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High Dynamic Range Video Technology Part 3-6: Technical Requirements and Test Methods – Player Device for Media Player Software

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Contents

High Dynamic Range Video Technology Part 3-6: Technical Requirements and Test Methods – Player Device For Media Player Software

1 Scope

This document specifies the technical requirements and test methods for hardware equipment applicable to HDR Vivid playback software.

This document is applicable to hardware devices that support HDR Vivid video by software decoding.

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the dated version is applicable to this document. For undated references, the latest version (including all modified versions) is applicable to this document.

SJ/T 11324 Terminology of Digital TV Display Equipment

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

GY/T 315-2018 High dynamic range TV program production and image exchange parameter values

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

T/UWA 005.3-1-2022 High Dynamic Range (HDR) Video Technology Part 3-1: Technical Requirements and Test Scheme Display Equipment

T/UWA 005.3-4-2022 High Dynamic Range (HDR) Video Technology Part 3-4: Technical Requirements and Test Scheme Playing Software

3 Terms and definitions

The following terms and definitions defined in SJ/T 11324 are applicable to this document.

3.1 HDR Vivid

It refers to HDR technical specifications and supporting derivative technologies specified in T/UWA 005.1-2022.

3.2 HDR Vivid playback software

Analyze and adjust the video signal in the way of independent software according to T/UWA 005.1-2022, and display it on the hardware equipment it carries, including but not limited to smart phones, tablet computers, smart TV APP, PC platform applications, etc. Consistent with the definition of T/UWA 005.3-4-2022, this document is referred to as playback software for short.

3.3 Device for HDR Vivid playback software

The device that runs the playback software and displays the image obtained after decoding the video signal according to the definition of T/UWA 005.1-2022, hereinafter referred to as the device.

3.4 Software control state

When the playback software is running on the device, it will control the display capability of the device through the software program API, such as display dynamic range, color gamut, etc. This state of the device controlled by the playback software is referred to as the software control state in this document. And we refer to it simply as SCS in the following.

4 Abbreviations

The following abbreviations are applicable to this document.

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

5 Device grading criteria

5.1 Grading standard of display capability

5.1.1 Summary

In order to give play to the display capability of the device, the hardware manufacturer allows the playback software to control the display capability of the device by providing a program interface to the software developer. This chapter specifies the grading standards of various display capabilities of equipment under SCS.

5.1.2 Gamut coincidence

The equipment under the SCS shall support BT.2020 gamut image rendering, and the gamut overlap shall not be less than 60%.

5.1.3 Non-linear transfer capability

Under the SCS, the playback software can enable the PQ display mode of the device (refer to A.2 in Appendix A for the implementation method), and can accept the PQ video signal decoded by the playback software and tone mapped from HDR Vivid image as the video input source. Its output luminance accuracy error meets the provisions of Table 1.

Table 1 **Test samples of non-linear transfer capability (non-linear RGB signals in the full range of PQ domain)**

NO.	Input signal: full range PQ domain 10bit RGB signal			Reference luminance (*cd/m*²)	relative error
	R signal	G signal	B signal		
1	450	450	450	49.7907	≤ 20%
2	520	520	520	100.2301	≤ 15%
3	592	592	592	199.1536	≤ 15%
4	668	668	668	401.5059	≤ 15%
5	923	923	923	L_{max} [Note 1]	≤ 10%

Note 1: In the case No. 5, since the theoretical value of the PQ curve has far exceeded the maximum luminance of the consumer terminal screen in the current market, the expected output reference luminance is marked as, representing the maximum display luminance of the configuration equipment provided by the equipment for inspection.L_{max}

5.1.4 Dynamic range of display

The dynamic range of equipment display under the SCS is divided into two levels, and each level shall comply with the provisions in Table 2.

Table 2 **shows the dynamic range classification table**

NO.	10% white window peak luminance (cd/m2)	Minimum black luminance (cd/m2)	Dynamic range (%)
1	≥ 800	≤ 0.05	≥ 42
2	≥ 450	≤ 0.05	≥ 40

5.1.5 Display quantization precision

Under the SCS, the playback software can specify the display quantization precision of the device (refer to A.3 in Appendix A for the implementation method), and complete the rendering of the output image of the playback software according to this precision. The quantification accuracy of equipment display is divided into two levels, and each level shall comply with the provisions in Table 3.

Table 3 **shows the quantization precision grading table**

NO.	Precision (bit)
1	10
2	8

5.2 Color management ability

The current video content platform and service provider provide its users with software service applications that, in addition to the movie playing (on-demand playback, live broadcast, etc.) function, also provide other functions such as movie information display, user viewing interaction, and advertising sales around the movie. Therefore, as shown in Figure 1, the layout of the application interface where video users view movies is often composed of the following two types of layers, including:

- Video layer: the layer used by playback software to render video frames.
- Interactive layer: the layer used by playback software to draw non video frames, such as text, pictures, UI controls and other program interface elements.

These two types of layers may overlap. As shown in Figure 1, the left side is a small built-in window playing scene, which is generally used to display the detailed information of the current movie in one view page. At this time, the video layer to render the video frames overlaps the interactive layer to draw the movie detailed information pane; The right side shown in Figure 1 is a full screen playback scene. At this time, the interactive layers of interface elements such as pop-up screen and control bar are superimposed on the video layers of (full screen) rendered video frames.

During the operation of the application program containing the above video playback scene, under SCS, each layer area in the hardware device screen should be able to accurately restore the original color. In particular, hardware devices can also provide their own accurate brightness and color presentation for the overlapping area of the playback layer and the interactive layer. For example:

- When the video layer overlaps the interactive layer and the interactive layer presents sRGB color gamut, the video layer should present the BT.2020 color gamut and highlight required by HDR rendering.

- When the interactive layer overlaps the video layer and the video layer shows the color gamut and highlight required by HDR rendering, the interactive layer still shows the sRGB color gamut of SDR rendering.

Under SCS, the color management requirements for hardware playback equipment are shown in Table 4:

Table 4 **Color Management Requirements**

<table>
<tr><th>NO.</th><th colspan="2">Items</th><th colspan="2">Technical Requirements</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">Video layers</td><td rowspan="3">Luminance deviation</td><td>Input luminance L_0<100</td><td>≤ 20%</td></tr>
<tr><td>100 ≤ L_0 ＜ 1000</td><td>≤ 15%</td></tr>
<tr><td>1000 ≤ L_0 ≤ 4000</td><td>≤ 10%</td></tr>
<tr><td>chromaticity distortion ($\Delta u, \Delta v$)</td><td colspan="2">0.04</td></tr>
<tr><td>2</td><td>Interactive layers</td><td>chromaticity distortion ($\Delta u, \Delta v$)</td><td colspan="2">0.04</td></tr>
</table>

Figure 1 **Schematic diagram of relationship between video layer and interaction layer in user application software**

6 Test method

6.1 Test conditions

6.1.1 Atmospheric environmental conditions

The test shall be conducted under the following standard atmospheric conditions:
Ambient temperature: 15 ℃~35 ℃;
Relative humidity: 20%~80%.

6.1.2 Power supply mode

During the test, the battery shall be used for power supply or power connection, and the battery power shall not be less than 50% during the test.

6.1.3 Stabilization time

Start the test 10 minutes after the display device is turned on stably.

6.2 Test instrument

6.2.1 Color luminance meter

The color luminance meter is used to measure the luminance and chroma values of various types of display devices such as mobile phones and tablet computers, and its range needs to meet 0.01 cd/m^2~5000 cd/m^2. When the luminance is lower than 2 cd/m^2, the chromaticity coordinate of small area on the test screen (x, y) or (u', v').

Considering the convenience and error requirements of the test, it is recommended to use a colorimeter that supports the spectral mode.

6.3 Test working status

a) Restore the image settings of the device to the factory status;

b) If there is no factory status, adjust the image mode to the standard mode, and restore other menus of the device to the settings after startup;

c) If there is automatic brightness adjustment, turn off the automatic brightness option and adjust the backlight or brightness of the whole machine to the maximum;

d) Start the playback software conforming to T/UWA 005.3-4-2022 standard, and the equipment should be under SCS.

6.4 Test method for gamut coincidence

The test steps are as follows:

a) The playback software sets the device display color gamut to BT.2020 (see the reference example in Appendix A-1);

b) Use the playback software to play the test example described in Table 5, and record the central test coordinates;(u'_r, v'_r)

c) Use the playback software to play the test samples described in Table 6, and record the central test coordinates;(u'_g, v'_g)

d) Use the playback software to play the test samples described in Table 7, and record the central test coordinates;(u'_b, v'_b)

e) According to Section 7.5.4 of T/UWA 005.3-1-2022 standard, use formula (1) to calculate whether the gamut coincidence meets the provisions of 5.1.2.

Table 5 **Gamut Coincidence Test Samples**

R signal	G signal	B signal
923	0	0

Table 6 **Gamut Coincidence Test Samples**

R signal	G signal	B signal
0	923	0

Table 7 **Gamut Coincidence Test Samples**

R signal	G signal	B signal
0	0	923

$$G_{coincide} = \frac{S_{concide}}{0.1118} \times 100\% \qquad \text{...... Formula (1)}$$

6.5 Test method for non-linear transfer capability

The test steps are as follows:

a) The playback software sets the non-linear transfer mode of the equipment to the input brightness to the PQ mode (see the reference example in Appendix A-1);

b) Video test signal: the image content is a 10% window signal as shown in Figure 2, the background signal is 0 cd/m^2 (code value: 0/0/0), the input values of each component of the window signal are in accordance with Table 1, and the signal changes in turn;

c) Input the above test bitstream into the playback software, and each test bitstream will continue to play for 10 seconds. The output image on the screen will be measured within 5 seconds, and the luminance value will be recorded;

d) The actual luminance value measured by the five input signals corresponding to Table 1 is, and the above value is expressed in candela per square meter (cd/m^2);$M[k], k \in \{1,2\cdots 5\}$

e) The reference luminance of the expected output of each input signal in Table 1 is, expressed in candela per square meter (cd/m^2);$P[k], k \in \{1,2\cdots 5\}$

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

$$A[k] = \frac{|P[k] - M[k]|}{P[k]} * 100\%$$

g) When the calculated relative error $A[k], k \in \{1,2\cdots 5\}$ meets the relative error range given in Table 1, it can be considered that the submitted equipment can achieve PQ brightness conversion output capability under SCS.{ }

6.6 Test method for dynamic range of display

The test steps are as follows:

a) The playback software sets the non-linear transfer mode of the equipment to the input brightness to the PQ mode (see the reference example in Appendix A-1);

b) Play software output test data and drive hardware display;

c) The input video test signal is a white rectangle displayed on an area covering 10% of the screen. As Figure 2 shows, the central rectangle's luminance value is 3987.99 cd/m^2 (code value: 923/923/923), background's luminance value is 0 cd/m^2 (code value: 0/0/0), and the dynamic metadata adopts the straight through mapping curve. Measure its peak luminance and record its value as L_W;

d) The input video test signal is four white rectangles displayed in the corners covering 2.5% of the screen in total. As Figure 3 shows, the luminance value of each white rectangle in the corner is 603.75 cd/m^2 (code value: 713/713/713), background's luminance value is 0 cd/m^2 (code value: 0/0/0), and the dynamic metadata uses the straight through mapping curve. Measure its minimum black luminance, and record its value as L_B;

e) Use the above luminance values to calculate the display dynamic range of the current equipment according to T/UWA 005.3-1-2022 standard, as follows:

$$HDR_{coverage} = \frac{\lg L_W - \lg L_B}{\lg L_{Wr} - \lg L_{Br}}$$

The value L_{Wr} is 10000 cd/m^2 (SMPTE ST.2048) and the value L_{Br} is 0.000001 cd/m^2 (SMPTE ST.2048).

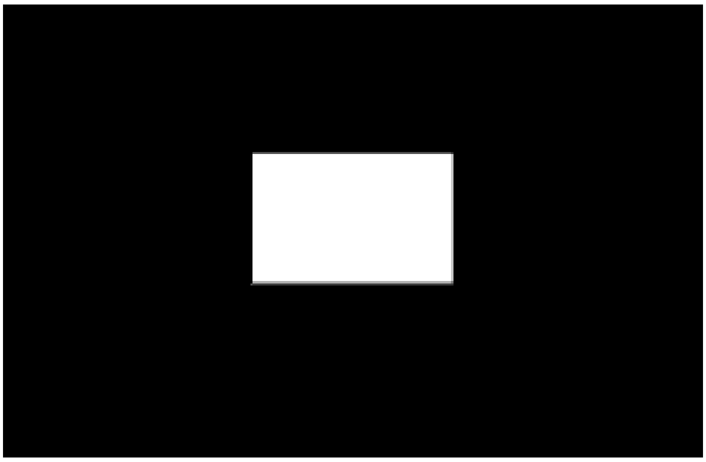

Figure 2- **Schematic diagram of 10% white window signal**

Figure 3- **Schematic diagram of 2.5% corner white window signal**

6.7 Test method for display quantization precision

The test steps are as follows:

a) Adjust the player and equipment to the test working state specified in 6.3;

b) Under SCS, the equipment plays the test sample as shown in Figure 4: stripe grayscale signal, the first is the 32nd order grayscale signal stepping from (0/0/0) to (1023/1023/1023), the second is the 16th order grayscale signal stepping from (660/660/660) to (675/675/675), the third is the 64th order grayscale signal stepping from (1023/1023/1023) to (0/0), and the fourth is the 4th order grayscale signal stepping from (660/660/660) to (672/672/672) gray scale signal, The dynamic metadata adopts the direct mapping curve;

c) Display the above signal on the screen for 30s, and observe the number of visible grayscales generated by the second line on the display screen;

d) If there is gradient effect and no gradation or the number of grayscales is greater than 4, the display accuracy of the device is 10bit, otherwise it is 8bit;

e) If it is impossible to judge, observe the fourth gray scale. If the fourth gray scale can distinguish the fourth gray scale and the second gray scale cannot, the display accuracy of the equipment is 10bit, otherwise it is 8bit.

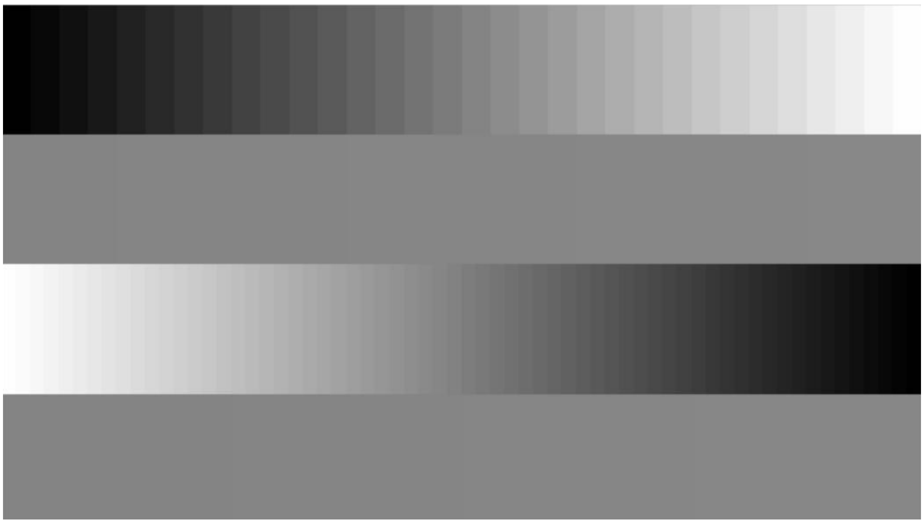

Figure 4- **Schematic diagram of display precision output signal**

6.8 Test method for color management ability

6.8.1 Test preparation

The color management test of the device under SCS is conducted for the video layer and interactive layer respectively, and the preparation steps include:

a) The playback software creates a playback interface containing two types of layers as shown in Figure 1;

b) At least one video layer exists in the above interface, which is set under SCS as follows: color gamut coverage to wide color gamut mode (BT.2020/DCI-P3), and non-linear transfer capability is PQ;

c) There is also at least one interactive layer in the above interface for drawing non video frames, such as UI control elements;

d) During the running of the playback software, measure the output signals of the video layer and the interactive layer respectively.

6.8.2 Video layer color management test

（1）Luminance error test

The luminance error test is consistent with the 6.5 non-linear transfer test method, and the luminance response of the video layer needs to coincide with the PQ curve.

（2）Chromaticity error test

The test steps are as follows:

a) The playback software outputs test signals $P[k,j]$ to the video layer according to Table 8, where *j*=1,2 represents the component u' and v' respectively, *k* represents the serial number of the corresponding input chromaticity, each signal lasts for 30 seconds to represent, and record the measured chromaticity value as (u',v')

b) The actual output value measured by recording the corresponding input chromaticity is $M[k,j]$, where j=1,2 represents the component u' and v' respectively;

c) Calculate the absolute error between the expected output chromaticity value and the actual measured value:$A[K]$

$$A[K] = max(|P[k,1] - M[k,1]|, |P[k,2] - M[k,2]|)$$

d) The final chromaticity error is the maximum absolute error.

6.8.3 Interactive layer color management test

The interactive layer mainly displays pictures, text and other non-video content, and its luminance response follows the standard to which the content belongs. Under normal circumstances, it belongs to the conventional default configuration of all devices in the current market, so this technical specification does not repeat the luminance error test. The chromaticity error in the case of multiple layers is mainly investigated. The test steps for chromaticity error are as follows:

a) The playback software outputs test signals $P[k,j]$ to the video layer according to Table 9, where *j*=1,2 represents the component u' and v' respectively, k represents the serial number of the corresponding input chromaticity, each signal lasts for 30 seconds to represent
b) The actual output value measured by recording the corresponding input chromaticity is $M[k,j]$, where *j*=1,2 represents the component u' and v' respectively;
c) Calculate the absolute error $A[K]$ between the expected output chromaticity value and the actual measured value:

$$A[K] = max(|P[k,1] - M[k,1]|, |P[k,2] - M[k,2]|)$$

The final chromaticity error is the maximum absolute error.

Table 8 **Chromaticity test signal of video layer**

NO.	RGB code value in PQ domain (10 bits, BT.2020 color gamut)			Reference color coordinates	
	R signal	G signal	B signal	u'	v'
1	441	409	389	0.2320	0.4867
2	449	413	381	0.2377	0.4946
3	465	449	437	0.2137	0.4790
4	477	550	622	0.1503	0.3960
5	518	602	233	0.1385	0.5726

Table 9 **Chromaticity Test Signal of Interactive Layer**

NO.	SRGB domain RGB code value (8-bits, BT.709 color gamut limited range)			Reference color coordinates	
	R signal	G signal	B signal	u'	v'
1	235	16	16	0.4013	0.9412
2	16	235	16	0.1634	0.1030
3	16	16	235	0.9412	0.4617

7 Device grading policy

7.1 Summary

The equipment is graded according to the test results in Chapter 6 to guide the streaming service providers to provide appropriate video content distribution strategies and enable the playback software to adapt according to different grading results, so that the equipment presents the best HDR Vivid display effect.

The equipment is divided into three profiles: Main, Baseline and Compatible. Technical requirements at all profiles shall meet the provisions in Table 10.

The main profile equipment can obtain the best HDR Vivid display effect under the control of the playback software.

The baseline profile equipment has correct HDR Vivid display effect under the control and adaptation of the playback software.

Compatible profile equipment cannot play correct HDR Vivid effect through playback software, but backward compatible HDR Vivid display effect can be obtained through SDR display adaptation in T/UWA 005.1-2022.

Table 10 **Capacity Requirements of Equipment of Each Grade**

Equipment capability item	**Support requirements**		
	Main Profile	Baseline Profile	Compatible Profile
Gamut coincidence	accord with	accord with	Non conformance
Non-linear transfer capability	accord with	accord with	Non conformance
Show Dynamic Range	Level 1	Level 2	Below Level 2
Display quantization precision	Level 1	Level 2	Level 2
Color Management	accord with	accord with	accord with

Appendix A
(Informative appendix) Software control method

A.1 Summary

This appendix takes Android device as an example to illustrate the implementation method of SCS described in this specification.

A.2 The sample codes to enable software PQ mapping:

When creating a render window using EGL's API

```
EglCreateWindowSurface（EGLDisplay display,
                        EGLConfig config,
                        EGLNationalWindowType win,
                        Const EGLint * attrib_list);
```

Where the enumeration value EGL_GL_COLORSPACE_BT2020_PQ_EXT is included in the gamut parameters of the fourth input argument to the above method, as follows:

```
std:: vector<EGLint> attrib_list;
attrib_list.push_back(EGL_GL_COLORSPACE_KHR);
attrib_list.push_back(EGL_GL_COLORSPACE_BT2020_PQ_EXT);
attrib_list.push_back(EGL_NONE);
```

A.3 The sample codes to test if devices support 10bit rendering

The bit depth queried through the EGL interface should be equal to 10. The code calling method is as follows:

```
EGLDisplay display;
EGLConfig config;
//
//Omit the processing of display and config
//
EGLint r_size, g_size, b_size;
eglGetConfigAttrib(display, config, EGL_RED_SIZE, &r_size);
eglGetConfigAttrib(display, config, EGL_GREEN_SIZE, &g_size);
eglGetConfigAttrib(display, config, EGL_BLUE_SIZE, &b_size);
assert(r_size == 10);
assert(g_size == 10);
assert(b_size == 10);
```