UHD World Association
世界超高清视频产业联盟

HDR Video Technology Part 3-4

Technical Requirements and Test Methods

-Player Software

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Contents

High Dynamic Range Video Technology Part 3-4:

Technical Requirements and Test Methods – Player Software

1 Scope

This document stipulates the requirements and test methods for player software that supports the HDR technical standard specified in T/UWA 005.1-2022

This document applies to all types of player software that support the HDR technical standard specified in T/UWA 005.1-2022.

2 Normative References

The contents of the following documents referred as normative references constitute the indispensable provisions of this document. For dated references, only the version corresponding to the date applies to this document; for undated references, the latest version (including any amendment) applies.

SJ/T 11324 Terminology of Digital Television Receiving Equipment

GY/T 307-2017 Parameter values for ultra-high definition television systems for programme production and exchange

GY/T 315-2018 Image parameter values for high dynamic range television systems for programme production and exchange

T/UWA 005.1-2022 High Dynamic Range (HDR) Video Technology Part 1: Metadata and Tone Mapping

3 Terms and Definitions

In this document, the following terms and definitions apply.

3.1 HDR Vivid

HDR Vivid is the generic term for the HDR technical standard specified in T/UWA 005.1-2022 and any derivative technologies.

3.2 HDR Vivid Elementary Stream

HDR Vivid Elementary Stream refers to the video elementary streams that meet the standard specified in T/UWA 005.1-2022.

3.3 HDR Vivid Player Software

HDR Vivid player software parses and adjusts the video signal in accordance with T/UWA 005.1-2022 as standalone software and displays the image on a connected display device. Types of player software may include, but are not limited to, mobile phone apps, tablet apps, smart TV apps, PC apps, etc. In this document, HDR Vivid player software is referred to as player software.

3.4 HDR Vivid Player Software Equipped Display Device

A device that uses data transmitted by HDR Vivid player software for image display, referred to in this document as a display device.

3.5 Companion Device

Devices equipped with the HDR Vivid player software to be tested. Companion devices include mobile phones and tablets.

3.6 Statistics Mode

The dynamic metadata mode which only includes the statistical information.

3.7 Curve Parameter Mode

The dynamic metadata mode which includes base curve parameters, target display reference luminance, refined curve parameters, and cubic spline adjustment parameters, in addition to statistical information.

3.8 Reference Software

Software that calculates reference values in accordance with T/UWA 005.1-2022.

4 Abbreviations

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

EOTF Electro-Optical Transfer Function

HDR High Dynamic Range

OETF Opto-Electrical Transfer Function

PQ Perceptual Quantizer

5 Technical Requirements

5.1 Platforms

The player software should be able to run on one or more common software platforms, such as Windows, macOS, CentOS, iOS, Android, and HarmonyOS.

5.2 Supported Signal Formats

The player software should, at least, support all the signal formats specified in Table 1.

Table 1 Supported Signal Formats and Technical Requirements

No.	Format	Unit	Technical Requirements
1	Resolution	Pixel	1920 × 1080
2	Frame rate	Hz	50 and 60
3	Scanning mode	-	Progressive
4	Precision of quantization	bit	10
5	Color gamut	-	Complies with the specification in 3.3 of GY/T 307-2017
6	Transfer functions	-	Complies with the specification in 4.4 of

			GY/T 315-2018
7	Metadata	-	Complies with T/UWA 005.1-2022

5.3 Video Decoding

The player software should be able to support one or more video encoding formats, such as AVS2, AVS3, HEVC, VVC, VP9, and AV1.

5.4 Display Function Requirements for Player Software

Table 2 lists the display function requirements for the player software.

Table 2 Function Requirements for Display Device

No.	Function	Technical Requirements
1	Automatic switching to HDR Vivid mode	The display device automatically switches to HDR Vivid mode when it receives the HDR Vivid signals.
2	HDR Vivid visual identification*	In the test mode, a menu or other means are provided to check whether the received signal is HDR Vivid signal.
Note: *This requirement must be met by December 31, 2021.		

5.5 Dynamic Metadata Processing

5.5.1 Calculation of Conversion Curve Parameters

The player software calculates the color dynamic adjustment curve based on the target device feature parameters and HDR Vivid dynamic metadata according to T/UWA 005.1-2022 9.1, 9.2 and 9.3, including linear spline curve, cubic spline curve and base curve, and the error between each parameter of the curve and the parameter calculated by HDR Vivid reference software is less than the preset threshold T_1, where T_1=0.001, see Table 3 for specific requirements, where t_i is the parameter value calculated by the player software, r_i is the parameter value calculated by HDR Vivid reference software, and ABS indicates calculation in absolute value.

Table 3 Technical Requirements for Color Signal Dynamic Conversion Curve Parameter Accuracy

Curve	Parameter	Value Calculated by the Player software	Value Calculated by the Reference Software	Technical Requirements
Linear Spline Curve	TH3[0]	t_0	r_0	$ABS(r_0 - t_0) \ll T_1$
	MB[0][0]	t_1	r_1	$ABS(r_1 - t_1) \ll T_1$
	base_offset	t_2	r_2	$ABS(r_2 - t_2) \ll T_1$

Table 3 (Continued)

Cubic Spline Curve	TH1[1]	t_3	r_3	$ABS(r_3 - t_3) \ll T_1$
	TH2[1]	t_4	r_4	$ABS(r_4 - t_4) \ll T_1$
	TH3[1]	t_5	r_5	$ABS(r_4 - t_4) \ll T_1$
	MA[0][1]	t_6	r_6	$ABS(r_6 - t_6) \ll T_1$
	MB[0][1]	t_7	r_7	$ABS(r_7 - t_7) \ll T_1$
	MC[0][1]	t_8	r_8	$ABS(r_8 - t_8) \ll T_1$
	MD[0][1]	t_9	r_9	$ABS(r_9 - t_9) \ll T_1$
	MA[1][1]	t_{10}	r_{10}	$ABS(r_{10} - t_{10} \ll T_1$
	MB[1][1]	t_{11}	r_{11}	$ABS(r_{11} - t_{11}) \ll T_1$
	MC[1][1]	t_{12}	r_{12}	$ABS(r_{12} - t_{12}) \ll T_1$
	MD[1][1]	t_{13}	r_{13}	$ABS(r_{13} - t_{13}) \ll T_1$
Base Curve	m_p	t_{14}	r_{14}	$ABS(r_{14} - t_{14}) \ll T_1$
	m_m	t_{15}	r_{15}	$ABS(r_{15} - t_{15}) \ll T_1$
	m_n	t_{16}	r_{16}	$ABS(r_{16} - t_{16}) \ll T_1$
	m_a	t_{17}	r_{17}	$ABS(r_{17} - t_{17}) \ll T_1$
	m_b	t_{18}	r_{18}	$ABS(r_{18} - t_{18}) \ll T_1$
	K1	t_{19}	r_{19}	$ABS(r_{19} - t_{19}) \ll T_1$
	K2	t_{20}	r_{20}	$ABS(r_{20} - t_{20}) \ll T_1$
	K3	t_{21}	r_{21}	$ABS(r_{21} - t_{21}) \ll T_1$
Cubic Spline Curve	TH1[2]	t_{22}	r_{22}	$ABS(r_{22} - t_{22}) \ll T_1$
	TH2[2]	t_{23}	r_{23}	$ABS(r_{23} - t_{23}) \ll T_1$
	TH3[2]	t_{24}	r_{24}	$ABS(r_{23} - t_{23}) \ll T_1$
	MA[0][1]	t_{25}	r_{25}	$ABS(r_{25} - t_{25}) \ll T_1$
	MB[0][1]	t_{26}	r_{26}	$ABS(r_{26} - t_{26}) \ll T_1$
	MC[0][1]	t_{27}	r_{27}	$ABS(r_{27} - t_{27}) \ll T_1$
	MD[0][1]	t_{28}	r_{28}	$ABS(r_{28} - t_{28}) \ll T_1$
	MA[1][1]	t_{29}	r_{29}	$ABS(r_{29} - t_{29}) \ll T_1$
	MB[1][1]	t_{30}	r_{30}	$ABS(r_{30} - t_{30}) \ll T_1$
	MC[1][1]	t_{31}	r_{31}	$ABS(r_{30} - t_{30}) \ll T_1$
	MD[1][1]	t_{32}	r_{32}	$ABS(r_{32} - t_{32}) \ll T_1$

5.5.2 Image Adaption

The average error between the image *test* calculated by the player software and the reference image *ref* calculated by the HDR Vivid reference software is less than a preset threshold of 2, according to the adaptation process specified in T/UWA 005.1-2022, 9.4 and 9.5.

5.5.3 Output of Player Software Test Information

The player software should have the test mode, which can identify the HDR Vivid elementary stream and output the following two parts of information based on the dynamic metadata in the HDR Vivid elementary stream and the maximum and minimum luminance of the target device:

1) the parameters of the dynamic range adjustment curve calculated in accordance with T/UWA 005.1-2022, 9.1, 9.2 and 9.3, and the format of the parameter output is shown in (1),

$$\text{cuva\_tm\_params}=t_0:t_2:\ldots:t_{32} \quad (1)$$

where *t0* to *t32* are the parameters defined in Table 2 and are floating-point types with a precision of 6 decimal places.

2) image data obtained from the first frame following the HDR Vivid dynamic metadata in the test elementary stream after performing color signal dynamic range conversion and color correction calculation in accordance with T/UWA 005.1-2022, 9.4 and 9.5, and the pixel values of image *r, g* and *b* are output in the order from left to right in the format shown in (2),

$$p_{j,1}^{r}\ldots p_{j,i}^{r}\ldots p_{j,W}^{r}p_{j,1}^{g}\ldots p_{j,i}^{g}\ldots p_{j,W}^{g}p_{j,1}^{b}\ldots p_{j,i}^{b}\ldots p_{j,W}^{b} \quad (2)$$

where $p_{j,i}^{r}$ is the pixel value of the jth row and the ith column of the image, the type is floating point, the precision is 6 decimal places. *r, g* and *b* correspond to the three primary colors. *W* and *H* are the width and height of the test video, respectively.

5.6 Display Performance Recommendations for Software-Equipped Device

It is recommended that the HDR Vivid player software is used with display devices that meet the performance requirements specified in Table 4.

Table 4 Display Performance Recommendations

No.	Parameter	Unit	Technical Requirements
1	Peak brightness (10% white window)	cd/m^2	≥ 450
2	Stable peak brightness (5%, 10% and 20% white window)	cd/m^2	≥ 450
3	Lowest black level	cd/m^2	≤ 0.5
4	Dynamic luminance range	%	≥ 30
5	Color gamut overlap (BT.2020)	%	≥ 60
6	D65 white balance	-	Δu ≤ 0.01 Δv ≤ 0.01
7	Display quantization precision	Bit	≥ 8

5.7 HDR Vivid Video Restoration

The video restoration requirements for companion devices are shown in Table 5.

Table 5 Video Restoration Recommendations

No.	Function	Technical Requirements
1	Video in statistics mode	No obvious flickering, no obvious distortion of color and luminance.
2	Video in curve parameter mode	No obvious flickering, no obvious distortion of color and luminance.

5.8 Device Adaption

The player software should be adapted to at least one playback device.

If the hardware to which the software is adapted is a display device, it should meet the requirements of Table 6.

Table 6 Dynamic Metadata Processing Requirements

No.	Item		Unit	Technical Requirements	
1	Curve parameter mode	Luminance deviation	%	Input luminance (L_0/nit) < 100	≤ 20%
				100 ≤ L0 < 1000	≤ 15%
				1000 ≤ L0 ≤ 4000	≤ 10%
		Chroma deviation (Δu', Δv')	-	Skin color	≤ 0.02
				Sky color	≤ 0.02
				Floral color	≤ 0.02

If the hardware to be adapted is a playback device without display function, refer to the processing accuracy requirements of Monitor Mode under the standard profile in "High Dynamic Range (HDR) Video Technology Part 3-3: Technical Requirements and Test Methods for Playback Devices".

6 Test Conditions

6.1 Environmental Conditions

Testing should be performed under the following standard atmospheric conditions:

- Temperature: 15°C ~ 35°C
- Relative humidity: 25% to 75%
- Atmospheric pressure: 86kPa~106kPa

6.2 Test Signal

The requirements in section 5.2 should apply to the test signals. Descriptions of the elementary streams can be found in Appendix A.

6.3 Player Software and Display Device Settings

Set the player software to HDR Vivid mode. Disable the auto illuminance adjustment function of the companion device, and disable the auto image enhancement function and other automatic image quality adjustment functions of the device. If the device supports backlight adjustment, set it to maximum brightness.

6.4 Companion Device

The hardware platform used in the test should be capable of running the player software and have a display function.

If the target hardware platform (such as the STB) of the player software does not have a display function, an additional display device that is compliant with the HDR Vivid standard should be connected.

During the test, the companion device or devices shall be powered by batteries or connected to power supply. If a battery-powered device is used, the battery level during the test shall be no lower than 50%.

7 Test Methods

7.1 Operating Platform

7.1.1 Overview

The purpose of this test is to ascertain whether the player software is supported by the operating platform.

7.1.2 Test Conditions

Test signals: HDR Vivid color bar elementary streams as specified in 6.2.

7.1.3 Test Procedure

a) Install the player software on the companion device.

b) Play the HDR Vivid color bar elementary streams.

c) Check whether the display device functions properly.

7.1.4 Result

The two possible test results are Supported and Not Supported, and the name and version of the operating platform should be recorded.

7.2 Supported Signal Format Test

7.2.1 Overview

The purpose is to test the signal format supported by the player software.

7.2.2 Test Conditions

Test signals: The video elementary streams specified in 6.2.

7.2.3 Test Procedure

a) Adjust the companion device as specified in 6.3.

b) Play the color bar test signals specified in 5.2 using the player software specified in 6.4.

c) Check whether the display function is normal.

7.2.4 Result

The two possible test results are Supported and Not Supported.

7.3 Decoding Function Test

7.3.1 Overview

The purpose is to test the HDR stream decoding performance.

7.3.2 Test Conditions

Video test signals: The video test streams specified in 5.2.

7.3.3 Test Procedure

a) Adjust the companion device as specified in 6.3.

b) Play the video streams in sequence using the player software.

c) Check whether the streams can be decoded and displayed.

7.3.4 Result

The two possible test results are Supported and Not Supported.

7.4 Function Requirements Test

7.4.1 Automatic Switch to HDR Vivid Mode

7.4.1.1 Overview

The purpose is to test whether HDR Vivid mode is automatically enabled after an HDR Vivid signal is received.

7.4.1.2 Test Conditions

Video test signals: The HDR Vivid color bar elementary streams specified in 5.2. The video compression and encoding format is the encoding format supported by the player software.

7.4.1.3 Test Procedure

a) Adjust the companion device as specified in 6.3.

b) Play the HDR Vivid elementary streams using the player software.

c) Check whether HDR Vivid mode is automatically enabled.

7.4.1.4 Result

The two possible test results are Supported and Not Supported.

7.4.2 Test of HDR Vivid Visual Identification

7.4.2.1 Overview

The purpose of this section is to ascertain whether visual identification function is enabled when an HDR Vivid signal is received.

7.4.2.2 Test Conditions

Video test signals: The HDR Vivid elementary streams specified in 5.2.

7.4.2.3 Test Procedure

a) Adjust the companion device as specified in 6.3.

b) Enable automatic switch to HDR Vivid mode.

c) Play the HDR Vivid elementary streams.

d) Check whether a menu is displayed to indicate that the current signal format is HDR Vivid.

7.4.2.4 Result

The two possible test results are Supported and Not Supported.

7.5 Dynamic Metadata Processing

7.5.1 Conversion Curve Parameter Calculation

7.5.1.1 Overview

The purpose of this test is to ascertain whether the curve parameter calculation for color signal dynamic range conversion by the player software is accurate.

7.5.1.2 Test Conditions

Test signal in statistics mode: 10% window signal with the background luminance at 0 cd/m^2 (corresponding code value is 0/0/0). The input values for each component of the window signal are shown in Table 7.

Table 7 Luminance Test Signal (Nonlinear Full-Range PQ RGB Signal)

Luminance Test Signal		PQ RGB Code Value (10-bit, BT.2020 Gamut)		
No. [k]	Input Luminance (cd/m^2)	R Signal	G Signal	B Signal
1	401.5059	668	668	668

Dynamic metadata settings: Three sets of dynamic metadata are applied in the test:

- Set 1
- Set 2
- Set 3

For details about the dynamic metadata in each set, see Appendix A.1.

Figure 1 is the sample test image.

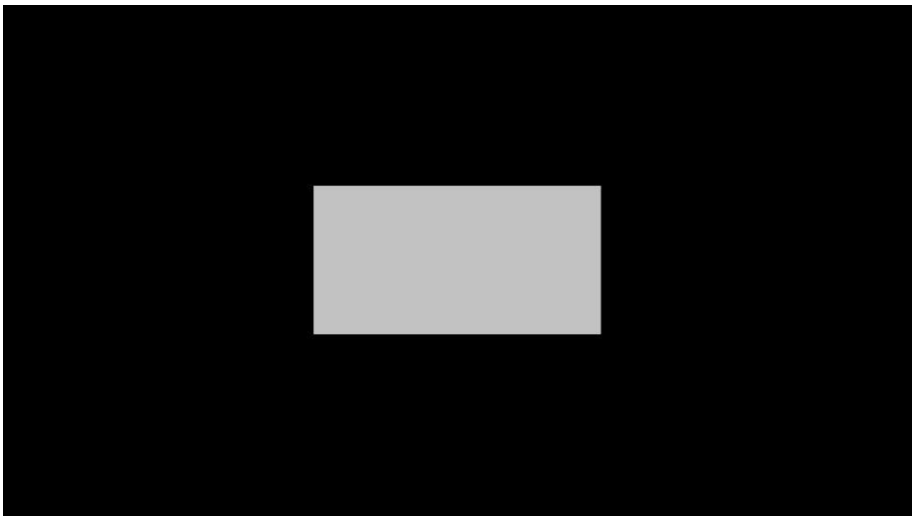

Figure 1 Input Luminance at 401.5059 cd/m^2

Test signal in curve parameter mode: 10% window signal with the background luminance at 0 cd/m^2 (corresponding code value is 0/0/0). The input values for each component of the window signal are shown in Table 4.

Three sets of dynamic metadata are applied in the curve parameter mode:

- Set 4
- Set 5
- Set 6

For details about dynamic metadata in each set, see Appendix A.2.

1.5.1.3 Test Procedure

1) The player software to be tested enters the debug mode, and reads the test samples through local storage or a network connection.
2) Play the test signal on the player software and output the dynamic range conversion curve parameters as specified in 5.5.3 (1).

3) The HDR Vivid reference software reads the test samples though local storage or a network connection.
4) Play the test samples on the HDR Vivid reference software.
5) Output the dynamic range conversion curve parameters as specified in 5.5.3 (1).
6) Based on the data output in (2) and (5), calculate the differences between the parameters output by the tested software and those output by the reference software according to the technical requirements in Table 2.

7.5.1.4 Result

Take the largest discrepancy between the output by the player software and that by the reference software as the final result.

7.5.2 Image Adaptation

7.5.2.1 Overview

The purpose of this test is to ascertain whether the image adaptation of the player software functions correctly.

7.5.2.2 Test Conditions

Test signals in statistics mode: 10% window signals with the background luminance at 0 cd/m^2 (code value is 0/0/0). The input values for each component of the window signals are shown in Table 8.

Table 8 Luminance Test Signals (Nonlinear Full-Range PQ RGB Signals)

Luminance Test Signals		RGB Code Value in PQ Gamut (10-bit, BT.2020 Gamut)		
No. [k]	Input Luminance (cd/m^2)	R Signal	G Signal	B Signal
1	49.7907	450	450	450
2	100.2301	520	520	520
3	199.1536	592	592	592
4	401.5059	668	668	668
5	998.9344	769	769	769
6	3987.9926	923	923	923

Dynamic metadata settings: Three sets of dynamic metadata are applied in the test:

- Set 1
- Set 2
- Set 3

For details about dynamic metadata in each set, see Appendix A.1.

Figure 2 is the sample test image.

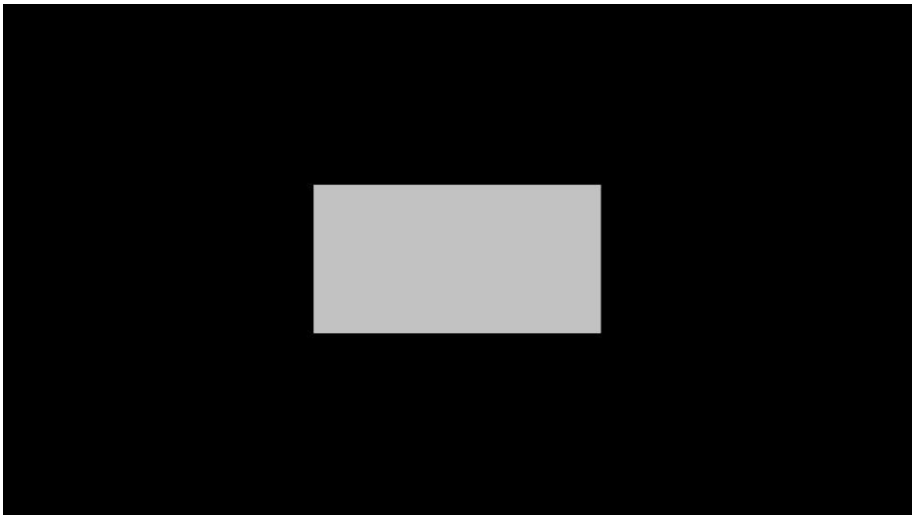

Figure 2 Input Luminance at 49.7907 cd/m^2

Test signals in curve parameter mode: 10% window signals with the background luminance at 0 cd/m^2 (code value is 0/0/0). The input values for each component of the window signals are shown in Table 8.

Three sets of dynamic metadata are applied in the curve parameter mode:

- Set 4
- Set 5
- Set 6

For details about dynamic metadata in each set, see Appendix A.2.

7.5.2.3 Test Procedure

1) The player software to be tested enters the debug mode, and reads the test samples through local storage or a network connection.
2) Play the test signal.
3) Output the pixel value of the Line $H/2$ after color signal dynamic range conversion, as specified in 5.5.3 (2);
4) The HDR Vivid reference software reads test samples through local storage or a network connection.
5) Play the test signals on the HDR Vivid reference software.
6) For the 10 consecutive frames of the image, output the pixel value of the Line $H/2$ after color signal dynamic range conversion, as specified in 5.5.3 (2).

Based on the data output in (3) and (6), obtain the deviation of color signal dynamic range conversion.

$$d = \sum_{c=\{r,g,b\}} \sum_{i=1}^{W} ABS(test^{c}_{(H/2,i)} - ref^{c}_{(H/2,i)})/(W \times 3) \quad (3)$$

Where r, g, and b correspond to three primary colors, and W and H indicate the width and height of the tested image.

7.5.2.4 Result

If the average deviation of color signal dynamic range conversion in statistics mode and curve parameter mode is less than 2, the calculation result is deemed accurate.

7.6 Video Restoration

7.6.1 Overview

The purpose of this test is to ascertain whether HDR Vivid video restoration is supported by the player software.

7.6.2 Test Conditions

Test signals: As specified in 6.2, (1) video elementary streams with the HDR Vivid dynamic metadata that only contains statistical information; and 2) video elementary streams with the HDR Vivid dynamic metadata that contains curve parameter information.

7.6.3 Test Procedure

a) Adjust the player device as specified in 6.3.
b) Using the player software, play the video elementary streams with the HDR Vivid dynamic metadata that only contains statistical information.
c) Check whether there is visible flickering, distorted color or unstable luminance.
d) Play the video elementary streams with the HDR Vivid dynamic metadata that contains curve parameter information using the player software.
e) Check whether there is visible flickering, distorted color or unstable luminance.

7.6.4 Result

The two possible test results are Supported and Not Supported.

7.7 Terminal Device

If the terminal device is a display device, see T/UWA 005.3-2-2022 7.6.2 for test methods.

If the adaptation device is a player device, see T/UWA 005.3-3-2022 9.3.4 for test methods.

Appendix A (Standard) Dynamic Metadata Configuration Parameters

A.1 Configuration under the Statistics Mode

The dynamic metadata only contains statistical information, and relevant settings are as follows in Table A.1:

Table A.1 Dynamic Metadata Configuration under the Statistics Mode

Dynamic Metadata	Set 1	Set 2	Set 3
system_start_code	1	1	1
minimum_maxrgb_pq	0	0	0
average_maxrgb_pq	1893	2309	3047
variance_maxrgb_pq	4055	3583	2103
maximum_maxrgb_pq	4094	4094	4094
tone_mapping_enable_mode	0	0	0
color_saturation_mapping_flag	1	1	1
color_saturation_num	2	2	2
color_saturation_gain[0]	38	38	38
color_saturation_gain[1]	25	25	25

A.2 Configuration under the Curve Parameter Mode

The dynamic metadata contains curve parameter information (base curve parameters, reference luminance, corrected curve parameters, and cubic spline adjustment). See Table A.2. for relevant settings:

Table A.2 Dynamic Metadata Configuration under the Curve Parameter Mode

Dynamic Metadata	Set 4	Set 5	Set 6
system_start_code	1	1	1
minimum_maxrgb_pq	0	0	0
average_maxrgb_pq	1893	2309	3047
variance_maxrgb_pq	4055	3583	2103
maximum_maxrgb_pq	4094	4094	4094
tone_mapping_enable_mode	1	1	1
tone_mapping_param_enable_num	1	1	0
targeted_system_display_maximum_luminance_pq[0]	2770	2770	2770
base_enable_flag[0]	1	1	1
base_param_m_p[0]	9241	8871	8217
base_param_m_m[0]	24	24	24
base_param_m_a[0]	750	723	707
base_param_m_b[0]	0	0	0
base_param_m_n[0]	10	10	10
base_param_K1[0]	1	1	1
base_param_K2[0]	1	1	1
base_param_K3[0]	1	1	1

Table A.2 (Continued)

Dynamic Metadata	Set 4	Set 5	Set 6
base_param_Delta_enable_mode[0]	1	1	1
base_param_enable_Delta[0]	16	8	0
3Spline_enable_flag[0]	1	1	1
3Spline_enable_num[0]	1	1	1
3Spline_TH_enable_mode[0][0]	0	0	0
3Spline_TH_enable_MB[0][0]	224	204	176
3Spline_TH_enable[0][0][0]	368	599	1007
3Spline_TH_enable_Delta1[0][0]	267	271	139
3Spline_TH_enable_Delta2[0][0]	534	391	279
3Spline_enable_Strength[0][0]	127	127	114
3Spline_TH_enable_mode[1][0]	1	1	1
3Spline_TH_enable[1][0]	2715	2855	3499
3Spline_TH_enable_Delta1[1][0]	613	613	291
3Spline_TH_enable_Delta2[1][0]	613	613	291
3Spline_enable_Strength[1][0]	165	165	165
targeted_system_display_maximum_luminance_pq[1]	2080	2080	NA
base_enable_flag[1]	0	0	NA
3Spline_enable_flag[1]	1	1	NA
3Spline_enable_num[1]	0	0	NA
3Spline_TH_enable_mode[0][1]	1	1	NA
3Spline_TH_enable[0][1]	1973	2783	NA
3Spline_TH_enable_Delta1[0][1]	794	819	NA
3Spline_TH_enable_Delta2[0][1]	1023	491	NA
3Spline_enable_Strength[0][1]	127	127	NA
color_saturation_mapping_flag	1	1	1
color_saturation_num	2	2	2
color_saturation_gain[0]	38	38	38
color_saturation_gain[1]	25	25	25