mode, or supports both the HDR Vivid receiver-side adaptation mode and the HDR Vivid monitor-adaptation mode, the player shall encapsulate HDR Vivid dynamic metadata into DIP information complying with 8.4.4 and send it to the display device together with the HDR Vivid video images.

Metadata and variables defined in T/UWA 005.1 shall apply to all formulas contained in Clause 8.4.

8.4.2 HDR Vivid Capability Description

8.4.2.1 Syntax

HDR Vivid capabilities shall be described using the DCCD data block shown in Table 17. Bytes 0 to 2 carry GPMI-defined information for dynamic HDR capability description. Bytes 3 to 27 contain information required for HDR Vivid.

Table 17 DCCD Data Block Information Syntax

Byte\Bit	7	6	5	4	3	2	1	0
0	0x1C (HDR Vivid Capabilities)							
1	0 (Reserved)			Version_code (=0x01)				
2	Length (=25)							
3	system_start_code[7…0]							
4	version_code[3..0]				0(Reserved)	0(Reserved)	0(Reserved)	0(Reserved)
5	display_maximum_luminance [7…0]							
6	display_maximum_luminance [15…8]							
7	display_maximum_luminance [23…16]							
8	display_maximum_luminance [31…24]							
9	display_minimum_luminance [7…0]							
10	display_minimum_luminance [15…8]							
11	monitor_mode_support	rx_mode_support	0（Reserved）					
12~27	0（Reserved）							

8.4.2.2 Semantics

8.4.2.2.1 system_start_code

8-bit unsigned integer. It indicates the HDR Vivid version supported by the terminal; the value for the current version shall be set to 1.

If the version number contained in the display device's DCCD is greater than or equal to the system_start_code carried in dynamic metadata received from the bitstream, dynamic metadata shall be transmitted to the display device encapsulated in the DIP packet structure specified in 8.4.4. Otherwise, the

player shall perform display-side adaptation processing, and transmit the adapted image together with metadata information in the DIP packet structure specified in 8.4.3 to the display device.

8.4.2.2.2 version_code

4-bit unsigned integer. It indicates the system version number; the value for the current version shall be set to 1.

8.4.2.2.3 display_maximum_luminance

32-bit unsigned integer. It represents the maximum luminance the display device can output under D65 colour temperature, in units of 0.0001 cd/m². Codeword 0x00000001 corresponds to 0.0001 cd/m². The final value MaxDisplay = display_maximum_luminance / 10000. When the display device supports monitor-adaptation mode, display_maximum_luminance shall be set to a valid value for image processing by the player. When the display device does not support monitor-adaptation mode, display_maximum_luminance shall be set to 0.

8.4.2.2.4 display_minimum_luminance

16-bit unsigned integer. It represents the minimum luminance the display device can output under D65 colour temperature, in units of 0.0001 cd/m². Codeword 0x0001 corresponds to 0.0001 cd/m². The final value MinDisplay = display_minimum_luminance / 10000. When the display device supports monitor-adaptation mode, display_minimum_luminance shall be set to a valid value for image processing by the player. When the display device does not support monitor-adaptation mode, display_minimum_luminance shall be set to 0.

8.4.2.2.5 monitor_mode_support

1-bit unsigned integer. It indicates whether the display device supports monitor-adaptation mode. monitor_mode_support =1 means monitor-adaptation mode is supported; monitor_mode_support =0 means monitor-adaptation mode is not supported.

8.4.2.2.6 rx_mode_support

1-bit unsigned integer. It indicates whether the display device supports receiver-side adaptation mode. rx_mode_support =1 means receiver-side adaptation mode is supported; rx_mode_support =0 means receiver-side adaptation mode is not supported.

8.4.3 Static Metadata Transmission

8.4.3.1 Syntax

Under HDR monitor-adaptation mode over GPMI, static metadata is transmitted from the player to the display device via DIP packets. The format of the HDR static-metadata DIP packet is specified in Table 18. HB0~HB3 are GPMI-defined headers for HDR static-metadata DIP packets. CRC0~CRC3 are cyclic redundancy check values for the HDR static-metadata DIP packet and take fixed values within this clause.

Table 18 Static-Metadata DIP Packet Format

Byte\Bit	7	6	5	4	3	2	1	0
HB0	DIP_Type (=0x04)							

HB1	0 (Reserved)	Index (=0)			
HB2	OUI (= 0001b)	Meta_Type (=0000b)			
HB3	Length (= 0x5)				
DB0	0 (Reserved)				
DB1	0 (Reserved)				
DB2	0 (Reserved)				
DB3	system_start_code[7…0]				
DB4	version_code[3…0]	monitor _mode_ enable (=1)	transfer_ character (=0)	0(Reserved)	0(Reserved)
DB5~DB31	0 (Reserved)				
CRC0	CRC32[31:24]				
CRC1	CRC32[23:16]				
CRC2	CRC32[15:8]				
CRC3	CRC32[7:0]				

8.4.3.2 Semantics

version_code: 4-bit unsigned integer. It indicates the system version number; the value for the current version shall be set to 1.

monitor_mode_enable: 1-bit unsigned integer. Within this document, monitor_mode_enable is fixed to 1, indicating that the HDR Vivid signal interconnection adaptation operates in monitor-adaptation mode.

transfer_character: 1-bit unsigned integer, indicating the electro-optical transfer characteristic of the image. When transmitting HDR Vivid static metadata under this clause, transfer_character shall be fixed to 0, meaning the electro-optical transfer function is SMPTE ST 2084 EOTF under monitor-adaptation mode.

CRC32: 32-bit unsigned integer, used to verify data integrity from HB0 to DB31 within the packet. CRC32 calculation shall follow 8.4.5.

8.4.4 Dynamic Metadata Transmission

8.4.4.1 Syntax

Under HDR Vivid receiver-side adaptation mode over GPMI, dynamic metadata is transmitted from the player to the display device via DIP packets. HDR Vivid dynamic-metadata DIP packets shall conform to Table 19 and Table 20. HB0 to HB3 are GPMI-defined headers for HDR dynamic-metadata DIP packets and take fixed values in this clause. CRC0 to CRC3 are cyclic redundancy check values for HDR dynamic-metadata DIP packets and shall be generated according to actual packet content.

Since HDR Vivid dynamic metadata exceeds 32 bytes in length, two DIP packets are required for complete transmission. The first HDR Vivid dynamic-metadata DIP packet is shown in Table 19. The second HDR Vivid dynamic-metadata DIP packet is shown in Table 20.

Table 19 First Dynamic-Metadata DIP Packet Format

Byte\Bit	7	6	5	4	3	2	1	0
HB0	DIP_Type (=0x04)							

HB1	0 (Reserved)				Index (=0)		
HB2	OUI (= 0001b)				Meta_Type (=0001b)		
HB3	Length (= 0x20)						
DB0	0 (Reserved)						
DB1	0 (Reserved)						
DB2	0 (Reserved)						
DB3	system_start_code[7…0]						
DB4	version_code[3…0]				minimum_maxrgb_pq [11…8]		
DB5	minimum_maxrgb_pq [7…0]						
DB6	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	average_maxrgb_pq [11…8]		
DB7	average_maxrgb_pq [7…0]						
DB8	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	variance_maxrgb_pq [11…8]		
DB9	variance_maxrgb_pq [7…0]						
DB10	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	maximum_maxrgb_pq [11…8]		
DB11	maximum_maxrgb_pq [7…0]						
DB12	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	targeted_system_display_maximum_luminance_ pq[11…8]		
DB13	targeted_system_display_maximum_luminance_ pq[7…0]						
DB14	transfer_ character	base_enab leflag[0]	base_param_m_p[13…8]				
DB15	base_param_m_p[7…0]						
DB16	0 (Reserved)	0 (Reserved)	base_param_m_m [5…0]				
DB17	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	base_param_m_a[9,8]
DB18	base_param_m_a[7…0]						
DB19	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	base_param_m_b[9,8]
DB20	base_param_m_b[7…0]						
DB21	0 (Reserved)	0 (Reserved)	base_param_m_n[5…0]				
DB22	0 (Reserved)	0 (Reserved)	base_param_K1[1..0]		base_param_K2[1..0]		base_param_K3[1..0]
DB23	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	base_param_Delta_enable_mode[2..0]	
DB24	0 (Reserved)	base_param_enable_Delta[6…0]					
DB25	0	0	0	3Spline_enable_num		3Spline_	3Spline_TH_enable_

	(Reserved)	(Reserved)	(Reserved)		enable_ flag[0]	mode0[1,0]
DB26	3Spline_TH_enable_MB0[7…0]					
DB27	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable0[11…8]	
DB28	3Spline_TH_enable0[7…0]					
DB29	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable_ 0Delta1[9,8]
DB30	3Spline_TH_enable_0Delta1[7…0]						
DB31	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable_ 0Delta2[9,8]
CRC0	CRC[31:24]						
CRC1	CRC[23:16]						
CRC2	CRC[15:8]						
CRC3	CRC[7:0]						

Table 20 Second Dynamic- Metadata DIP Packet Format

Byte\Bit	7	6	5	4	3	2	1	0
HB0	DIP_Type (=0x04)							
HB1	0 (Reserved)				Index (**=1**)			
HB2	OUI (= 0001b)				Meta_Type (=0001b)			
HB3	Length (**= 0x1A**)							
DB0	3Spline_TH_enable_0Delta2[7…0]							
DB1	3Spline_enable_Strength0[7:0]							
DB2	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable_ mode1[1,0]	
DB3	3Spline_TH_enable_MB1[7…0]							
DB4	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable1[11…8]			
DB5	3Spline_TH_enable1[7…0]							
DB6	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable_ 1Delta1[9,8]	
DB7	3Spline_TH_enable_1Delta1[7…0]							
DB8	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	3Spline_TH_enable_ 1Delta2[9,8]	
DB9	3Spline_TH_enable_1Delta2[7…0]							
DB10	3Spline_enable_Strength1[7…0]							

DB11	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	0 (Reserved)	color_saturation_enable_num[2…0]
DB12	color_saturation_enable_gain0[7…0]					
DB13	color_saturation_enable_gain1[7…0]					
DB14	color_saturation_enable_gain2[7…0]					
DB15	color_saturation_enable_gain3[7…0]					
DB16	color_saturation_enable_gain4[7…0]					
DB17	color_saturation_enable_gain5[7…0]					
DB18	color_saturation_enable_gain6[7…0]					
DB19	color_saturation_enable_gain7[7…0]					
DB20	graphic_ source_display_value_pq[7…0]					
DB21	0 (Reserved)					
DB22	max_display_mastering_luminance,MSB					
DB23	max_display_mastering_luminance,LSB					
DB24	min_display_mastering_luminace,MSB					
DB25	min_display_mastering_luminace,LSB					
DB26	0 (Reserved)					
DB27	0 (Reserved)					
DB28	0 (Reserved)					
DB29	0 (Reserved)					
DB30	0 (Reserved)					
DB31	0 (Reserved)					
CRC0	CRC32[31:24]					
CRC1	CRC32[23:16]					
CRC2	CRC32[15:8]					
CRC3	CRC32[7:0]					

8.4.4.2 Semantics

8.4.4.2.1 version_code

4-bit unsigned integer. It indicates the system version number; the value for the current version shall be set to 1.

8.4.4.2.2 transfer_character

1-bit unsigned integer, indicating the electro-optical transfer characteristic of the image. transfer_character =0: transfer characteristic is SMPTE ST 2084 EOTF. transfer_character=1: transfer characteristic is HLG OETF.

8.4.4.2.3 graphic_source_display_value_pq

8-bit unsigned integer. It represents the PQ-domain nonlinear normalized content display luminance code value for graphics transmitted from player to display device. The colour gamut and transfer characteristic of graphic content are consistent with those of video, and the transfer characteristic is determined by

transfer_character. graphic_source_display_value_pq =0 means no graphic content is being transmitted. The graphic-source luminance parameter graphic_source_value_pq = graphic_source_display_value_pq /255. Graphic processing for receiver-side-adaptation-mode display-side adaptation shall follow 8.4.4.3.

8.4.4.2.4 max_display_mastering_luminance

16-bit unsigned integer, assembled by concatenating max_display_mastering_luminance_MSB and max_display_mastering_luminance_LSB. Codeword 0x0001 corresponds to 1 cd/m²; codeword 0xFFFF corresponds to 65535 cd/m².

8.4.4.2.5 min_display_mastering_luminance

16-bit unsigned integer, assembled by concatenating min_display_mastering_luminace_MSB and min_display_mastering_luminace_LSB. Codeword 0x0001 corresponds to 0.0001 cd/m²; codeword 0xFFFF corresponds to 6.5535 cd/m².

8.4.4.2.6 CRC32

32-bit unsigned integer for integrity verification of all data bytes from HB0 to DB31 within the packet. CRC32 calculation shall comply with 8.4.5.

8.4.4.2.7 Other Parameters

For other parameters in Table 19 and Table 20, refer to Clause 7.3 of T/UWA 005.1-2024.

Parameters not transmitted in Table 19 and Table 20 shall be derived as follows: a) tone_mapping_enable_mode_flag: 1-bit unsigned integer indicating the tone-mapping enable flag with value range {0,1}. tone_mapping_enable_mode_flag shall take the same value as base_enable_flag[0]. b) tone_mapping_param_enable_num: 1-bit unsigned integer, representing the number of tone-mapping parameter groups minus one. The default value is 0, meaning only one set of tone-mapping parameters is transmitted. c) color_saturation_mapping_enable_flag: binary variable. When color_saturation_enable_num =0, color_saturation_mapping_enable_flag shall be 0; otherwise it shall be 1.

8.4.4.3 Graphic Processing for Display-Side Adaptation under Receiver-Side Adaptation Mode

Under receiver-side adaptation mode, to implement user-interaction functions such as volume adjustment, the player superimposes graphic content such as user menus onto HDR Vivid video before sending to the display device. To prevent such superimposed graphic content from undergoing unintended luminance variation caused by dynamic-metadata processing, graphic content shall be processed as specified below:

a) After receiving the dynamic-metadata packet, the receiver parses the HDR Vivid metadata and graphic-source-display-value parameters from the HDR Vivid metadata packet structure.

b) Graphic processing shall be performed in accordance with 8.3.5.

8.4.4.4 Procedure for Verifying Monotonic-Increasing Property of Cubic-Spline Curves

The procedure for verifying whether a cubic-spline curve is monotonically increasing shall comply with 8.3.6.

8.4.5 CRC32 Calculation for GPMI DIP Packets

Key parameters for CRC32 check-value generation are specified below:

a) CRC32 generator polynomial: $g(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$

b) Initial register value: 0xFFFF_FFFF;

c) Input bit-reflection: enabled (True);

d) Output bit-reflection: enabled (True);

e) Final output XOR mask: 0xFFFF_FFFF.

The CRC32 generation circuit is shown in Figure 7, where DW denotes a 32-bit double word. After all bits under check are input, the circuit outputs the check result CRC[31:0].

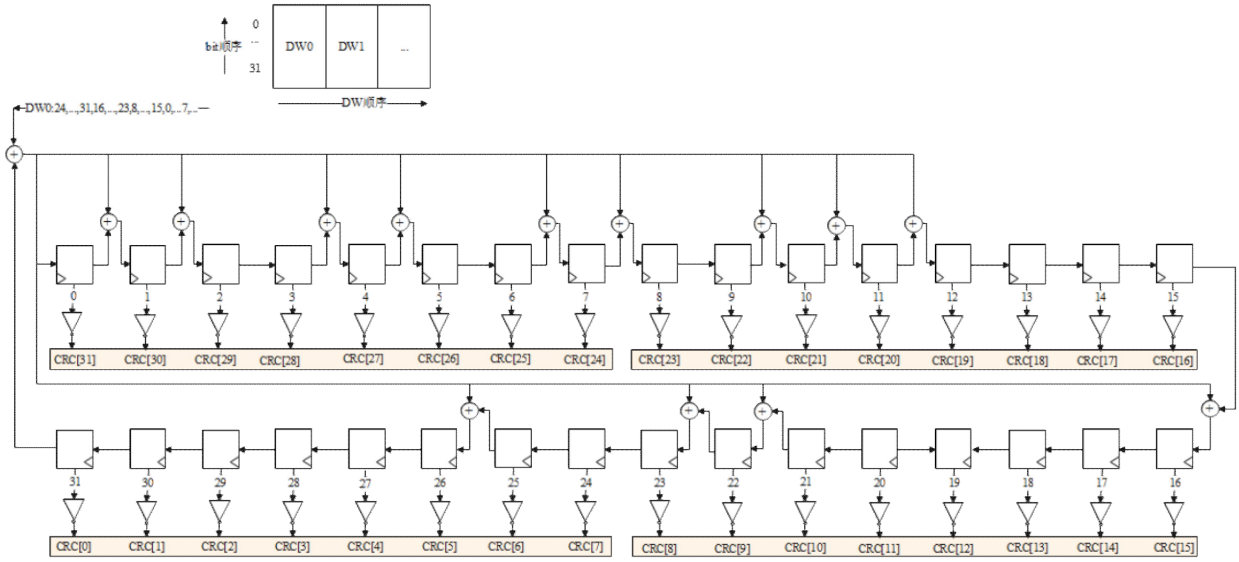


Figure 7 CRC32 Generation Circuit

9 Content Protection

HDR Vivid video streams can be encrypted and decrypted by regular digital copyright protection systems. Because the associated metadata cannot be restored or reversely derived from video streams if encrypted, it is recommended not to apply additional content protection to HDR metadata, which increases system complexity.

Annex A

XML encapsulation examples of HDR metadata in IMF/MXF

A.1 XML encapsulation example of HDR static metadata

A.1.1 XML encapsulation example of static metadata in curve parameter mode

<HDRVividMeta xmlns=" **http://www.theuwa.com/hdrvivid-static/1_0_0**">

It is the official website address of UWA (UHD WORLD ASSOCIATION), where the HDR Vivid *standard was published*

<Version>1.0</Version>

The current version of HDR Vivid metadata is 1.0

<BasicInfo>

<LastModifiedTime>2024-10-23-11:35:00</LastModifiedTime>

The recorded time when the file was last modified

<Producer>XXXX</Producer>

The name of the producer for recording

<SoftwareVersion>XXXX</SoftwareVersion>

Software version of the producer for recording

<HDRVividProfile>Global</HDRVividProfile>

HDR Vivid standard profile. Possible Values: Global, Local. Currently only Global is supported

<TrimMode>Curve</TrimMode>

The mode of metadata. Possible Values: Statistical, Curve

</BasicInfo>

<OutputStructure>

<OutputName>TEST_Vivid</OutputName>

The name of the output file

<MetadataGeneratedTime>2024-10-23-11:35:00</MetadataGeneratedTime>

The time when the metadata was generated

<Resolution>4096x2160</Resolution>

The resolution of the file

<Video>

<Track>

<FrameRate>24fps</FrameRate>

The frame rate of the file

<MasteringDisplay>1000nits</MasteringDisplay>

MasteringDisplay setting in project, static metadata

<TargetDisplay>HDR BT2020 GAMMA PQ 1000nits</TargetDisplay>

TargetedDisplay setting in project, possible values are:

SDR BT709, Gamma 2.4, 100nits

HDR BT2020, Gamma PQ, 500nits

HDR BT2020, Gamma PQ, 600nits

HDR BT2020, Gamma PQ, 800nits

HDR BT2020, Gamma PQ, 1000nits
HDR BT2020, Gamma PQ, 2000nits
HDR BT2020, Gamma PQ, 4000nits
HDR BT2020, Gamma PQ, 10000nits
HDR BT2020, Gamma HLG, 1000nits

```
                    <EncodingInfo>
                        <TransferCharacteristics>PQ</TransferCharacteristics>
```

Signal coding format. Possible values: PQ, HLG

```
                        <ColorSpace>RGB</ColorSpace>
```

Signal color space. Possible values: RGB, YCbCr…

```
                        <ColorPrimaries>BT.2020</ColorPrimaries>
```

Signal color primaries. Possible values: BT.709, BT.2020…Currently only BT.2020 is used

```
                        <SignalRange>Limited</SignalRange>
```

Signal Range. Possible Values: Full, Limited

```
                    </EncodingInfo>
                    <Cut cutID="cut_0001" time="00:00:00.00000" duration="00:08:00.00000"></Cut>
```

cutID: the id of the scene cut
time: the start time of the scene cut
duration:the duration of the scene cut, hour:minute:second:millisecond

```
                    <Cut cutID="cut_0002" time="00:08:03.00000" duration="00:08:05.05000"></Cut>
                </Track>
            </Video>
        </OutputStructure>
</HDRVividMeta>
```

A.1.2 XML encapsulation example of static metadata in statistical information mode

The static metadata in statistical information mode is the same as A.1.1, except that <TrimMode> is "Statistical"

A.2 XML encapsulation example of HDR dynamic metadata

A.2.1 XML encapsulation example of dynamic metadata in curve parameter mode

```
<UWAFrameData xmlns="http://www.theuwa.com/hdrvivid-dynamic/1_0_0>
    <UniqueID>b6ea0722-155f-4333-89b5-58999845e3de</UniqueID>
```

UniqueID of dynamic frame

```
    <DynamicMeta>
        <SystemStartCode>1</SystemStartCode>
```

8bit Integer, system version number, always set to 1 now

```
        <MinimumMaxrgb>139</MinimumMaxrgb>
```

12bit Integer, minimum brightness, ranging from 0 to 4095

```
        <AverageMaxrgb>1643</AverageMaxrgb>
```

12bit Integer, average brightness, ranging from 0 to 4095

```
        <VarianceMaxrgb>2859</VarianceMaxrgb>
```

12bit Integer, range of brightness change, ranging from 0 to 4095

<MaximumMaxrgb>3071</MaximumMaxrgb>

12bit Integer, maximum brightness, ranging from 0 to 4095

<TonemappingFlag>1</TonemappingFlag>

1bit Integer, whether metadata contains tone mapping parameters, always 1 for curve mode

<TonemappingCurveNumMinusOne>1</TonemappingCurveNumMinusOne>

1bit integer, the number of tone mapping curve sets minus 1. Possible Values: 0(one set of curve), 1(two sets of curve, HDR & SDR). Currently we have two sets of parameters in curve mode

<HDRCurveMeta>

<TargetedDisplayLuminance>3078</TargetedDisplayLuminance>

*12bit integer, mastering display luminance when generating the metadata, ranging from 0 to 4095. Calculation method: PQ value * 4095. E.g. 500nit -> PQ 0.6766 -> 2770*

<BaseCurveMeta>

<BaseCurveFlag>1</BaseCurveFlag>

1bit integer, the flag of HDR base curve, always set to 1 in curve mode

<BaseCurveMp>7260</BaseCurveMp>

4bit integer, HDR Base curve parameter m_p, ranging from 0 to 16383

<BaseCurveMm>24</BaseCurveMm> •

6bit integer, HDR Base curve parameter m_m, ranging from 0 to 63

<BaseCurveMa>825</BaseCurveMa>

10bit integer, HDR Base curve parameter m_a, ranging from 0 to 1023

<BaseCurveMb>0</BaseCurveMb>

10bit integer, *HDR Base curve parameter m_b, ranging from 0 to 1023*

<BaseCurveMn>10</BaseCurveMn>

6bit integer, HDR Base curve parameter m_n, ranging from 0 to 63

<BaseCurveK1>1</BaseCurveK1>

2bit integer, HDR Base curve parameter K1, ranging from 0 to 3

<BaseCurveK2>1</BaseCurveK2>

2bit integer, HDR Base curve parameter K2, ranging from 0 to 3

<BaseCurveK3>1</BaseCurveK3>

4bit integer, HDR Base curve parameter K3, ranging from 0 to 15

<BaseCurveDeltaMode>6</BaseCurveDeltaMode>

3bit integer, HDR Base curve parameters adaptation mode when display luminance does not equal to ‘TargetedDisplayLuminance

<BaseCurveDelta>28</BaseCurveDelta>

7bit integer, *HDR Base curve parameters adaptation value*

</BaseCurveMeta>

<CubicSplineCurveMeta>

<CubicSplineCurveFlag>1</CubicSplineCurveFlag>

1bit integer, the flag of HDR cubic splines, always set to 1 in curve mode

<CubicSplineNumMinusOne>1</CubicSplineNumMinusOne>

1bit integer, the number of HDR cubic splines minus 1. Possible Values: 0 (1 set of cubic spline), 1(2 set of cubic spline)

<LowAreaMode>0</LowAreaMode>

2bit integer, the mode of low light cubic spline, always set to 0

<LowSplineSlope>216</LowSplineSlope>

8bit integer, higher 6bit represents the slope of linear spline when mode is 0

<LowAreaTH>535</LowAreaTH>

12bit integer, the horizontal coordinate of the first anchor point in low light cubic spline

<LowAreaTHDelta1>306</LowAreaTHDelta1>

10bit integer, the offset from ‘LowAreaTH’. LowAreaTH2=LowAreaTH+LowAreaTHDelta1

<LowAreaTHDelta2>306</LowAreaTHDelta2>

10bit integer, the offset from ‘LowAreaTH2’. LowAreaTH3=LowAreaTH2+LowAreaTHDelta2

<LowAreaStrength>123</LowAreaStrength>

8bit integer, the modified strength of the low light cubic spline

<HighAreaMode>1</HighAreaMode>

2bit integer, the mode of high light cubic spline, Possible Values: 1, 2, 3

<HighAreaTH>1933</HighAreaTH>

2bit integer, the horizontal coordinate of the first anchor point in high light cubic spline

<HighAreaTHDelta1>562</HighAreaTHDelta1>

10bit integer, the offset from ‘HighAreaTH’. HighAreaTH2=HighAreaTH+HighAreaTHDelta1

<HighAreaTHDelta2>562</HighAreaTHDelta2>

10bit integer, the offset from ‘HighAreaTH2’. HighAreaTH3=HighAreaTH2+HighAreaTHDelta2

<HighAreaStrength>153</HighAreaStrength>

8bit integer, the modified strength of the high light cubic spline

</CubicSplineCurveMeta>

</HDRCurveMeta>

<SDRCurveMeta>

<TargetedDisplayLuminance>2080</TargetedDisplayLuminance>

12bit integer, mastering display luminance when generating the metadata, ranging from 0 to 4095. For SDR case, it always set to 100nit -> 0.508PQ -> 2080

<BaseCurveMeta>

<BaseCurveFlag>1</BaseCurveFlag>

1bit integer, the flag of SDR base curve, always set to 1 in curve mode

<BaseCurveMp>7260</BaseCurveMp>

14bit integer, SDR Base curve parameter m_p, ranging from 0 to 16383

<BaseCurveMm>24</BaseCurveMm>

6bit integer, SDR Base curve parameter m_m, ranging from 0 to 63

<BaseCurveMa>618</BaseCurveMa>

10bit integer, SDR Base curve parameter m_a, ranging from 0 to 1023

<BaseCurveMb>0</BaseCurveMb>

10bit integer, SDR Base curve parameter m_b, ranging from 0 to 1023

<BaseCurveMn>10</BaseCurveMn>

6bit integer, SDR Base curve parameter m_n, ranging from 0 to 63

<BaseCurveK1>1</BaseCurveK1>

2bit integer, SDR Base curve parameter K1, ranging from 0 to 3

<BaseCurveK2>1</BaseCurveK2>

2bit integer, SDR Base curve parameter K2, ranging from 0 to 3

<BaseCurveK3>1</BaseCurveK3>

4bit integer, SDR Base curve parameter K3, ranging from 0 to 15

<BaseCurveDeltaMode>6</BaseCurveDeltaMode>

3bit integer, SDR Base curve parameters adaptation mode when display luminance does not equal to 'TargetedDisplayLuminance'

<BaseCurveDelta>6</BaseCurveDelta>

7bit integer, *SDR Base curve parameters adaptation value*

</BaseCurveMeta>

<CubicSplineCurveMeta>

<CubicSplineCurveFlag>1</CubicSplineCurveFlag>

1bit integer, the flag of SDR cubic splines, always set to 1 in curve mode

<CubicSplineNumMinusOne>1</CubicSplineNumMinusOne>

1bit integer, the number of SDR cubic splines minus 1. Possible Values:

0 (1 set of cubic spline), 1(2 set of cubic spline)

<LowAreaMode>0</LowAreaMode>

2bit integer, the mode of low light cubic spline, always set to 0

<LowSplineSlope>128</LowSplineSlope>

8bit integer, higher 6bit represents the slope of linear spline when mode is 0

<LowAreaTH>535</LowAreaTH>

12bit integer, the horizontal coordinate of the first anchor point in low light cubic spline

<LowAreaTHDelta1>283</LowAreaTHDelta1>

10bit integer, the offset from 'LowAreaTH'. LowAreaTH2=LowAreaTH+LowAreaTHDelta1

<LowAreaTHDelta2>283</LowAreaTHDelta2>

10bit integer, the offset from 'LowAreaTH2'. LowAreaTH3=LowAreaTH2+LowAreaTH Delta2

<LowAreaStrength>126</LowAreaStrength>

8bit integer, the modified strength of the low light cubic spline

<HighAreaMode>2</HighAreaMode>

2bit integer, the mode of high light cubic spline, Possible Values: 1, 2, 3. If mode 2 is selected, another slope needs to be set in high light cubic spline

<HighSplineSlope>0</HighSplineSlope>

8bit integer, the slope of high light cubic spline (at HighAreaTH3) when mode is 2

<HighAreaTH>1933</HighAreaTH>

2bit integer, the horizontal coordinate of the first anchor point in high light cubic spline

<HighAreaTHDelta1>562</HighAreaTHDelta1>

10bit integer, the offset from 'HighAreaTH'. HighAreaTH2=HighAreaTH+HighAreaTHDelta1

<HighAreaTHDelta2>562</HighAreaTHDelta2>

10bit integer, the offset from 'HighAreaTH2'. HighAreaTH3=HighAreaTH2+HighAreaTHDelta2

<HighAreaStrength>140</HighAreaStrength>

8bit integer, the modified strength of the high light cubic spline

</CubicSplineCurveMeta>

</SDRCurveMeta>

<SaturationMeta>

<SaturationMappingFlag>1</SaturationMappingFlag>

1bit integer, indicate whether saturation adjustment parameters will be contained

<SaturationParamsNum>2</SaturationParamsNum>
3bt integer, indicate the number of saturation adjustment parameters.
<SaturationGain1>38</SaturationGain1>
8bit integer, indicate the first saturation adjustment strength
<SaturationGain2>24</SaturationGain2>
8bit integer, indicate the second saturation adjustment strength
</SaturationMeta>
</DynamicMeta>
<TrimSettings>
<HDRTrim>
<BlackLevelShift>0.00</BlackLevelShift>
The black level shift manual control for HDR. Legal data range: 0.00~1.00
<DarkOffset>0.00</DarkOffset>
The dark region offset manual control for HDR. Legal data range: -1.00~1.00
<DarkBrightness>0.00</DarkBrightness>
The dark region brightness manual control for HDR. Legal data range:-1.00~1.00
<DarkDetail>0.00</DarkDetail>
The dark region detail manual control for HDR. Legal data range:-1.00~1.00
<MidtoneBrightness>0.00</MidtoneBrightness>
The mid-tone brightness manual control for HDR. Legal data range:-1.00~1.00
<BrightOffset>0.00</BrightOffset>
he brightness region offset manual control for HDR. Legal data range:-1.00~1.00
<BrightBrightness>0.00</BrightBrightness>
The bright region brightness manual control for HDR. Legal data range:-1.00~1.00
<BrightDetail>0.00</BrightDetail>
The bright region detail manual control for HDR. Legal data range:-1.00~1.00
<HighlightCrop>0.00</HighlightCrop>
The high light crop manual control for HDR. Legal data range:-1.00~1.00
<GlobalSaturation>0.00</GlobalSaturation>
The global color saturation manual control for HDR. Legal data range:-1.00~1.00
<HighlightSaturation>0.00</HighlightSaturation>
The high light color saturation manual control for HDR. Legal data range:-1.00~1.00
</HDRTrim>
<SDRTrim>
<BlackLevelShift>0.00</BlackLevelShift>
The black level shift manual control for SDR. Legal data range: 0.00~1.00
<DarkOffset>0.00</DarkOffset>
The dark region offset manual control for SDR. Legal data range: -1.00~1.00
<DarkBrightness>0.00</DarkBrightness>
The dark region brightness manual control for SDR. Legal data range:-1.00~1.00
<DarkDetail>0.00</DarkDetail>
The dark region detail manual control for SDR. Legal data range:-1.00~1.00
<MidtoneBrightness>0.00</MidtoneBrightness>
The mid-tone brightness manual control for SDR. Legal data range:-1.00~1.00

<BrightOffset>0.00</BrightOffset>
The brightness region offset manual control for SDR. Legal data range:-1.00~1.00
<BrightBrightness>0.00</BrightBrightness>
The bright region brightness manual control for SDR. Legal data range:-1.00~1.00
<BrightDetail>0.00</BrightDetail>
The bright region detail manual control for SDR. Legal data range:-1.00~1.00
<HighlightCrop>0.00</HighlightCrop>
The high light crop manual control for SDR. Legal data range:-1.00~1.00
<GlobalSaturation>0.00</GlobalSaturation>
The global color saturation manual control for SDR. Legal data range:-1.00~1.00
<HighlightSaturation>0.00</HighlightSaturation>
The high light color saturation manual control for SDR. Legal data range:-1.00~1.00
</SDRTrim>
</TrimSettings>
<FrameNumber>103</FrameNumber>
</UWAFrameData>

A.2.2 XML encapsulation example of dynamic metadata in statistical information mode

<?xml version="1.0" encoding="UTF-8"?>
<UWAFrameData xmlns="http://www.theuwa.com/ hdrvivid-dynamic/1_0_0">
<UniqueID>b6ea0722-155f-4333-89b5-58999845e3de</UniqueID>
UniqueID of dynamic frame
<DynamicMeta>
<SystemStartCode>1</SystemStartCode>
8bit Integer, system version number, always set to 1 now
<MinimumMaxrgb>139</MinimumMaxrgb>
12bit Integer, minimum brightness, ranging from 0 to 4095
<AverageMaxrgb>1643</AverageMaxrgb>
12bit Integer, average brightness, ranging from 0 to 4095
<VarianceMaxrgb>2859</VarianceMaxrgb>
12bit Integer, range of brightness change, ranging from 0 to 4095
<MaximumMaxrgb>3071</MaximumMaxrgb>
12bit Integer, maximum brightness, ranging from 0 to 4095
<TonemappingFlag>0</TonemappingFlag>
1bit Integer, whether metadata contains tone mapping parameters, always 0 for statistical mode
<SaturationMappingFlag>0</SaturationMappingFlag>
1bit Integer, whether metadata contains saturation parameters, always 0 for statistical mode
</DynamicMeta>
<AutoAnalyze>
<Min>139</Min>
The manual adjusted value of MinimumMaxrgb for selected HDR Output
<Average>1643</Average>
The manual adjusted value of AverageMaxrgb for selected HDR Output
<Variance>2859</Variance>

The manual adjusted value of VarianceMaxrgb for selected HDR Output

<Max>3071</Max>

The manual adjusted value of MaximumMaxrgb for selected HDR Output

</AutoAnalyze>

<FrameNumber>103</FrameNumber>

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