UHD World Association
世界超高清视频产业联盟

HDR Video Technology Part 3-1

Technical Requirements and Test Methods

-Display Device

（Version NO. 1.1）

Release Time
2023-04-20

UHD World Association (UWA)
T/UWA 005.3-1-2023

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HDR Video Technology Part 3-1:

Technical Requirement and Test Method - Display Device

1 Scope

This technical specification stipulates HDR display technical requirements and test methods for display devices or systems (hereinafter referred to as "display devices") that support the HDR Vivid standard.

This technical specification applies to display devices that support various HDR Vivid technologies.

2 Normative References

The following documents are indispensable for the application of this technical specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 26270-2010 Standard Test Signals for Digital Television Receiving Equipment

SJ/T 11324 Terminology of Digital Television Receiving Equipment

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

GY/T 315-2018 Image parameter values for high dynamic rang television for use in production and programme exchange

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

T/UWA 005.2-1-2022 High Dynamic Range (HDR) Video Technology Part 2-1: Application Guidelines - System Integration

UWA-TC-HDR-302 Specification for Use of HDR Vivid Visual Recognition V1.0

3 Terms and Definitions

For the purpose of this document, the terms and definitions given in SJ/T 11324, T/UWA 005.1 and T/UWA 005.2-1 and in the following apply.

3.1 HDR Vivid

An HDR technical standard provided in T/UWA 005.1. It is the generic term for derivative technologies of the same.

3.2 HDR Vivid Playback Device

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

3.3 HDR Vivid Display Device

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

3.4 Statistics Mode

The mode that the dynamic metadata only contains the statistics.

3.5 Curve Parameter Mode

In addition to the statistics, the mode that the dynamic metadata also includes the maximum brightness of the

reference target display, base curve parameters, cubic spline curve parameters, cubic spline curve adjustment parameters, and color correction parameters.

4 Abbreviations

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

EOTF Electro-Optical Transfer Function
HDR High Dynamic Rang
HLG Hybrid Log-Gamma
OETF Opto-Electrical Transfer Function
PQ Perceptual Quantizer

5 Technical Requirements

5.1 Interfaces

The display device should have at least one of digital video input interface, video stream input interface, or video file input interface.

5.2 Supported Signal Formats

The display device should support signal formats specified in Table 1 at least.

Table 1 Supported Signal Formats and Technical Requirements

No.	Format	Unit	Technical Requirement
1	Resolution	Pixel	3840×2160
2	Frame rate	Hz	50 and 60
3	Scanning mode	-	Progressive
4	Quantization accuracy	bit	10
5	Color gamut	-	Support 3.3 of GY/T 307-2017
6	Transfer functions	-	Support the PQ and HLG system reference nonlinear transfer function in 4.4 of GY/T 315-2018
7	Metadata	-	Support T/UWA 005.1

5.3 Decoding Function Requirements

The device should support HDR Vivid streams decoding in formats of HEVC, AVS2, or other formats, if it is provided with video stream or file input interface.

5.4 Function Requirements

The function requirements for the display device are shown in Table 2.

Table 2 Function Requirements

No.	Function	Technical Requirement
1	HDR Vivid display auto adaptation	1）By default, the display device should automatically adapt to the HDR Vivid display when it receives the HDR Vivid signal.

2	HDR Vivid visual identification	1）After receiving the HDR Vivid signal and adapting to the HDR Vivid display, the display device should automatically display the logo or text (“菁彩HDR” in Chinese or “HDR Vivid”) specified in UWA-TC-HDR-302 for at least 3s, or provide a menu for display. 2）The device should not display HDR Vivid identification if it does not receive the HDR Vivid signal or is not in HDR Vivid display mode.
3	Switch between different video signal formats	When switching between HDR Vivid and other signal formats, the display device maintains stable display without any noticeable flicker or other abnormal effects.
4	Digital video input interface adaptation mode	If the display device has a digital video input interface, at least one digital video input interface should support HDR Vivid format, and at least one of the two adaptation modes should be supported, receiver adaptation mode and monitor adaptation mode.

5.5 Display Performance Requirements

See Table 3 for display performance requirements for the display device.

Table 3 Display Performance Requirements

No.	Parameter	Unit	Technical Requirement
1	Peak luminance (10% white window)	cd/m^2	≥ 300
2	Stable peak luminance	cd/m^2	≥ 300
3	Lowest black level	cd/m^2	≤ 0.1
4	Dynamic luminance range:	%	≥ 35
5	Contrast	-	≥ 400:1
6	Color gamut overlap (BT2020)	%	≥ 50
7	D65 white balance	-	Δu ≤ 0.01 Δv ≤ 0.01
8	Display quantization accuracy	bit	≥ 8 bits if the peak luminance is 300-800 cd/m^2 ≥ 10 bits if the peak luminance is equal to or higher than 800 cd/m^2

5.6 Dynamic Metadata Processing Requirements

Dynamic metadata processing should meet the requirements of Table 4.

Table 4 Dynamic Metadata Processing Requirements

No.	Item		Unit	Technical Requirement	
1	Statistics mode	Luminance deviation	%	Input luminance (L_0/nit) < 100	≤ 20%
				100 <= L_0 < 1,000	≤ 15%
				1,000 <= L_0 <= 4,000	≤ 10%
2	Curve parameter mode	Luminance deviation	%	Input luminance (L_0/nit) < 100	≤ 20%
				100 <= L_0 < 1,000	≤ 15%
				1,000 <= L_0 <= 4,000	≤ 10%
		Chroma deviation	-	Skin color	≤ 0.02

		(Δu', Δv')		Sky color	≤ 0.04
				Plant color	≤ 0.04
3	Metadata synchronization		-	Support	
4	HDMI interface	Requirements for EDID information of HDMI	-	Mode identification in VS-VDB is correct.	

As specified in T/UWA 005.1-2022, HDR Vivid dynamic metadata is processed in two modes, namely statistics mode and curve parameter mode. In statistics mode, metadata is formatted and transmitted as statistics. After the terminal device receives the statistics, it generates tone mapping curves and processes the corresponding images in accordance with the method specified in T/UWA 005.1-2022. In curve parameter mode, metadata is formatted and transmitted as tone mapping curves. The statistics mode will be replaced by the curve parameter mode if curve parameters are included in the dynamic metadata. In other words, the curve parameter mode has higher priority.

When the display device works in the monitor adaptation mode, the dynamic metadata processing should meet the requirements in Table 5.

Table 5 Dynamic Metadata Processing Requirements for Monitor Adaptation Mode

No.	Item		Unit	Technical Requirement	
1	Curve parameter mode	Luminance deviation (Scenario 5)	%	Input luminance (L0/nit) ＜ 100	≤20%
			%	100≤ L0＜1000 100 ≤ L0 ＜ 1000	≤15%
				1000≤ L0≤4000 1000 ≤ L0 ≤ 4000	≤10%
		Chroma deviation (Scenario 5) (Δu', Δv')	— -	Skin color	≤0.02
				Sky color	≤0.04
				Plant color	≤0.04
2	HDMI interface test	Requirements for EDID information of HDMI	— -	Mode identification in VS-VDB is correct. The maximum and minimum brightness fields are correct	

6 Test Conditions

6.1 Environment

6.1.1 Atmospheric Conditions

The display device should be tested under standard atmospheric conditions as specified below.

—— Temperature: 15°C to 35°C~~, preferably 20°C~~

—— Humidity: 25% RH to 75% RH

—— Atmospheric pressure: 86 kPa to 106 kPa

6.1.2 Power Supply

The performance of the display device should be tested under the rated voltage, and the change of voltage should not exceed ±2% during the test. When using AC power supply, the frequency fluctuation of the power supply should be controlled within ±2%, and the harmonic component within ±5%.

6.1.3 Warming-up

The display device is turned on and warmed up for 15 minutes at default settings before the test starts. This is to prevent the performance stability from significant changes during testing over time.

6.1.4 Test Conditions

The display performance should be tested in a dark room, where the stray light illuminance on the screen surface of the display device is equal to or less than 0.01 lx when the device is turned off.

6.2 Test Signal

The requirements provided in 5.2 apply for the test signal, and the decoding requirements provided in 5.3 apply for the test stream.

6.3 Test Instruments

6.3.1 Luminance Meter and Colorimeter

The luminance meter is used to test the brightness of a small area on the screen. The test range should be from 0.001 cd/m^2 to 5,000 cd/m^2 and the test accuracy should be ±3%.
The colorimeter should be able to test the chromaticity coordinates (x, y) or (u', v') of a small area on the screen, when the luminance is lower than 2 cd/m^2. Spectroscopic colorimeter is recommended for testing and the test accuracy should meet ±0.003.

6.3.2 Video Signal Generator

The video signal generator should generate test signals as specified in 6.2, and the interface of the generator should meet the requirements of 5.1.

6.4 Test Interfaces

If the device under test has different types of signal input interfaces, the test interfaces are divided into main test interfaces and verification test interfaces. One of the interfaces is chosen as the main test interface in this priority: 1) video file input interface; 2) video stream input interface; and 3) digital video input interface. The verification test interface is the digital video input interface.
If the display device has only one type of test interface, only items related to that interface are tested.
See Table 6 for test items and corresponding test interfaces.

Table 6 Test Interfaces

No.	Test Item		Test Interface
1	Interface		All interfaces.
2	Supported signal formats		1) Main test interface, 2) verification test interface.
3	Decoding		Video file or video stream input interface.
4	Function requirements	Automatic switch to HDR Vivid display mode	1) Digital video input interface, 2) video stream input interface.
		HDR Vivid visual identification	1) Main test interface, 2) verification test interface.
		Switch between different signal formats	
		Digital video input interface adaptation mode	1) Digital video input interface
5	Display performance		Main test interface.
6	Dynamic	Statistics mode	1) The main test interface should be tested in all

	metadata		scenarios. 2) The verification test interface should be tested in scenario 2.
		Curve parameter mode	1) The main test interface should be tested in all scenarios. 2) The verification test interface should be tested in scenario 5.
		Metadata synchronization	1) Main test interface, 2) verification test interface.
		HDMI test	1) Digital video input interface.

6.5 Adjustment of Working Status

Unless otherwise specified, the working status of the display device is adjusted for testing in following steps:

6.5.1 Initialize the status.

Reset image settings of the display device to default.
Otherwise, set the image mode to standard, and set other menus to the original settings after the device is powered on.

6.5.2 Adjust the working status.

The display device is tested in HDR Vivid display mode.

6.5.3 Disable automatic environment adjustment.

Before the test, the test personnel should manually disable the automatic environment adjustment functions to avoid the influence on the test result accuracy. These functions include but are not limited to ambient light adaptation (automatic screen brightness adjustment based on the ambient brightness) and ambient color temperature adaptation (automatic adjustment of the screen color temperature based on the ambient color temperature).

6.6 Position of Test Instruments

The optical axis of the optical test instrument should be perpendicular to the center of the display screen. If spectroscopic luminance meter and spectroscopic colorimeter are used, the test distance should be 1.5 times the screen height of the display device. The figure below shows the position of the test instrument.

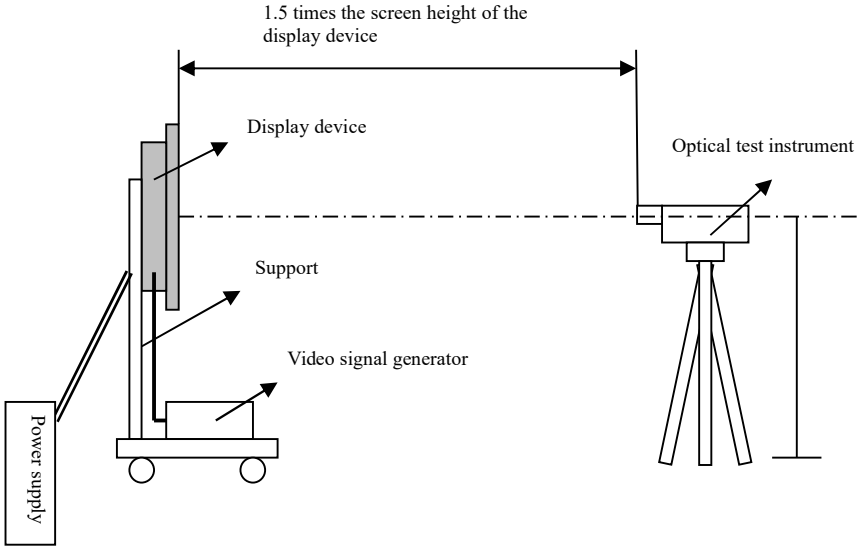

Figure 1 Position of Test Instrument

7 Test Methods

7.1 Interface Test

7.1.1 Overview

This section specifies the test of interface types supported by the display device.

7.1.2 Test Conditions

Video signal generator: generates test color bar and outputs it through interfaces specified in 5.1.
Interface to be tested: All interfaces.

7.1.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Turn on the video signal generator to input the test color bar to the display device through interfaces specified in 5.1 respectively.
c) Check if the display device works normally.

7.1.4 Result

The test result is Support or Not Support.

7.2 Test of Supported Signal Formats

7.2.1 Overview

This section specifies the test of signal formats supported by the display device.

7.2.2 Test Conditions

Video signal generator: generates the test color bar in the signal formats specified in 5.2.
Test interfaces: 1) main test interface, 2) verification test interface.

7.2.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Turn on the video signal generator to output the test color bar in the signal formats specified in 5.2.
c) Check if the display device works normally.

7.2.4 Result

The test result is Support or Not Support.

7.3 Test of Decoding Function

7.3.1 Overview

This section specifies the test of HDR stream decoding performance of the display device.

7.3.2 Test Conditions

Video test signal: video streams specified in 5.3.
Test interfaces: 1) video file or video stream input interface.

7.3.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Choose the video file input interface (if any) and play the video streams in sequence.

c) Check whether the display device can normally decode and play the video streams.

7.3.4 Result

The test result is Support or Not Support.

7.4 Test of Function Requirements

7.4.1 Automatic Adaption of HDR Vivid Display

7.4.1.1 Overview

This section specifies the testing of the ability of display devices to automatically adapt to HDR Vivid display, when it receives the HDR Vivid signal.

7.4.1.2 Test Conditions

Video test signal: HDR Vivid and other signals in formats specified in 5.3.
Test interfaces: 1) digital video input interface, 2) video stream input interface.

7.4.1.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Input the non-HDR Vivid signal through interfaces specified in 5.1, and switch to the HDR Vivid signal when the display device is in stable operation.
c) Check whether the display device automatically adapts to the HDR Vivid display with relevant prompts.

7.4.1.4 Result

The test result is Support or Not Support.

7.4.2 Test of HDR Vivid Visual Identification

7.4.2.1 Overview

This section specifies the test of HDR Vivid visual identification when the display device receives the HDR Vivid signal.

7.4.2.2 Test Conditions

Video test signal: HDR Vivid and other signals in formats specified in 5.3.
Test interfaces: 1) main test interface, 2) verification test interface.

7.4.2.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Input HDR Vivid signal through the test interface.
c) Check whether the tested device automatically displays the logo or text specified in UWA-TC-HDR-302 (菁彩 HDR in Chinese or HDR Vivid) for at least 3s;
d) If the logo or text can not be automatically displayed, continue to check whether the tested device has the identification or text (菁彩 HDR in Chinese or HDR Vivid) specified in UWA-TC-HDR-302 displayed in the relevant menu;
e) If the requirements of step c or step d are met, it is considered to be supported.

7.4.2.4 Result

The test result is Support or Not Support.

7.4.3 Test of Switch between Different Signal Formats

7.4.3.1 Overview

This section specifies the test of the switch from SDR, PQ-HDR, and HLG-HDR to HDR Vivid.

7.4.3.2 Test Conditions

Video test signal: HDR Vivid , SDR, PQ-HDR and HLG-HDR signals specified in 5.2.
Test interface: 1) digital video input interface, 2) video stream input interface or file input interface.

7.4.3.3 Test Steps

a) Adjust the display device to the working status as specified in 6.5.
b) Input the video signals that include multiple switchable formats through interfaces specified in 5.1.
c) Check whether the display device can play the video stably when switching between different formats, without noticeable flickers or other display defects.

7.4.3.4 Result

The test result is Support or Not Support, and the test phenomena are recorded.

7.4.4 Digital video input interface adaptation mode

7.4.4.1 Overview

It is used to test the support of digital video interface of display device for adaptation mode.

7.4.4.2 Test Steps

The test step is the same as specified in 7.6.4.
If Monitor_mode_support is equal to 1, the monitor adaptation mode is supported; If Rx_mode_support is equal to 1, the receiver adaptation mode is supported.

7.4.4.3 Result

The test result is Support Receiver Mode, Support Monitor Mode or Not Support.

7.5 Display Performance Test

7.5.1 Peak Luminance

7.5.1.1 Overview

This section specifies the test of luminance limit of the display device.

7.5.1.2 Test Conditions

Video test signal: 10% white window image with window luminance at 3,987.99 cd/m^2 (code value: 923/923/923) and background luminance at 0 cd/m^2 (code value: 0/0/0).
Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

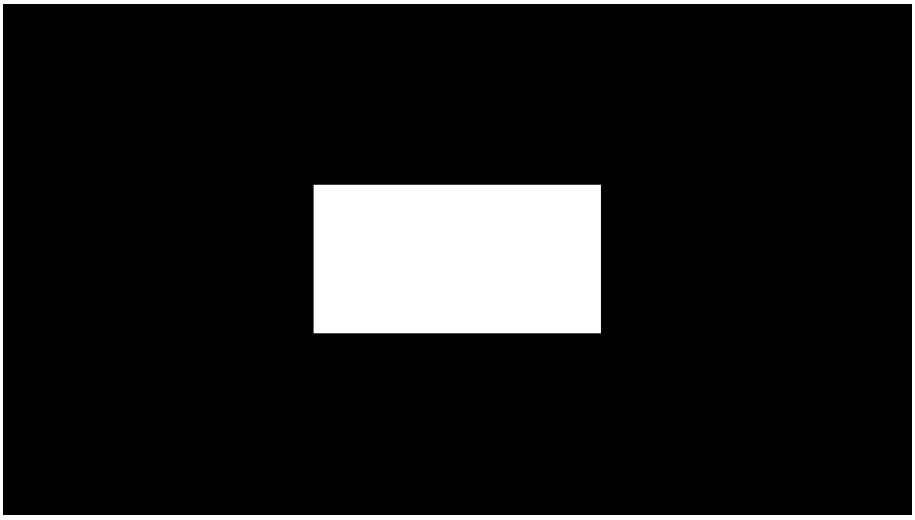

Figure 2 10% White Window Signal

Test interfaces: main test interface.

7.5.1.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input the black test image and display it stably for more than 30s.

c) Switch to the 10% white window image and measure the luminance at the center point of the screen for 3 times within 1 min. Specifically, measure at 5th, 25th, and 45th seconds respectively after the signal is switched.

d) Record the largest of the 3 measured luminance values as the peak luminance.

7.5.1.4 Result

The test result is a number in Candela per square meter (cd/m^2).

7.5.2 Stable Peak Luminance

7.5.2.1 Overview

This section specifies the test of display luminance when the display device is in stable operation.

7.5.2.2 Test Conditions

Video test signal: 1) 10% white window image with window luminance at 3,987.99 cd/m^2 (code value: 923/923/923) and background luminance at 0 cd/m^2 (code value: 0/0/0); 2) 5% white window image with window luminance at 3,987.99 cd/m^2 (code value: 923/923/923) and background luminance at 0 cd/m^2 (code value: 0/0/0); 20% white window image with window luminance at 3,987.99 cd/m^2 (code value: 923/923/923) and background luminance at 0 cd/m^2 (code value: 0/0/0).

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

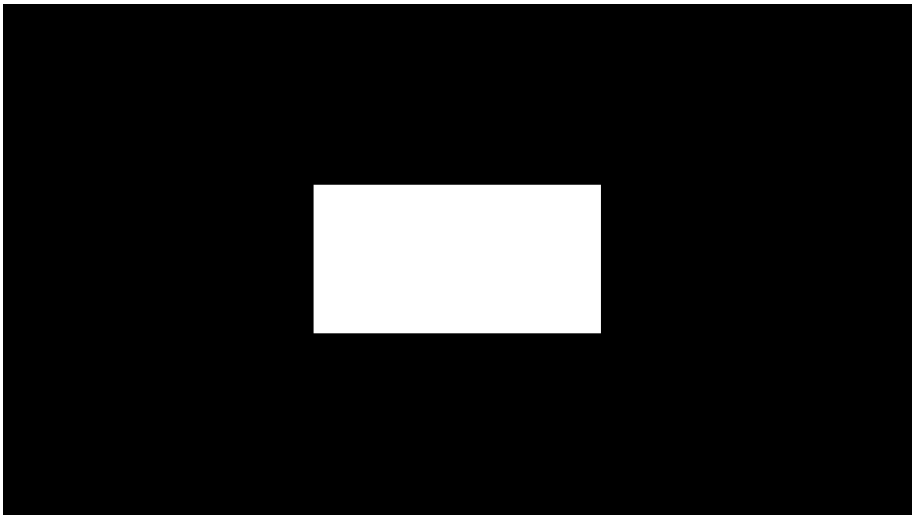

Figure 3 10% White Window Signal

Test interfaces: The same as specified in 7.5.1.

7.5.2.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input white window images in this order: 5% > 10% > 20%. Display each image for 30s and for 4 times.

c) Measure the luminance at the center point of the screen every time the 10% white window image is displayed. Specifically, measure at 5th and 25th seconds respectively after the signal is switched.

d) Record the lowest value among the eight measurements as the stable peak luminance.

7.5.2.4 Result

The test result is a number in Candela per square meter (cd/m^2).

7.5.3 Lowest Black Level

7.5.3.1 Overview

This section specifies the test of black level limit of the display device.

7.5.3.2 Test Conditions

Video test signal: 2.5% corner window image with window luminance at 603.75 cd/m^2 (code value: 713/713/713) and background luminance at 0 cd/m^2 (code value: 0/0/0).

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

Figure 4 2.5% Corner Window Signal

Test interfaces: The same as specified in 7.5.1.

7.5.3.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input the 2.5% corner window signal and measure the luminance at the center point of the screen, while shielding the gray areas at the four corners of the screen with opaque materials.

7.5.3.4 Result

The test result is a number in Candela per square meter (cd/m^2).

7.5.4 Color Gamut Overlap

7.5.4.1 Overview

The color gamut overlap is the ratio of the overlapped area between the RGB (red/green/blue) gamut triangle and the ITU-R BT.2020 gamut triangle to the ITU-R BT.2020 gamut triangle.

7.5.4.2 Test Conditions

Video test signal: red field signal (923/0/0)
green field signal (0/923/0)
blue field signal (0/0/923)

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

Test interfaces: The same as specified in 7.5.1.

7.5.4.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Display red, green, and blue field signal respectively and measure the chromaticity coordinates ($(u_r^{'}, v_r^{'})$, $(u_g^{'}, v_g^{'})$, and $(u_b^{'}, v_b^{'})$) at the center point with a colorimeter. Then, calculate the overlap area $S_{coincide}$.

c) Calculate the color gamut overlap $G_{coincide}$ with the following formula:

$$G_{coincide} = \frac{S_{coincide}}{0.1118} \times 100\% \quad \text{..... (4)}$$

7.5.4.4 Result

The test result is a percentage (%).

7.5.5 Contrast

7.5.5.1 Overview

This section specifies the test of contrast of the display device.

7.5.5.2 Test Conditions

Video test signal: black and white windows.

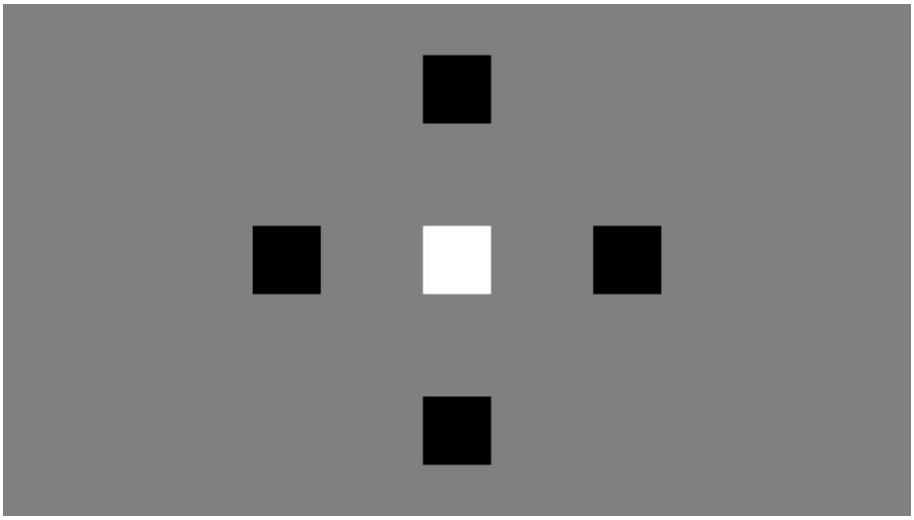

Figure 5 Black and White Window Signal

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.
Test interfaces: The same as specified in 7.5.1.

7.5.5.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Set the dimming to default.

c) Display the black and white windows as shown in Figure 5. Then, place the luminance meter on a line perpendicular to the white window and measure its luminance. Record the value as L0.

d) Place the luminance meter on lines perpendicular to the four black windows and measure their luminance. Record the values as L1, L2, L3, and L4, respectively.

e) Calculate the contrast with the following formula C_r:

$$C_r = \frac{L_0}{L_{bw}} \quad \text{.....(5)}$$

In this formula:

L_{bw} is the average value of L_1, L_2, L_3, and L_4.

7.5.5.4 Result

The test result is a number that indicates the ratio.

7.5.6 Dynamic Luminance Range

7.5.6.1 Overview

This section specifies the test of dynamic luminance range of the display device.

7.5.6.2 Test Conditions

The same as specified in 7.5.1 and 7.5.3.

7.5.6.3 Test Steps

The test steps are as follows:
a) Measure the peak luminance in accordance with steps in 7.5.1 and the lowest black level in accordance with steps in 7.5.3.
b) Calculate the dynamic luminance range with formula (7):

$$HDR_{coverage} = \frac{lgL_W - lgL_B}{lgL_{Wr} - lgL_{Br}} \times 100\% \quad \text{……(7)}$$

In this formula:
L_W — Peak luminance
L_B — Lowest black level
L_{Wr} — 10,000 cd/m^2 (SMPTE ST.2084)
L_{Br} — 0.000001 cd/m^2 (SMPTE ST.2084)

7.5.6.4 Result

The test result is a percentage (%).

7.5.7 White Balance

7.5.7.1 Overview

This section specifies the test of white balance performance of the display device.

7.5.7.2 Test Conditions

Video test signal: 10% window signal with the background luminance at 0 cd/m^2 (corresponding code value for the nonlinear full range PQ RGB signal is 0/0/0). The input value for each component of the window signal changes as indicated in Table 7.

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

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

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

Test interfaces: The same as specified in 7.5.1.

7.5.7.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input the test code streams, maintain for 30s for each luminance level, and measure the chromaticity coordinates (u', v') at the 5th second. The measured chromaticity value is recorded as M[k, j] {k = 1,...,5; j = 1,2}, where j=1,2 represents component the u' and v ' respectively.

c) Calculate the respective absolute difference Δu' and Δv' between the chromaticity coordinates at each luminance level and the standard D65 coordinates (0.1978, 0.4683).

d) Take the maximum values of Δu' and Δv' as the final results.

7.5.7.4 Result

The test results are the maximum values of Δu' and Δv'.

7.5.8 Display Quantization Accuracy

7.5.8.1 Overview

This section specifies the test of the quantization accuracy of the display device, in order to check if the display device produces serious banding artifacts within the range of peak luminance.

7.5.8.2 Test Conditions

Video test signal: gray scale stripe signals. The first signal is a 32-level gray scale signal stepping from (0/0/0) to (1023/1023/1023). The second signal is a 16-level gray scale signal stepping from 660/660/660 to 675/675/675 with a step of 1. The third signal is a 64-level gray scale signal stepping from (1023/1023/1023) to (0/0/0), and the fourth signal is a 4-level gray scale signal stepping from 660/660/660 to 672/672/672 with a step of 4.

Dynamic metadata settings: Set to direct mapping curve. See A.3 in Appendix A for relevant parameters.

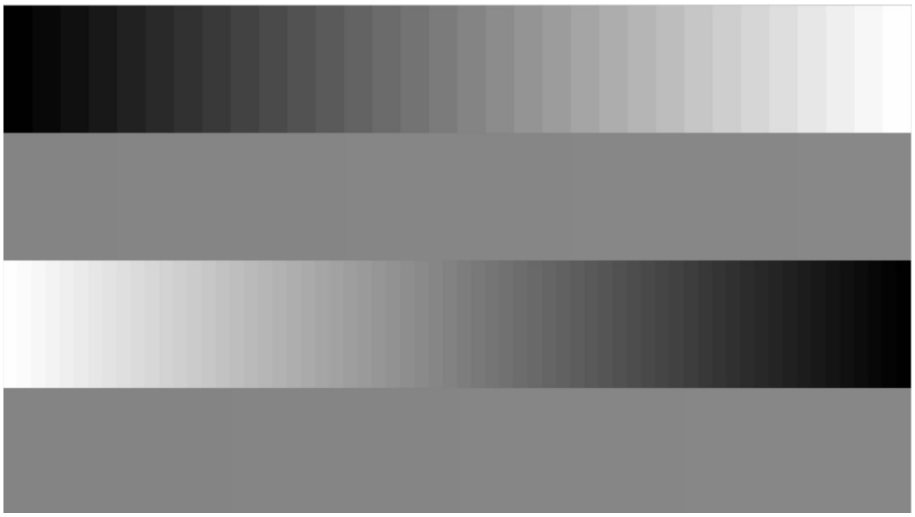

Figure 6 Display Quantization Accuracy

Test interfaces: The same as specified in 7.5.1.

7.5.8.3 Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input the gray scale stripe signals and display for 30s.

c) Observe the second stripe on the screen and count the number of visible gray scales.

d) In case of smooth gradient with no visible gray scales or more than 4 gray scales, the accuracy is 10 bits, otherwise it is 8 bits.

e) If the result cannot be obtained, observe the fourth stripe. If the fourth stripe shows 4 distinguishable gray scales while the second does not, the accuracy is 10 bits, otherwise it is 8 bits.

7.5.8.4 Result

The test result is a bit number.

7.6 Test of Dynamic Metadata Processing

7.6.1 Statistics Mode

7.6.1.1 Overview

This section specifies the test of consistency of the tone mapping process defined by HDR Vivid in statistics mode of the display device when the dynamic metadata contains data statistics.

7.6.1.2 Luminance Test Conditions

Video test signal: 10% window signal with the background luminance at 0 cd/m^2 (code value: 0/0/0). The input value for each component of the window signal changes as indicated in Table 8.

Table 8 Luminance Test Signal (Nonlinear Full Range PQ RGB Signal)

Luminance Test Signal		RGB Code in PQ (10-bit, BT.2020 Gamut)		
No. [k]	Input Luminance (cd/m^2)	R	G	B
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	3,987.9926	923	923	923

Dynamic metadata configuration: See Scenarios 1, 2, and 3 in A.1 of Appendix A for three sets of dynamic metadata applied in the test.

Test interfaces: 1) main test interface; 2) verification test interface. The main test interface should be tested in all three scenarios, while the verification test interface is tested only in scenario 2.

Figure 7 is the sample test image.

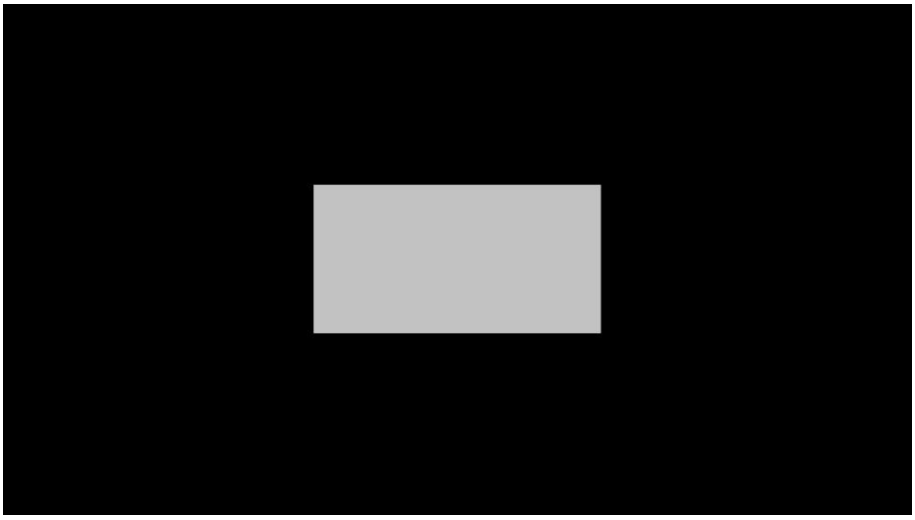

Figure 7 Sample Image with Input Luminance at 49.7907 cd/m^2

7.6.1.3 Luminance Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.

b) Input the test streams and test the luminance values of the center.

c) Record the six measured luminance values as *M[k] (k* = 1,...,6} in Candela per square meter (cd/m^2).

d) Take the metadata corresponding to the test code streams, nominal maximum(*Ps*) and minimum luminance of the display device, and 6 input luminance values as the input data. Then, calculate the expected luminance *P[k]* {*k* = 1,...,6} corresponding to each input luminance, in accordance with the image processing method specified in Chapters 9 and 10 of T/UWA 005.1-2022. The unit for the result is Candela per square meter (cd/m^2).

e) Based on the nominal maximum luminance of the display device and the peak luminance (*Pm*) measured as per 7.5.2, calculate the screen luminance adjustment coefficient S with the following formula:

$$\mathrm{S} = \frac{Pm}{Ps}$$

f) Calculate the relative error A[k] between the expected and measured luminance values:

$$\mathrm{A[k]} = \frac{\left| P[k] - \frac{M[k]}{S} \right|}{P[k]} \times 100\%$$

7.6.1.4 Luminance Test Result

Take the largest *A[k]* in all scenarios in each luminance range which specified in Table 4 under statistics mode as the final result of the luminance range.

7.6.2 Curve Parameter Mode

7.6.2.1 Overview

This section specifies the test of consistency of the tone mapping process defined by HDR Vivid in curve parameter mode of the display device, when the dynamic metadata contains curve parameter information.

See Scenario 4, 5, and 6 in A.2 of Appendix A for three sets of dynamic metadata applied in curve parameter mode for the test.

7.6.2.2 Luminance Test Conditions

Luminance test conditions in curve parameter mode are the same as those in statistics mode. For more details, see 7.6.1.2.

7.6.2.3 Luminance Test Steps

Luminance test steps in curve parameter mode are the same as those in statistics mode. For more details, see 7.6.1.3.

7.6.2.4 Luminance Test Result

The result of luminance test in curve parameter mode is indicated in the same way as that in statistics mode. For more details, see 7.6.1.4.

7.6.2.5 Chromaticity Test Conditions

Video test signal: 10% window signal with the background luminance at 0 cd/m^2 (corresponding code value for the nonlinear full range PQ RGB signal is 0/0/0). The input value for each component of the window signal changes as indicated in Table 9.

Table 9 Chromaticity Test Signal (Nonlinear Full Range PQ RGB Signal)

Color Test Signal		RGB Code in PQ (10-bit, BT.2020 Gamut)		
No. [k]	Type	R	G	B
1	Skin color 1#	441	409	389
2	Skin color 2#	449	413	381
3	Skin color 3#	465	449	437
4	Sky color	477	550	622
5	Plant color	518	602	233

See Scenario 4, 5, and 6 in A.2 of Appendix A for three sets of dynamic metadata applied in the test.
Test interfaces: 1) main test interface; 2) verification test interface. The main test interface should be tested in all three scenarios, while the verification test interface is tested only in scenario 5.

Figure 8 Input Chromaticity of Skin Color 2#

7.6.2.6 Chromaticity Test Steps

The test steps are as follows:

a) Adjust the display device to the working status as specified in 6.5.
b) Input the test streams and measure the chromaticity coordinates (u', v') of the center.
c) Record the 5 measured chromaticity values as $M[k, j]$ $\{k = 1,...,5; j = 1,2\}$, where j=1,2 represents component the u' and v ' respectively.
d) Take the metadata corresponding to the test code streams, nominal maximum and minimum luminance of the display device, and 5 input chromaticity values as the input data. Then, calculate the expected output chromaticity corresponding to each input luminance, in accordance with the image processing method specified in Chapters 9 and 10 of T/UWA 005.1-2022. The expected output chromaticity is represented as RGB components, which are then converted to u' and v'. Record the results as $P[k, j]$ $\{k = 1,...,5; j = 1,2\}$, where j=1,2 represents component the u' and v ' respectively.
e) Calculate the absolute error $A[k]$ between the expected and measured chromaticity values:

$$A[k] = \max(|P[k,1] - M[k,1]|, |P[k,2] - M[k,2]|), \quad k = 1,...,5$$

7.6.2.7 Chromaticity Test Result

For skin colors, take the largest value among $A[1]$, $A[2]$, and $A[3]$ as the result in the scenario. For the sky color, take $A[4]$ as the result in the scenario. For the plant color, take $A[5]$ as the result in the scenario.
Take the largest among values in all scenarios in curve parameter mode as the final test result, and check whether the value is in the error range specified in Table 4.

7.6.3 Metadata Synchronization Test

7.6.3.1 Overview

This section specifies the test of synchronization between the video image and the dynamic metadata.
HDR Vivid uses dynamic metadata, which may change from one frame to another. In a terminal device, it is necessary to ensure that each frame of image accurately uses the corresponding dynamic metadata.
The code stream used in this test is specially constructed. As shown in Figure 9 , the stream is composed of two 10% window signals with different luminance, i.e. input image 1 and 2. By using different dynamic metadata, they can output windows with the same luminance. When the processing of dynamic metadata does not synchronize with that of the image, the window is displayed with instable luminance, showing obvious flickers.

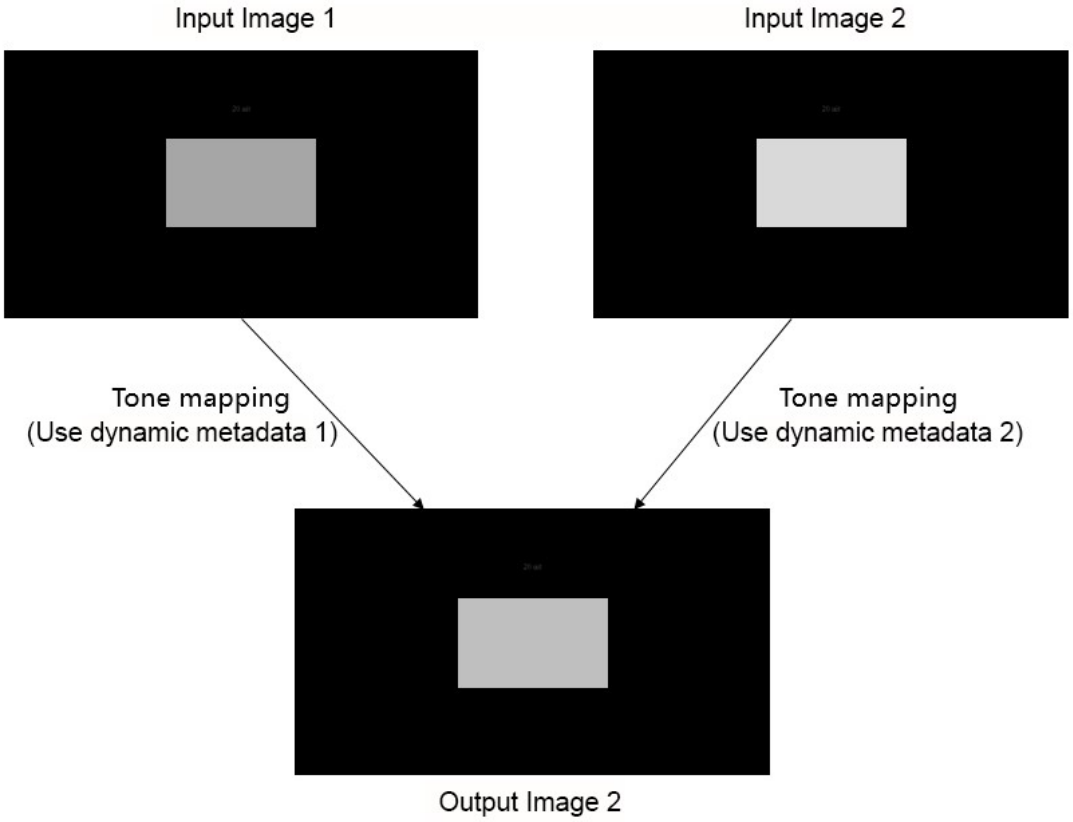

Figure 9 Metadata Synchronization Test

7.6.3.2 Test Conditions

Video test signal: 10% window signal with the background luminance at 0 cd/m2 (corresponding code value for the nonlinear full range PQ RGB signal is 0/0/0). The input values of each component of the window signal are as shown in Table 10.Test image 1 and test image 2 are displayed alternately. The alternate mode of test image 1 and test image 2 includes: 1) ABAB; 2) AABBAABB; 3) AAABBBAAABBB... three types, each lasting no less than 10s.

Table 10 Synchronization Test Signal (Nonlinear Full Range PQ RGB Signal)

RGB Code in PQ (10-bit, BT.2020 Gamut)			
No. [k]	R	G	B
Test image 1	683	683	683
Test image 2	765	765	765

See A.4 in Appendix A for the dynamic metadata configurations in the test.
Test interfaces: 1) main test interface; 2) verification test interface.

7.6.3.3 Synchronization Test Steps

The test steps are as follows:
a) Adjust the display device to the optimal working status as specified in 6.5.
b) Input the metadata synchronization test stream and visually check whether the luminance of the window signal is stable.
c) If the window luminance at the center of the display screen is stable without obvious flickers, the display device passes the metadata synchronization test. Otherwise, it fails to pass the test.

7.6.4 HDMI Test

7.6.4.1 Overview

The display device can receive video images and dynamic metadata through the HDMI interface. This section specifies the test to verify if the HDMI interface of the display device supports the HDR Vivid standard.

7.6.4.2 HDMI EDID Test Conditions

Test interfaces: HDMI.

7.6.4.3 HDMI EDID Test Steps

a）Connect the EDID analyzer to the display device under test.
b）Turn on the EDID analyzer to read and analyze the EDID of the display device.
c）The display device meets requirements of the standard, if its EDID includes the VS-VDB data block of the format specified by T/UWA 005.2-1, and at least one value of Monitor_mode_support or Rx_mode_support equals to 1.
d）When the value of Monitor_mode_support equals to 1, the values of display_maximum_luminance and display_minimum_luminance fields in the EDID should be consistent with those indicated by the manufacturer. When the value of Monitor_mode_support equals to 0, the values of display_maximum_luminance and display_minimum_luminance fields should be equal to 0.

7.6.4.4 HDMI EDID Test Result

The test result is Conform or Not Conform.

7.6.5 Monitor adaptation mode

In the monitor adaptation mode, the test of the curve parameter mode and HDMI interface of the display device is consistent with 7.6.2 and 7.6.4 respectively, except that the video test signal generator works in the monitor adaptation mode.

Appendix A

Metadata Configuration Parameters

A.1 Configurations in Statistics Mode

The dynamic metadata only contains statistical information, which is used for the conformity test of terminal devices in statistics mode. See Table A.1 for metadata settings:

Table A.1 Metadata Configuration Parameters of Statistical Mode

Static metadata	Scenario 1	Scenario 2	Scenario 3
max_display_mastering_luminance	4000	4000	4000
Dynamic Metadata	Scenario 1	Scenario 2	Scenario 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 Configurations in Curve Parameter Mode

The dynamic metadata contains curve parameter information (base curve parameters, refined curve parameters, reference luminance, and adjustment information of cubic spline), which are used for the conformity test of terminal devices in curve parameter mode. See Table A.2 for metadata settings:

Table A.2 Metadata Configuration Parameters of Curve Parameter Mode

Static metadata	Scenario 4	Scenario 5	Scenario 6
max_display_mastering_luminance	4000	4000	4000
Dynamic Metadata	Scenario 4	Scenario 5	Scenario 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
base_param_Delta_enable_mode[0]	6	6	6
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

A.3 Configurations of Direct Mapping Curve

With the direct mapping curve, the display device directly maps the video content if its luminance is lower than the nominal maximum luminance, and truncates the content if otherwise. Display performance, peak luminance, color gamut, and other screen performance can be tested in this mode. See Table A.3 for metadata settings:

Table A.3 Metadata Configuration Parameters of Curve Parameter Mode

Static metadata	Direct Mapping Curve
max_display_mastering_luminance	4000
Dynamic Metadata	Direct Mapping Curve
system_start_code	1
minimum_maxrgb_pq	0
average_maxrgb_pq	1024
variance_maxrgb_pq	1024
maximum_maxrgb_pq	2048
tone_mapping_enable_mode	1
tone_mapping_param_enable_num	0
targeted_system_display_maximum_luminance_pq[0]	2674
base_enable_flag[0]	1
base_param_m_p[0]	5734
base_param_m_m[0]	24
base_param_m_a[0]	920
base_param_m_b[0]	0
base_param_m_n[0]	10
base_param_K1[0]	1
base_param_K2[0]	1
base_param_K3[0]	1
base_param_Delta_enable_mode[0]	0
base_param_enable_Delta[0]	0
3Spline_enable_flag[0]	0
color_saturation_mapping_flag	0

A.4 Curve Parameters for Synchronization Test

The dynamic metadata contains curve parameter information (base curve parameters, refined curve parameters, reference luminance, and adjustment information expressing cubic spline), which are used in curve parameter mode of the terminal device. See Table A.4 for metadata settings:

Table A.4 Metadata Configuration Parameters of Curve Parameter Mode

Static metadata	Test Image 1	Test Image 2
max_display_mastering_luminance	4000	4000
Dynamic Metadata	Test Image 1	Test Image 2
system_start_code	1	1
minimum_maxrgb_pq	0	0
average_maxrgb_pq	3046	3046
variance_maxrgb_pq	1535	1535
maximum_maxrgb_pq	4095	4095
tone_mapping_enable_mode	1	1
tone_mapping_param_enable_num	0	0
targeted_system_display_maximum_luminance_pq[0]	2770	2770

base_enable_flag[0]	1	1
base_param_m_p[0]	5734	5734
base_param_m_m[0]	24	24
base_param_m_a[0]	563	510
base_param_m_b[0]	0	0
base_param_m_n[0]	10	10
base_param_K1[0]	1	1
base_param_K2[0]	1	1
base_param_K3[0]	1	1
base_param_Delta_enable_mode[0]	0	0
base_param_enable_Delta[0]	0	0
3Spline_enable_flag[0]	1	1
3Spline_enable_num[0]	0	0
3Spline_TH_enable_mode[0][0]	0	0
3Spline_TH_enable_MB[0][0]	224	224
3Spline_TH_enable[0][0]	0	0
3Spline_TH_enable_Delta1[0][0]	511	511
3Spline_TH_enable_Delta2[0][0]	511	511
3Spline_enable_Strength[0][0]	127	127
color_saturation_mapping_flag	1	1
color_saturation_num	2	2
color_saturation_gain[0]	38	38
color_saturation_gain[1]	25	25