UHD World Association
世界超高清视频产业联盟

High dynamic range video technology Part 3-7: Technical requirement and test method - Projection display

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PREFACE

This document is part 3-7 of T/UWA 005 "High Dynamic Range (HDR) Video Technology". T/UWA 005 "High Dynamic Range (HDR) Video Technology" includes the following sections:

——Part 1: Metadata and Adaptation

——Part 2-1: Application Guide System Integration

——Part 2-2: Post production requirements and processes

——Part 3-1: Technical requirements and test methods - Display devices

——Part 3-2: Technical requirements and test methods - Mobile display device

——Part 3-3: Technical requirements and test methods - Player device

——Part 3-4: Technical requirements and test methods - Soft media player

——Part 3-5: Technical requirements and test methods - Live encoder device

——Part 3-6: Technical requirements and test methods - Player device for media player software

——Part 3-7: Technical requirements and test methods - Projection display

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High dynamic range (HDR) video technology Part 3-7: Technical requirements and test methods - Projection display

1 Scope

This document specifies the requirements and test methods for HDR display technology for projection display devices or systems that support HDR Vivid technology (hereinafter referred to as "display devices").

This document is applicable to projection display devices or systems that support HDR Vivid technology.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

SJ/T 11324 Terminology for Digital Television Reception Equipment

GY/T 307-2017 Ultra High Definition Television System Program Production and Exchange Parameter Values

GB/T 41808-2022 High Dynamic Range Television Program Production and Exchange Image Parameter Values

T/UWA 005.1-2024 High Dynamic Range (HDR) Video Technology Part 1: Metadata and Adaptation

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

3 Term and definition

The terms and definitions defined in SJ/T 11324 and T/UWA 005.1 and T/UWA 005.2-1 are applicable to this document.

4 Abbreviation

The following abbreviations apply to this document.

HDR High Dynamic Range

HLG Hybrid Log Gamma

PQ Perceived Quantizer

5 Technical requirement

5.1 Interface

The display device shall have at least one of the following interfaces: digital video input interface, video stream input interface, or video file input interface.

5.2 Support signal formats

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

Table 1: Supporting Signal Format Requirements

No.	Format	Technical Requirement
1	Resolution (number of pixels)	3840 × 2160 or 7680 × 4320
2	Frame rate (Hz)	50
3	Scanning mode	Progressive
4	Quantization accuracy (bit)	10
5	Color gamut	Support 5.2 of GB/T 41808-2022
6	Transfer function	Supporting the provisions of 5.4 in GB/T 41808-2022 PQ and HLG systems reference nonlinear transfer functions
7	Metadata	Support T/UWA 005.1

5.3 Decoding requirements

If there is a video stream or file input interface, it shall support HDR Vivid stream decoding in formats such as HEVC/H.265, AVS2, or AVS3.

5.4 Functional requirements

The functional requirements of the display device are shown in Table 2.

Table 2 Equipment Functional Requirements

No.	Functional requirements	Technical requirement
1	HDR Vivid Display Automatic Adaptation	1) The display device shall automatically adapt to HDR Vivid display when receiving HDR Vivid signals in its as-shipped condition.
2	HDR Vivid Visual Recognition	1) After receiving the HDR Vivid signal and adapting to the HDR Vivid display, the display device automatically displays the identification or text (菁彩 HDR or HDR Vivid) specified by UWA-TC-HDR-302 once, and the display time is not less than 3 seconds, or provides a menu for display; 2) No HDR Vivid signal received or HDR Vivid display mode entered should display HDR Vivid identification.
3	Multi format video signal switching	The display device shall maintain visual stability during transitions between HDR Vivid and non-HDR Vivid formatted content, without perceptible flicker or other undesirable artifacts.
4	Adaptation mode of digital video input interface	If the display device has a digital video input interface, it shall have at least one digital video input interface supported HDR Vivid format, and it needs to support at least one of the receiver adaptation mode and monitor adaptation mode.

5.5 Display performance requirements

The display performance requirements of the display device are shown in Table 3.

Table 3 shows performance requirements

No.	Basic parameters	Unit	Technical requirement
1	Peak Luminance (10% white window)	cd/m^2	≥200
2	Contrast Ratio (Intra- frame)	—	≥ 200:1
3	Minimum black Luminance	cd/m^2	≤0.5
4	Luminance dynamic range	%	≥26
5	Color Gamut Coverage (BT.2020)	%	≥50
6	D65 White Balance	—	Δu≤0.02 Δv≤0.02
7	Display quantization Precision	bit	≥8 bit

5.6 Requirements for dynamic metadata processing

The requirements for dynamic metadata processing are shown in Table 4.

Table 4 Requirements for dynamic metadata processing

No.	Item		Unit	Technical requirement	
1	Statistical Information Mode	Luminance deviation	%	Input Luminance (L0/nit) ＜ 100	≤20%
				100≤ L0＜1000	≤15%
				1000≤ L0≤4000	≤10%
2	Curve parameter mode	Luminance deviation	%	Input Luminance (L0/nit) ＜ 100	≤20%
				100≤ L0＜1000	≤15%
				1000≤ L0≤4000	≤10%
		chromaticity distortion (Δu’、Δv’)	—	colour of skin	≤0.02
				Sky color	≤0.04
				Plant color	≤0.04
3	Metadata synchronization		—	support	
4	HDMI interface	HDMI EDID Information	—	The pattern identification in VS-VDB is correct	

	testing	Requirements		

According to T/UWA 005.1, the dynamic metadata of HDR Vivid includes two modes, namely statistical information mode and curve parameter mode.In the statistical information mode, metadata is represented and transmitted in the form of statistical information. After receiving the statistical information, the terminal device generates a tone mapping curve and processes the corresponding image according to the method specified in T/UWA 005.1.In the curve parameter mode, metadata is represented and transmitted in the form of tone mapping curves.When the dynamic metadata contains curve parameters, the statistical information mode will be ignored (i.e. the curve parameter mode has higher priority).

6 Test conditions

6.1 Environment

6.1.1 Atmospheric Conditions

Conduct the following tests under standard atmospheric conditions.
—— Temperature: 15 ℃~35 ℃;
—— Relative humidity: 25% RH to 75% RH;
—— Atmospheric pressure: 86kPa to 106kPa.

6.1.2 Power supply

The device must be tested under the rated supply voltage, and fluctuation of the supply voltage during the test shall not exceed ±2%. When using an AC mains power supply, fluctuation of the power supply frequency shall not exceed ± 5%.

6.1.3 Stability time

In order to ensure that the characteristics of the display device do not change significantly over time after the test begins, the display device is heated for 15 minutes in its factory state after being turned on to ensure stable performance.

6.1.4 Test conditions

The display performance test shall be conducted in a dark room. When the tested display device is turned off, the stray light intensity on the surface of the display screen shall be less than or equal to 0.01lx

6.2 Test signal

The test signal shall comply with the provisions of 5.2, and the test stream shall meet the decoding requirements specified in 5.3.

6.3 Test instrument

6.3.1 Luminance colorimeter

The Luminance meter tests the brightness of a small area on the screen, with a range of at least 0.001cd/m2 to 5000cd/m2, and a testing accuracy of ± 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 brightness is below 2cd/m2, and the testing accuracy should meet: ± 0.003.

It is recommended to use a Luminance colorimeter for testing.

6.3.2 Video test signal generator

The video test signal generator shall be able to generate the test signal specified in 6.2, and the interface shall meet the requirements of 5.1.

6.4 Test interface

When the tested device has multiple signal input interfaces, the test interface is divided into the main test interface and the verification test interface.Choose one of the interfaces as the main test interface, and the order of selecting the main test interface is: 1) Video file input interface;2) Video stream input interface;3) Digital video input interface.Verify that the test interface is a digital video input interface.

When there is only one test interface being tested, only the test items related to that interface are measured.

The test interfaces corresponding to each project should meet the requirements specified in Table 5.

Table 5 Test Interface

No.	Test item		Test interface
1	interface		All interfaces
2	Support signal formats		1) Main test interface, 2) Verification test interface.
3	Decoding function		File input interface or video stream input interface
4	Functional requirements	HDR Vivid display mode automatic switching	1) Digital video input interface, 2) Video stream input interface
		HDR Vivid Visual Recognition Requirements	1) Main test interface, 2) Verification test interface.
		Multi format content switching effect	
		Adaptation mode of digital video input interface	1) Digital video input interface
5	display performance		Main test interface
6	Dynamic Metadata	Statistical Information Mode	1) Test all scenarios of the main test interface, 2) Verify the interface testing as specified in Appendix A Scene 2.
		Curve parameter mode	1) Test all scenarios of the main test interface, 2) Verify the interface testing as specified in Appendix A
		Metadata synchronization	1) Main test interface, 2) Verification test interface.
		HDMI interface testing	1) Digital video input interface

6.5 Adjustment of standard working conditions

The adjustment of standard working conditions is as follows:

a) Using the standard lens of the projector, input a test signal that is consistent with the inherent resolution of the projector for adjusting the standard working state;

b) Initialize or reset the projector to its factory default state. If there is no reset option, the projector's power on state will be considered as the default state;

c) Adjust the position of the projector to make the projected image rectangular;

d) If it is a zoom lens, the focal length of the projector lens needs to be adjusted to the wide-angle end;

e) Adjust the focus of the projector to make the projected image clear and distinguishable;

f) The settings of image mode, color temperature, and other options should be adjusted according to product specifications or instructions. If there are no setting instructions, they should be set to the default state;

g) All settings related to ambient light adaptation should be turned off;

h) During the entire test process, if there is a need to readjust or replace the input signal, the product should be kept stable for at least 5 minutes before testing;

i) This state is the standard working state and should remain unchanged throughout the entire test process. Relevant settings and projector status should be recorded in the test records.

6.6 Adjustment before test

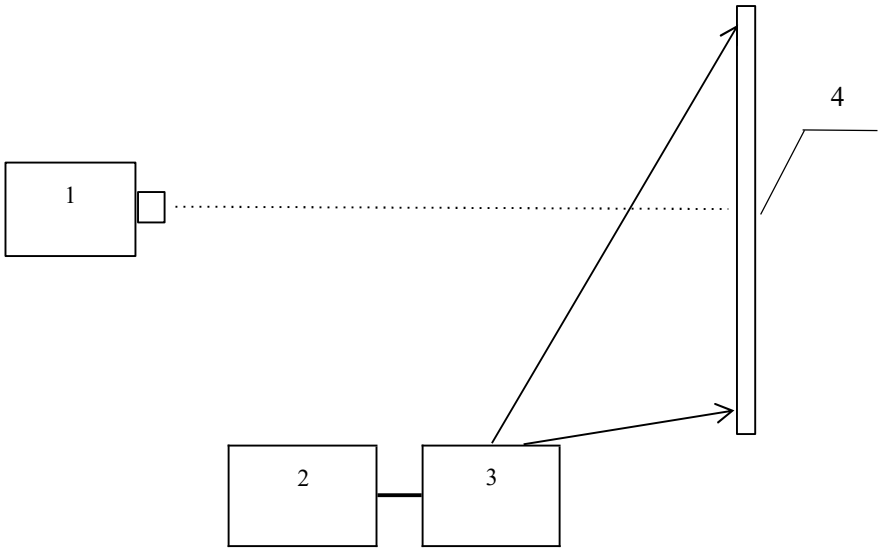
The adjustments before testing are as follows:

a) Check and record the usage time of the projection light source;

b) Connect the signal generator to the projector, as shown in Figure 1 for the test block diagram;

c) Test according to the optimal projection size indicated in the manual. If not indicated, it is recommended to use 80 inches and the projection size should be reflected in the report;

d) If the projector is equipped with a screen, use the standard screen for testing. If no screen is provided, use the standard screen (with a gain of 1.0) for testing;



Index number description:

1- Luminance colorimeter ;

2- Signal generator;

3- Projection display equipment;

4- Projection surface.

Figure 1 Location diagram of test instruments

e) Input the color bar signal to the projector;

f) Before officially starting the test, the projector should be preheated for no less than 15 minutes;

g) During testing, the l Luminance colorimeter is orthogonal and perpendicular to the projected image.

7 Test method

7.1 Interface testing

7.1.1 Overview

This section is used to test the interface types supported by the display device.

7.1.2 Test conditions

Video test signal generator: Output color bar test signals through the 5.1 interface.

Test interface: All interfaces.

7.1.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Input color bar test signals through the video test signal generator according to the 5.1 interface format;

c) Check if the display device is displaying properly.

7.1.4 Result

The test results are indicated by whether they are supported or not.

7.2 Support signal format testing

7.2.1 Overview

This section is used to test the signal formats supported by display devices.

7.2.2 Test conditions

Video test signal generator: Set the output to match the color bar test signal format specified in 5.2.

Test interface: 1) Main test interface, 2) Verification test interface.

7.2.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Set up a video test signal generator to output color bar test signals that comply with the signal format specified in 5.2;

c) Check if the display device is displaying properly.

7.2.4 Result

The test results are indicated by whether they are supported or not.

7.3 Decoding function test

7.3.1 Overview

This section is used to test the decoding ability of display devices for HDR streams.

7.3.2 Test conditions

Video test signal: Video stream, in compliance with 5.3 regulations.

Test interface: file input interface or video stream input interface.

7.3.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Prioritize selecting the video file input interface and play the video streams one by one;

c) Check if the display device supports the playback of the stream and decodes and displays it normally.

7.3.4 Result

The test results are indicated by whether they are supported or not.

7.4 Functional requirement testing

7.4.1 HDR Vivid Display Automatic Adaptation

7.4.1.1 Overview

This section is used to test the ability of a display device to automatically adapt to HDR Vivid display when it receives an HDR Vivid signal source.

7.4.1.2 Test conditions

Video test signal: HDR Vivid signal source and non HDR Vivid signal source that comply with 5.3 regulations.

Test interface: 1) Digital video input interface, 2) Video stream input interface.

7.4.1.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Input non HDR Vivid signal source through the interface specified in 5.1, and switch to HDR Vivid signal source after stabilization;

c) Subjective evaluation of whether the device automatically adapts to HDR Vivid display and has relevant prompts.

7.4.1.4 Result

The test results are indicated by whether they are supported or not.

7.4.2 HDR Vivid visual recognition

7.4.2.1 Overview

This section is used to test whether the display device has visual recognition function when receiving HDR Vivid signal source.

7.4.2.2 Test conditions

Video test signal: HDR Vivid signal source and non HDR Vivid signal source that comply with 5.3 regulations.

Test interface: 1) Main test interface, 2) Verification test interface.

7.4.2.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Input HDR Vivid signal source through test interface;

c) Check whether the tested device automatically displays the identification or text specified in UWA-TC-HDR-302 ("Jingcai HDR" or "HDR Vivid") once, and the display time is not less than 3 seconds;

d) If it does not display automatically, continue to check whether the tested device has the relevant menu to display the identification or text specified in UWA-TC-HDR-302 ("Jingcai HDR" or "HDR Vivid");

e) If the requirements of step c or step d are met, it is considered supported.

7.4.2.4 Result

The test results are indicated by whether they are supported or not.

7.4.3 Multi format content switching

7.4.3.1 Overview

This section is used to test the visual effect of the switching process when the display device switches from SDR, PQ-HDR, and HLG-HDR format video content to HDR Vivid video content in sequence.

7.4.3.2 Test conditions

Video test signal: HDR Vivid signal source and SDR, PQ-HDR, and HLG-HDR signal sources that meet the requirements of 5.2.

Test interface: 1) Digital video input interface, 2) Video stream input interface or file input interface.

7.4.3.3 Test procedure

a) Adjust the display device to the testing working state specified in 6.5;

b) Input video signals containing multiple video format switches through the interface format specified in 5.1;

c) The display device needs to be able to play input signals normally, and when switching between various video formats, the screen display should be smooth without obvious flickering, black screen, or other phenomena.

7.4.3.4 Result

The test results are represented by whether they are supported, and the test phenomena are recorded.

7.4.4 Adaptation mode of digital video input interface

7.4.4.1 Overview

Used to test the support of digital video interfaces for adaptation modes in display devices.

7.4.4.2 Test procedure

The test procedure are consistent with 7.6.4.

If the Monitor_made_Support identifier is equal to 1, monitor mode is supported;If the Rx_made_Support identifier is equal to 1, then the receiving end mode is supported.

7.4.4.3 Result

The test results are indicated by whether they are supported or not.

7.5 Display performance testing

7.5.1 Peak Luminance

7.5.1.1 Overview

This section is used to test the brightness limit capability of display devices.

7.5.1.2 Test conditions

Video test signal: 10% white window test image, window brightness 3987.99 cd/m2 (code value: 923/923/923), background 0 cd/m2 (code value: 0/0/0).

Metadata setting: using direct mapping curve, specific parameters are shown in Appendix C.3.

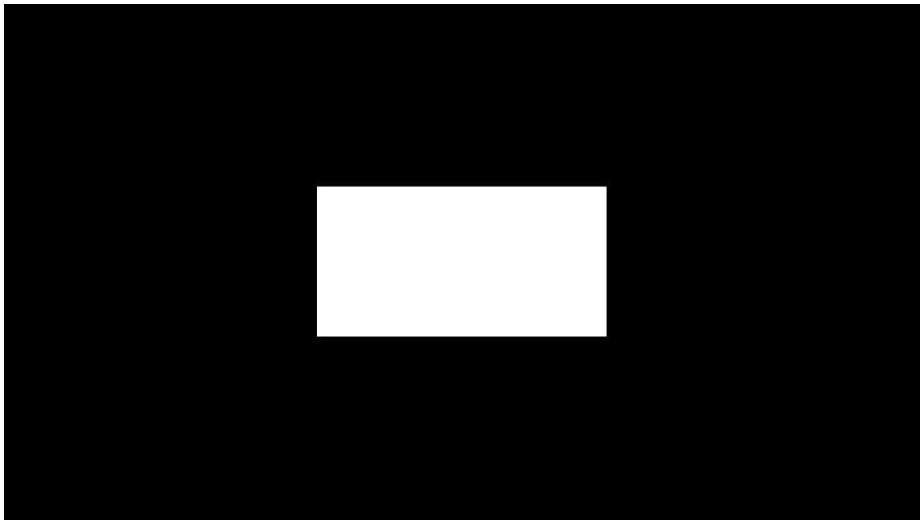


Figure 2 Schematic diagram of 10% white window signal

Test interface: Main test interface.

7.5.1.3 Test procedure

The test procedure are as follows:

a) Adjust the display device to the testing working state specified in 6.5;

b) Input the black field test image and display it stably for more than 30 seconds;

c) Switch to the 10% white window test image and test the center brightness of the screen, denoted as peak luminance;

7.5.1.4 Result

The test results are expressed in candela per square meter (cd/m^2).

7.5.2 Contrast ratio

7.5.2.1 Overview

This section tests the contrast of display devices.

7.5.2.2 Test conditions

Video test signal: black and white window signal.

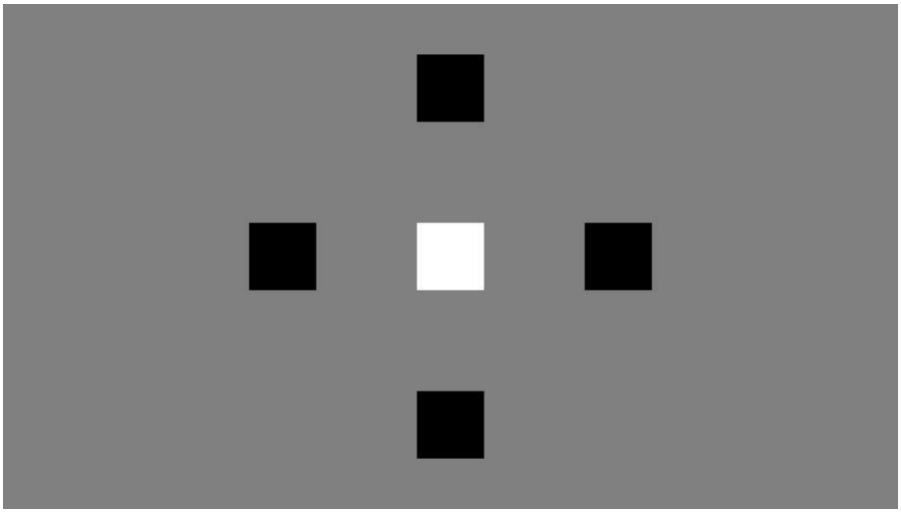


Figure 3 Black and white window signal

Dynamic metadata setting: using a direct mapping curve, specific parameters can be found in section A.3.

Test interface: Consistent with 7.5.1.

7.5.2.3 Test procedure

The test procedure are as follows:

a) Adjust the receiving to the testing work state specified in 6.5;

b) The partition backlight is set according to the factory default state;

c) Display the black and white window signal shown in Figure 5, place the brightness meter on the orthogonal vertical line of the white window, and measure the brightness value of the window, denoted as L0；

d) Place the brightness meter on four orthogonal vertical lines of black windows and test the brightness values of the four windows, denoted as L1, L2, L3, and L4 respectively；

e) Calculate the contrast Cr using the following formula:

$$C_r = \frac{L_0}{L_{bw}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

In the formula:

Lbw is the average of L1, L2, L3, and L4.

7.5.2.4 Result

The test results are expressed in multiples.

7.5.3 Minimum black luminance

7.5.3.1 Overview

This section tests the black luminance limit capability of the display device.

7.5.3.2 Test conditions

Video test signal: 2.5% corner window signal, window luminance: 603.75 cd/m2 (code value: 713/713/713), background is 0 cd/m2 (code value: 0/0/0).

Dynamic metadata setting: using a direct mapping curve, specific parameters can be found in section A.3.

Figure 4 Schematic diagram of 2.5% corner window signal

Test interface: Consistent with 7.5.1.

7.5.3.3 Test procedure

The test procedure are as follows:

a) Adjust the display device to the testing working state specified in 6.5;

b) Input the 2.5% corner window signal and test the brightness of the screen center.

7.5.3.4 Result

The test results are expressed in candela per square meter (cd/m^2).

7.5.4 Color gamut coverage degree

7.5.4.1 Overview

The color gamut overlap degree is the ratio of the triangle color gamut area composed of the chromaticity points of the three primary colors (R, G, B) to the triangle color gamut area composed of the ITU-R BT.2020 standard chromaticity points, to the ITU-R BT.2020 color gamut area.

7.5.4.2 Test conditions

Video test signal: Full Red Square signal (923/0/0);

Full green field signal;(0/923/0);

Full blue field signal.(0/0/923);

Dynamic metadata setting: using a direct mapping curve, specific parameters can be found in section A.3.

Test interface: Consistent with 7.5.1.

7.5.4.3 Test procedure

The test procedure are as follows:

a) Adjust the display device to the testing working state specified in 6.5;

b) Display the signals of all Red Square, all Green Field, and all Blue Field respectively, and use a colorimeter to test the chromaticity coordinates (u, v) and (u, v) of the center point in sequence. Calculate the overlapping area Sconcide of the triangle formed by (u, v) and ITU-R BT.2020 coordinates;

c) Calculate the color gamut coincidence Gcoincide using the following formula:

$$G_{coincide} = \frac{S_{coincide}}{0.1118} \times 100\% \quad \cdots\cdots (2)$$

7.5.4.4 Result

The test results are expressed as a percentage (%).

7.5.5 Luminance dynamic range

7.5.5.1 Overview

This section tests the luminance dynamic range of display devices.

7.5.5.2 Test conditions

Test according to conditions 7.5.1 and 7.5.3.

7.5.5.3 Test procedure

The test procedure are as follows:

a) Test peak luminance according to 7.5.1 and minimum black luminance according to 7.5.3;

b) Calculate the dynamic range according to formula (*3*):

$$HDR_{coverage} = \frac{lgL_W - lgL_B}{lgL_{Wr} - lgL_{Br}} \times 100\% \quad \cdots\cdots (3)$$

In the formula:

L_W - peak luminance;

L_B - minimum black luminance;

L_{Wr} - 10000 cd/m^2 (SMPTE ST.2084)

L_{Br} - 0.000001 cd/m^2 (SMPTE ST.2084)

7.5.5.4 Result

The test results are expressed as a percentage (%).

7.5.6 D65 white balance

7.5.6.1 Overview

This section tests the white balance capability of display devices.

7.5.6.2 Test conditions

Video test signal: The video content is a 10% window signal, with a background of 0 cd/m^2 (corresponding to the full range PQ non-linear RGB)

The signal codewords are 0/0/0, and the input values of each component of the window signal are transformed in sequence according to the signals shown in Table 5.

Table 6 Luminance Test Signal (Full Range PQ Nonlinear RGB Signal)

Luminance test signal		PQ domain RGB code value (10 bit, BT.2020 color gamut)		
Number [k]	Input Luminance (cd/m^2)	R signal	G signal	B signal
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 setting: using a direct mapping curve, specific parameters can be found in section C.3.

Test interface: Consistent with 7.5.1.

7.5.6.3 Test procedure

The test procedure are as follows:

a) Adjust the display device to the testing working state specified in 6.5;

b) Input different luminance test streams separately, measure the color coordinates of the center point, represented by (u ', v');

c) Calculate the absolute values Δ u 'and Δ v' of the difference between the color coordinates at each luminance and the color coordinates of D65 (u '=0.1978, v'=0.4683).

7.5.6.4 Result

Take the maximum values of Δ u 'and Δ v' at each brightness as the results.

7.5.7 Display quantization accuracy

7.5.7.1 Overview

This section tests whether the quantization accuracy of the display device produces significant contour display errors within the peak luminance range of the display device.

7.5.7.2 Test conditions

Video test signal: strip grayscale signal, the second is a 16th order grayscale signal stepping from 660/660/660 with 1 to 675/675/675, and the fourth is a 4th order grayscale signal stepping from 660/660/660 with 4 to 672/672/672.

Dynamic metadata setting: using a direct mapping curve, specific parameters can be found in section A.3.

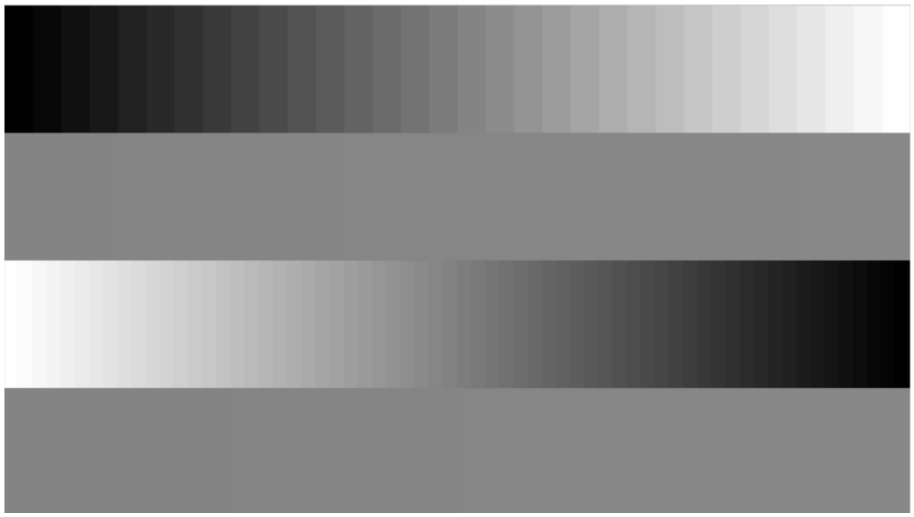


Figure 5 Display a schematic diagram of quantization accuracy

Test interface: Consistent with 7.5.1.

7.5.7.3 Test procedure

The test procedure are as follows:

a) Adjust the display device to the testing working state specified in 6.5;

b) Input strip grayscale signal, stable for 30 seconds;

c) Observe the number of visible gray levels generated by the second line on the display screen;

d) If the number of gray levels is greater than 4, it is 10 bits, and equal to 4, it is 8 bits;

e) If there is a gradient effect but no grading, observe the fourth gray level;

f) If the fourth grayscale can distinguish 4 levels, it is 10 bits, otherwise it is 8 bits.

7.5.7.4 Result

The result is expressed in bits.

7.6 Dynamic metadata processing test

7.6.1 Statistical information mode

7.6.1.1 Overview

This article tests the consistency of the tone mapping processing flow defined by HDR Vivid using statistical information mode on display devices when dynamic metadata values contain statistical information .

7.6.1.2 Luminance test conditions

Video test signal: The video content is a 10% window signal, with a background of 0 cd/m2 (code words are 0/0/0). The input values of each component of the window signal are as shown in Table 7.

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

Luminance test signal		PQ domain RGB code value (10 bit, BT.2020 color gamut)		
Number [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 configuration: This test uses three sets of dynamic metadata, as shown in Appendix A.1 for Scenario 1, Scenario 2, and Scenario 3.

Test interface: 1) Main test interface, 2) Verification test interface. The main test interface tests three scenarios, while the validation interface only tests scenario 2.

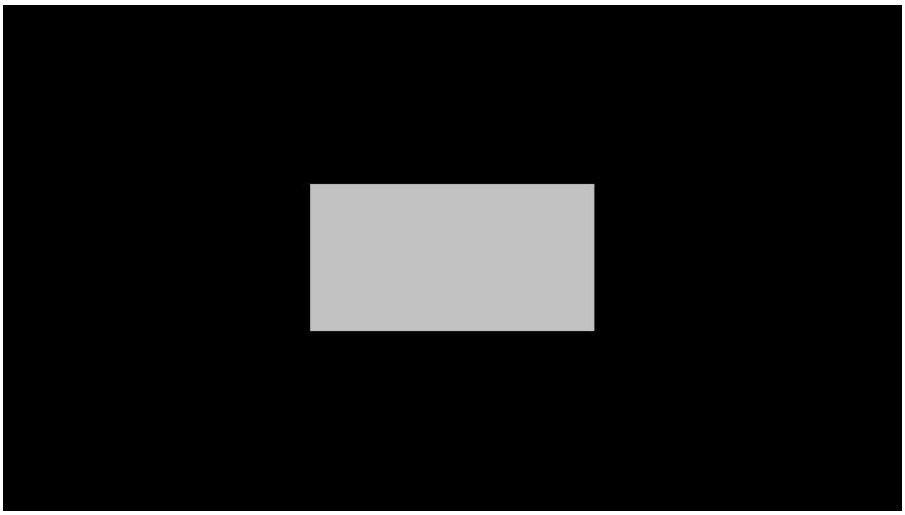


Figure 6 Schematic diagram of input Luminance at 49.7907 cd/m^2

7.6.1.3 Luminance Test procedure

The luminance Test procedure are as follows:

a) Adjust the tested equipment to the working state specified in 6.5;

b) Input the test stream and test the brightness of the testing center;

c) Record the test values of M [k] corresponding to the six input luminance measurements; {k=1,⋯,6}；

d) Using the metadata corresponding to the test stream, the maximum display luminance Ps and minimum display luminance configured in the tested device, and six input luminance values as inputs, according to the image processing flow in Chapters 9 and 10 of T/UWA 005.1-2022, calculate and obtain the expected luminance values corresponding to each input luminance, which are P [k]; {k=1, ⋯ , 6}；

e) According to the configuration provided by the testing machine, the maximum display luminance of the equipment is incorrect. Reference source not found. Stable peak luminance measured Pm, Calculate the screen luminance adjustment coefficient S as follows:

$$S = \frac{Pm}{Ps} \cdots\cdots (4)$$

f) Calculate the relative error A [k] between the expected luminance output and the actual test value:

$$A[k] = \frac{\left|P[k] - \frac{M[k]}{S}\right|}{P[k]} \times 100\% \cdots\cdots (5)$$

7.6.1.4 Result

The maximum value of all scene results A [k] for each input luminance interval specified in Table 4 under the statistical information mode is taken as the final result for that input luminance interval.

7.6.2 Curve parameter mode

7.6.2.1 Overview

Test the consistency of the color tone mapping process defined by HDR Vivid using the curve parameter mode on the tested device when the dynamic metadata contains curve parameter information.

The curve parameter mode uses three sets of dynamic metadata test cases, as shown in Appendix A.2, Scenario 4, Scenario 5, and Scenario 6.

7.6.2.2 Luminance test conditions

The luminance test conditions in the curve parameter mode are consistent with those in the statistical information mode, as detailed in section 7.6.1.2 .

7.6.2.3 Luminance Test procedure

The luminance Test procedure in curve parameter mode are the same as those in statistical information mode, please refer to section 7.6.1.3 for details.

7.6.2.4 Luminance test results

The luminance test results in curve parameter mode are consistent with the luminance test results in statistical information mode. Please refer to section 7.6.1.4 for details.

7.6.2.5 Chromaticity test conditions

Video test signal: The video content is a 10% window signal, with a background of 0 cd/m2 (corresponding to the full range PQ non-linear RGB)

The signal codewords are 0/0/0, and the input values of each component of the window signal are transformed in sequence according to the signals shown in Table 6.

Table 8 Chromaticity test signal (full range PQ nonlinear RGB signal)

Color test signal		PQ domain RGB code value (10 bits, BT.2020 color gamut)		
Number [k]	type	R signal	G signal	B signal
1	Skin tone 1	441	409	389
2	Skin color No.2	449	413	381
3	Skin color 3	465	449	437
4	Sky color	477	550	622
5	Plant color	518	602	233

This test uses three sets of dynamic metadata test cases as shown in Appendix A.2, Scenario 4, Scenario 5, and Scenario 6.

Test interface: 1) Main test interface, 2) Verification test interface. The main test interface tests three scenarios, while the validation interface only tests scenario 5.

Figure 7 Schematic diagram of color input chromaticity
for skin color No.2

7.6.2.6 Chromaticity Test procedure

The test procedure are as follows:

a) Adjust the tested equipment to the working state specified in 6.5;

b) Input the test stream and test the color coordinates of the center point (u ', v');

c) Record the actual test values of M [k, j] corresponding to 5 input chromaticities;{k=1,..., 5; j=1,2}, where j=1,2 respectively represent the u 'and v' components;

d) Using the metadata corresponding to the test stream, the highest display luminance configured in the tested device, and 5 input chromaticities as inputs, according to the image processing flow in Chapters 9 and 10 of T/UWA 005.1-2022, calculate and obtain the expected output color value corresponding to each input chromaticity, represented by RGB components, and convert the RGB components into u'v 'components, which are recorded as P [k, j] respectively;{k=1,..., K; j=1,2}, where j=1,2 respectively represent the u 'and v' components;

e) Calculate the absolute error A [k] between the expected output chromaticity value and the actual test value: A[k] = max （ |P[k,1] - M[k,1]|，|P[k,2] - M[k,2]| ） ， k=1,⋯,5

7.6.2.7 Chromaticity test results

The maximum value of skin color among A [1], A [2], and A [3] is taken as the result in this scene;The sky color sequence is taken as A [4], which is the result of this scene;The plant color is taken as the result of scene A [5].

Take the maximum value of all scene results in the curve parameter mode as the final result for that color, and determine whether it meets the error range requirements specified in Table 4.

7.6.3 Metadata synchronization test

7.6.3.1 Overview

This section tests the synchronization between video images and dynamic metadata.

HDR Vivid uses dynamic metadata, which can change every frame.In terminal devices, it is necessary to ensure that each frame of image accurately uses the corresponding dynamic metadata.

This test uses a specially constructed test stream, as shown in Figure 8, which contains two 10% window luminance signals with different luminance levels, namely input image 1 and input image 2. Their window luminance levels are different, but by using different dynamic metadata, windows with the same brightness can be output. When the processing flow of dynamic metadata is not synchronized with the image, the brightness of the

displayed window signal cannot be maintained stably, and there will be obvious flickering.

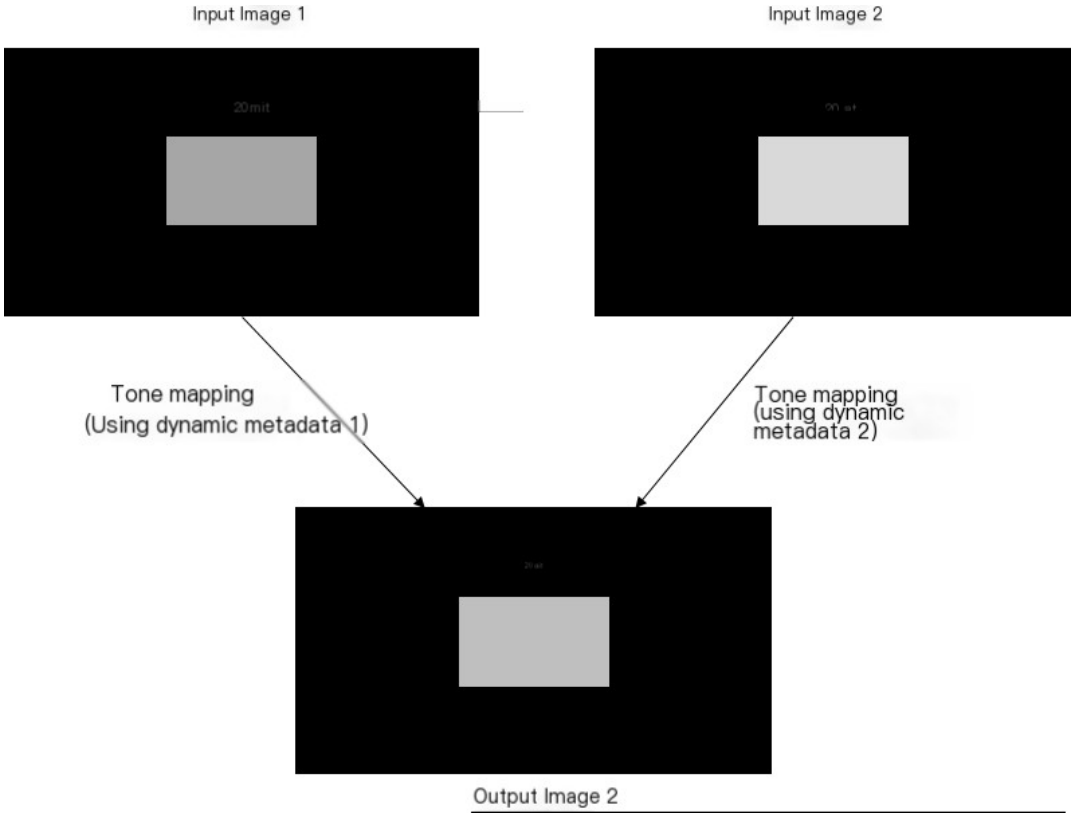


Figure 8 Schematic diagram of metadata synchronization test

7.6.3.2 Test conditions

Video test signal: The video content is a 10% window signal, with a background of 0 cd/m2 (corresponding to the full range PQ non-linear RGBsignal code words are 0/0/0), and the input values of each component of the window signal are shown in Table 9. Test image 1 and test image 2 are displayed alternately. The alternating pattern between test image 1 and test image 2 includes three modes: 1) ABAB⋯; 2)AABBAABB⋯; 3) AAABBBAAABBB..., each lasting no less than 10 seconds.

Table 9 Synchronization test signal (full range PQ nonlinear RGB signal)

PQ domain RGB code value (10 bits, BT.2020 color gamut)			
Number [k]	R signal	G signal	B signal
Test image 1	683	683	683
Test image 2	765	765	765

The dynamic metadata configuration used for test images can be found in C.4.

Test interface: 1) Main test interface, 2) Verification test interface.

7.6.3.3 Synchronization Test procedure

The test procedure are as follows:

a) Adjust the tested equipment to the optimal working state specified in 6.5;

b) Input metadata synchronization test stream and visually inspect whether the brightness of the window signal in the screen is stable;

c) If the brightness of the signal in the center window of the display screen is stable and there is no obvious flicker, it is judged that the metadata synchronization test of the test equipment has passed;Otherwise, it is determined that the metadata synchronization test of the test equipment has not passed.

7.6.4 HDMI interface testing

7.6.4.1 Overview

The display device can receive video images and dynamic metadata through the HDMI interface.This section is used to test the support of HDMI interface for HDR Vivid protocol on display devices.

7.6.4.2 HDMI EDID Test Conditions

Test interface: HDMI interface.

7.6.4.3 HDMI EDID Test procedure

a) Connect the EDID analyzer to the device under test;

b) The EDID analyzer reads and analyzes the EDID of the device under test;

c) If the tested device's EDID contains VS-VDB data blocks provided in the format specified in T/UWA005.2-1, and at least one of the Monitor_made_Support or Rx_made_Support identifiers is equal to 1, it complies with this standard; otherwise, it does not comply;

d) When Monitor_made_Support is set to 1 in the EDID of the device under test, the values of the corresponding fields ' display_maximum_1uminance ' and ' display-minimum_1uminance ' in the EDID must be consistent with the manufacturer's declared values; When Monitor_made_Support is set to 0 in EDID, the values of the display_maximum_luminance and display-minimum_luminance fields should be equal to 0.

7.6.4.4 HDMI EDID result

The test results are represented by whether they comply.

Appendix A (Normative) Metadata Configuration Parameters

A.1 Statistical information mode configuration

Dynamic metadata only contains statistical data information and is used for compliance testing in the statistical information mode of terminal devices. The specific settings related to metadata are shown in Table A.1:

Table A.1 Statistical Information Mode Metadata Configuration Parameters

Static metadata	**Scenario 1**	**Scenario 2**	**Scene 3**
max_display_mastering_luminance	4000	4000	4000
Dynamic Metadata	Scenario 1	Scenario 2	Scene 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 Curve parameter mode configuration

The dynamic metadata contains curve parameter information (basic curve parameters+reference brightness+correction curve parameters+adjustment information for expressing cubic splines), which is used for compliance testing in the curve parameter mode of terminal devices. The specific settings related to metadata are shown in Table A.2:

Table A.2 Curve Parameter Mode Metadata Configuration Parameters

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

Table A.2 Curve Parameter Mode Metadata Configuration Parameters (Continued)

Dynamic Metadata	**Scenario 4**	**Scenario 5**	**Scenario 6**
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 Direct mapping curve configuration

The direct mapping curve performs direct mapping processing on the content below the highest display luminance of the device configured in the tested device, and truncates the video content above the highest display luminance of the device.This mode can be used to test screen performance such as display performance, peak luminance, color gamut, etc. The specific settings related to metadata are shown in Table A.3:

Table A.3 Curve Parameter Mode Metadata Configuration Parameters

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 parameter configuration for synchronization testing

The dynamic metadata contains curve parameter information (basic curve parameters+reference brightness+correction curve parameters+adjustment information for expressing cubic splines), which is used for the curve parameter mode of terminal devices.The specific settings related to metadata are shown in Table A.4:

Table A.4 Curve Parameter Mode Metadata Configuration Parameters

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
color_saturation_gain[1]	25	25