DisplayHDR CTS v1.0 Errata E3
Published 02/12/19

This errata contains all SCRs published through 2/12/19.

The following SCRs are included in DisplayHDR_CTS_v1.0_E3:

- Refinement of the DPM Rise Time Performance Test
- Correction of the DisplayHDR_CTS, Appendix Table B-3
- DHDR_CTS_10%_patch_screen_saver_SCR v0.9
- DHDR_CTS_Add_True_Black_Level_SCR v0.92
- Updates to recommended test tool location & OS versions
- Introduction of the new 500 level to the DisplayHDR CTS
- DisplayHDR_Mode_Indicator_SCR
- DisplayHDR_DP_Certification_Requirement_SCR

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235F, Section 5):

TITLE:	Refinement of the DPM Rise Time Performance Test
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0.pdf
REVISION CATEGORY:	New material to clarify Rise Time and corrections to existing material to eliminate inconsistency.
SUBMITTED TO:	Task Group
SPONSOR:	Roland Wooster, Intel Corp.

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
02/13/2018	**Initial Submission of SCR 2/13/2018 Version 0.7**

(add more rows as needed)

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	02/13/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	04/21/2018 Adopted

1 Summary of the Proposed Change(s)

The current Rise Time test specification in the DisplayHDR CTS v1.0 is internally inconsistent, and incomplete in the following regards:

- Appendix B.8 states 10 seconds black, 10 seconds White patch. However, the DPM Test tool uses 5 seconds black, and 5 seconds with the white patch. During the VESA DPM meeting 1/30/2018 there was no objection to changing this to a 5 second sequence pattern.
- Appendix B.8 states that we use the image file defined in Appendix B.1, this is the 10% white patch that uses the Maximum White values of 10,000 cd/m2. However the test tool has been using the EDID Maximum White – i.e. the MaxLuminance value stated in the EDID. We need to ensure consistency between the CTS and the DPM Test tool. Best in this case to change the DPM Test tool to match the document, using white at 10,000 cd/m2.
- The CTS does not define how many times Rise Time should be measured. The Test Submission Template provides only space to record one value. However, based on discussion in the VESA DPM meeting 1/20/2018 it was proposed and agreed that we should test the Rise Time 5 times, the same number of times that we test during the Full-Screen Flash Test.

1.1 IPR (Intellectual Property Rights) declaration, if any

- None.

1.2 Benefits as a Result of the Changes

CTS internal consistency, and improved quality of the test by performing it 5 times rather than just 1.

1.3 Assessment of the Impact

Ensures consistency between testers using the DPM Test Tool versus tools developed by other parties.

1.4 Analysis of the Device Hardware Implication

Should not impact any devices negatively.

1.5 Analysis of the Device Software Implications

Minor update to the DPM Test tool to use existing image 1b rather than existing image 1a for the rise time sequence.

1.6 Analysis of the Compliance Test & Interop Implications

Test Submission Template has been updated to provide 5 boxes for entry of the 5 recordings rather than just 1.

1.7 New Referenced Documents Resulting from Change

VESA HDR Measurement Results_1.02.xlsx

1.8 Attachments

Provide details.

2 Proposed Document Change(s) or Addition(s)

The current CTS discusses Rise Time in Section 8 of the document, the final current section in section 8, is section 8.4. The proposed change is the new addition of a new section, 8.5. So this section is pure addition to the v1.0 CTS with nothing removed in section 8. Figure 8-3 is also new.

8.5 Rise Time Video Test Sequence

This section discusses the video sequence for validating the Rise Time. In this test the video transitions from a full black screen to the 10% patch test image, and then loops back to full black. This sequence then repeats and is measured 5 times. All 5 measurements must meet the performance requirements.

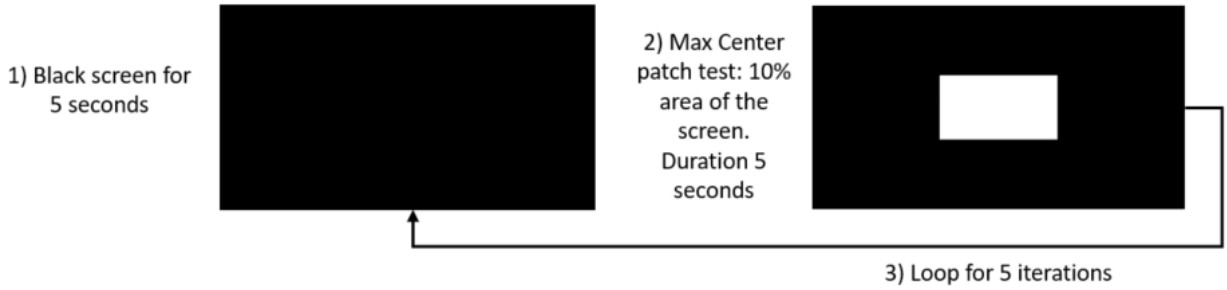


Figure 8-3: Rise-Time Sequence

The 10% center patch test uses the same values as stated in the Appendix B.1 for the "Max White" 10% patch test, using the 10,000 cd/m2 meta data and video pixel values.

Appendix B.8 also needs to be changed to be brought into internal consistency, changing the reference from 10 seconds to 5 seconds, and adding that we need to measure all of the first 5 Rise events:

B.8 Rise-time Test

This test uses the same image as for the 10% Center Patch Test (see Section B.1), switching on for ~~10~~ 5 seconds, switching off for ~~10~~ 5 seconds, and then looping indefinitely. The first five Rise-Times from black to white should be recorded and used for the measured values of the test.

- End of Document -

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235H, Section 5):

TITLE:	Correction of the DisplayHDR_CTS, Appendix Table B-3.
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0.pdf
REVISION CATEGORY:	Correction of Appendix B.4's Table B-3 to ensure consistency with the same document's Section 5.2.2 Table 5-6.
SUBMITTED TO:	Task Group
SPONSOR:	Roland Wooster, Intel Corp.

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
MM/DD/YYYY	**Initial Submission of SCR 3/13/2018 Version 0.7**

(add more rows as needed)

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	03/13/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	05/28/2018 Adopted

1 Summary of the Proposed Change(s)

Currently the CTS is not consistent with itself or with the DPM Test tool. In three places the following logic is stated or executed:

- Section 5.2.2, Table 5-6 defines the corner box luminance to scale with EDID stated luminance between the range of 400-600 cd/m2:

  > *For displays with a Maximum Luminance between 400 and 600cd/m2, the code value used for the corner box **white** would match the corresponding EOTF SMPTE ST 2084 code value for the stated Maximum Luminance value. Thus, the EOTF SMPTE ST 2084 code values would range from 668 to 712. For Maximum Luminance of 600cd/m2 or higher, a fixed code value of 712 is used for the corner box **white**.*

- The DPM test tool, in the February 27th 2018 version implements the behavior in a manner as stated above, explicitly:
  - For EDID MaxLuminance up to 400 cd/m2 the meta data shows a maximum of 400, and EOTF 2084 code value 668 (400 cd/m2) is used as the video signal.
  - For EDID MaxLuminance between 400 to 600 cd/m2 the metadata matches the EDID and the video signal is sent at a corresponding value to match the EDID value.
  - For EDID MaxLuminance at 600 cd/m2 and beyond the meta data shows a maximum of 600, and EOTF 2084 code value 712 (600 cd/m2) is used as the video signal.

- However, the problem lies in Appendix B.4, Table B-3. Which states:
  - Meta data is always 600 cd/m2, and the EOTF Code Value of 712 (600 cd/m2) to be used in all cases.

1.1 IPR (Intellectual Property Rights) declaration, if any

None.

1.2 Benefits as a Result of the Changes

CTS internal consistency.

1.3 Assessment of the Impact

Ensures consistency between testers using the DPM Test Tool versus tools developed by other parties.

1.4 Analysis of the Device Hardware Implication

No impact to device hardware.

1.5 Analysis of the Device Software Implications

No impact to device software.

1.6 Analysis of the Compliance Test & Interop Implications

Fixes an inconsistency, by increasing the complexity of the erroneously simplified Appendix. For a test house who has built test tools based on the Appendix this would result in some re-work of test development and increased complexity in that the same test can't be used for 400 cd/m2 and 600 cd/m2 displays.

1.7 New Referenced Documents Resulting from Change

None

1.8 Attachments

None.

2 Proposed Document Change(s) or Addition(s)

Current Appendix B.4, Table B-3 (Screen shot from the CTS):

B.4 Corner Box Test – Black-level Test

Table B-3: Corner Box Test – Black-level Test Specifications

Specification	Description
Image	• **Black** full-screen image, EOTF *SMPTE ST 2084*, code value of 0. • Four **white** rectangular boxes, EOTF *SMPTE ST 2084*, code value of 712, that each match the aspect ratio of the full screen, each comprising 2.5% of the screen's area (10% total). The four **white** rectangular boxes are "snapped" to the four corners of the **black** background, with two adjacent sides of the **white** boxes touching two of the **black** background's edges. Each **white** rectangular box is thus 15.81% of the screen's pixel height, and 15.81% of the screen's pixel width.
Metadata	• MaxCLL 600cd/m^2 • MasteringLuminance 600cd/m^2 • MaxFALL[a] 60cd/m^2 • Chromaticity Should be maximum *ITU-R BT.2020* values

a. MaxFALL is only 60cd/m^2 because the four corners at 600cd/m^2 total only 10% of the screen.

Proposed text within the updated Table B-3:

Image:

- **Black** full-screen image, EOTF *SMPTE ST 2084*, code value of 0.
- **White** luminance level of the corner box video signal is determined based on the MaxLuminance of the EDID of the display. For displays where the EDID is 400 cd/m2 the video signal will be EOTF *SMPTE ST 2084*, code value 668 (400 cd/m2), for displays where the EDID is 600 cd/m2 or higher, the EOTF *SMPTE ST 2084* code value of 712 will be used. For displays whose EDID MaxLuminance values are between 400 and 600, the EOTF *SMPTE ST 2084* code value will range from 668-712 and be selected so as to most closely match the luminance level indicated by the MaxLuminance of the EDID as possible.
- Four **white** rectangular boxes, EOTF *SMPTE ST 2084*, code value of between 668 and 712 using the logic defined above, that each match the aspect ratio of the full screen, each comprising 2.5% of the screen's area (10% total). The four **white** rectangular boxes are "snapped" to the four corners of the **black** background, with two adjacent sides of the **white** boxes touching two of the **black** background's edges. Each **white** rectangular box is thus 15.81% of the screen's pixel height, and 15.81% of the screen's pixel width.

Metadata:

- MaxCLL ranges from 400-600 cd/m2 designed to match the EDID, with a maximum of 600.
- MasteringLuminance 400-600 cd/m2 designed to match the EDID, with a maximum of 600
- MaxFALL ranges from 40-60[a] cd/m2 and is always 10% of the MaxCLL
- Chromaticity Should be maximum ITU-R BT.2020 values.

a. MaxFALL is only 10% of MaxCLL because the four corners cover only 10% of the full screen.

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235F, Section 5):

TITLE:	DHDR_CTS_10%_patch_screen_saver_SCR v0.9
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0.pdf
REVISION CATEGORY:	Category 2
SUBMITTED TO:	Task Group
SPONSOR:	Roland Wooster, Intel Corp.

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/20/2018	**Initial Submission of SCR**
10/29/2018	Revision 0.70
11/09/2018	Revision 0.9 – contains actual code for the box motion path

(add more rows as needed)

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/29/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	12/20/2018 - Adopted

1 Summary of the Proposed Change(s)

- There is a risk of screen damage with high luminance high contrast edges if a tool is used abusively or without limit. This SCR changes adds random motion to the 10% test patch, the patch stays a fixed size, and fixed aspect ratio which matches the screen, but "vibrates" up and down, left and right a few pixels to eliminate burn in damage.

1.1 IPR (Intellectual Property Rights) declaration, if any

- None.

1.2 Benefits as a Result of the Changes

- Greatly reduces the potential for screen damage that could potentially be caused by excessively long usage of the 10% test patch image.

1.3 Assessment of the Impact

- None.

1.4 Analysis of the Device Hardware Implication

- None.

1.5 Analysis of the Device Software Implications

- No impact to test routines

1.6 Analysis of the Compliance Test & Interop Implications

- None

1.7 New Referenced Documents Resulting from Change

- None

1.8 Attachments

None.

2 Proposed Document Change(s) or Addition(s)

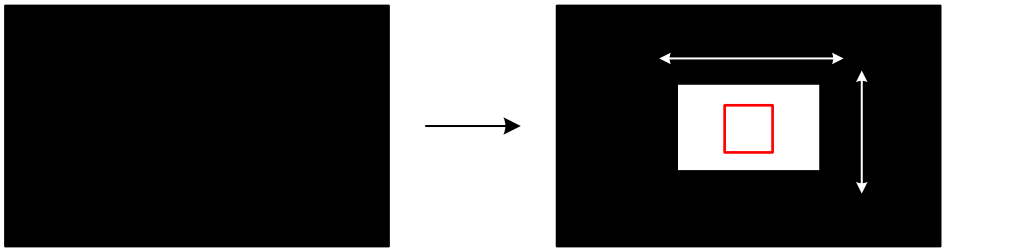
Delete the red text.

Add the blue text

Black text is original content that remains.

Replace section 5.1.1 with the following section

5.1.1 Minimum-white Luminance – 10% Center Patch Test



Assert a black image for 60 seconds for cool-down and reset.

Display a white centered patch that randomly dithers at 500 ms intervals, by 1% of the number of pixels in each direction. Apply the sequence for 30 minutes.

The red box illustrates the colorimeter probe target.

Replace Figure 5-1 with the above.

- Black video signal is provided for 60 seconds, code value 0. Actual backlight power would thus be determined by scaler/TCON/GPU.
- Bright white, code value 1023. Center Patch test is assumed to reach "steady state," from a power delivery and thermal perspective, within 30 minutes. Thus, there is no need to repeat the test more than once.

- A sequence of bright white, code value 1023, patches. The patch location shall be static for 500 ms and shift randomly in around the center with a uniform pseudorandom value. A constant random seed shall be used to obtain the same random sequence whenever the pattern starts.
- `The actual code used for the motion path is defined in Appendix B.1`

< Note, the above is matlab sample code, the pseudo code from the DisplayHDR test tool will be used in the final SCR>

- Luminance is measured at the screen's center once per minute for 30 measurements, over 30 minutes, using the same panel. The first measurement should be obtained within 5 seconds of when the **white** box begins to display. The red box in Figure 5-4 is only illustrative.
- All 30 measurements must be measured at a level that is higher than the Minimum Required Luminance specified in Table 5-2.

Table 5-2: 10% Center Patch Test Performance Requirements

DisplayHDR Performance Tier	Minimum Luminance Level (cd/m^2)
400	400
500	500
600	600
1000	1000

- Luminance delta between the highest and lowest of the 30 measurements must be less than 10%. The highest measurement divided by the lowest measurement must have a ratio less than 1.1:1.

Appendix

B.1 Minimum-white Luminance – 10% Center Patch Test

Black full-screen image, EOTF *SMPTE ST 2084*, code value of 0.

White rectangular box, EOTF *SMPTE ST 2084*, code value of 1023, that matches the aspect ratio of the full screen, comprising 10% of the screen's area, centered and placed on top of the **black** background. The rectangular box is thus 31.62% of the screen's pixel height, and 31.62% of the screen's pixel width.

Motion: The following motion algorithm is to be used for the white box:

```
    float c = nitstoCCCS(nits);
    float dpi = m_deviceResources->GetDpi();

    // create Brush to paint rectangle with
    ComPtr<ID2D1SolidColorBrush> peakBrush;
    DX::ThrowIfFailed(ctx->CreateSolidColorBrush(D2D1::ColorF(c, c, c), &peakBrush));

    // get screen dimensions in DIPS
    auto logSize = m_deviceResources->GetLogicalSize();
    float2 jitter;

#define randf()((float)rand()/(float(RAND_MAX)))              // standard posix integer
rand()
    do {
              jitter.x = 10.0*(dpi/96.)*randf()*2.f - 1.f;
              jitter.y = 10.0*(dpi/96.)*randf()*2.f - 1.f;
    }
    // round off the corners
    while( (jitter.x*jitter.x + jitter.y*jitter.y) > 10.f*dpi/96.);

    // compute rectangle to draw
    D2D1_RECT_F tenPercentRect =
    {
              (logSize.right - logSize.left) * (0.5f - sqrtf(0.1) / 2.0f) + jitter.x,
              (logSize.bottom - logSize.top) * (0.5f - sqrtf(0.1) / 2.0f) + jitter.y,
              (logSize.right - logSize.left) * (0.5f + sqrtf(0.1) / 2.0f) + jitter.x,
              (logSize.bottom - logSize.top) * (0.5f + sqrtf(0.1) / 2.0f) + jitter.y
    };

    // draw the actual rectangle
```

```
ctx->FillRectangle(&tenPercentRect, peakBrush.Get());
```

- End of Document -

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235H, Section 5)

TITLE:	DHDR_CTS_Add_True_Black_Level_SCR v0.92
AFFECTED DOCUMENT:	DisplayHDR CTS v1.0
REVISION CATEGORY:	
SUBMITTED TO:	DPM Task Group
SPONSOR:	Intel (Roland Wooster)

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/26/2018	**Initial Submission of SCR**
10/30/2018	Updates during DPM meeting (fixed "Premium" typo, and adjusted section 10.2 text)
11/09/2018	Version 0.9 – Updated to add a description of the need to prevent ambient light reflection from entering the screen and detrimentally impacting the black level measurement.
12/3/2018	Version 0.91 added inputs from Kavi Comments: #851 – Adding DCI-P3 color requirements. #829 – IEC 62341-6-1 dark measurement #830 – For dark readings taking 10 readings and averaging.
12/5/2018	Version 0.92 – updated to change True-Black-400 full-screen luminance to 250 nits, and to add additional requirements related to the sum of luminance values in the R, G, B tests. Changes implemented in Tables 10-1 and 10-2.

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/25/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)

DATE SCR ADOPTED or REJECTED or DISPOSITIONED	12/22/2018 Adopted

Summary of the Proposed Change(s)

This SCR is submitted as an alternative proposal to the SCR to add the Premium Quality Level to the DipslayHDR CTS. The schedule is so tight that this SCR is being created as a simpler alternative to the complete Premium level SCR. With this SCR we would be able to introduce a "True Black" (final marketing name TBD) level at CES 2019, and then work on a "Premium" (final marketing name TBD) level in 2019 for launch later. The new updated Premium level would then apply to both the existing (Classic/Baseline level) and the new "True Black" level.

IPR (Intellectual Property Rights) declaration, if any

No declarations.

Benefits as a Result of the Changes

Add a new display performance tier to the CTS for wider adoption of the DisplayHDR logo.

Assessment of the Impact

Increase use of the VESA logo.

Analysis of the Device Hardware Implication

Hardware compliance to the CTS required.

Analysis of the Device Software Implications

None.

Analysis of the Compliance Test & Interop Implications

Increased HDR interoperability will result. No tool updates required.

New Referenced Documents Resulting from Change

None.

Attachments

None.

Proposed Document Change(s) or Addition(s)

Item 1 – Additions and changes to the introduction, scope, glossary and references

1.1 Add as a new paragraph at the end of the Section 1.2 Introduction:

In addition to performance tiers, VESA defined a new quality level in the CTS version 1.1 to build upon each performance tier in recognition of higher-grade HDR quality. The new performance level(s) and associated logo label name(s) are listed, below. The test criteria for each tier and quality level are discussed throughout the remainder of this document.

1. "True Black" performance level (see Section 10)

1.2 Replace the Section 1.3 Scope, paragraph 2 with:

The defined specifications are designed for LCD and OLED.

1.3 Add the following terms to the Section 1.4 Glossary, Table 1-1:

Term	Description
OLED	Organic Light Emitting Diode.

1.4 Add the following document to Table 1-2

column 1: "Organic light emitting diodes -- Part 6-1: Measuring methods of optical and electro-optical parameters"

column 2: edition 2

column 3: 2017-01

column 4: IEC 62341-6-1

1.5 Replace the 4th paragraph of Section 3.4 Colorimeter Requirements with:

Depending upon the performance level of the display under test there are different minimum luminance requirement tests. Thus when testing hardware at the baseline performance level the measuring hardware must be capable of accurately measuring down to 0.05cd/m^2. To measure displays at the True Black level, the measuring hardware must be capable of accurately measuring down to 0.0005 cd/m^2 or less.

1.6 Replace Table 7-1 in Section 7.1 Bit-depth Specifications

Minimum Requirement	**Description**	**DisplayHDR PerformanceTier**		
		400	**500/ 600/ 1000**	**True Black**
10-bit video signal, per channel	Required of HDR10, and is required as the input video signal to the local or global dimming processing unit. Depending on the system design, this may be the scaler, GPU, TCON, or alternative chip; however, the requirement is simply that 10-bit input is required of the unit that is calculating the histogram and corresponding video transparency.	✔	✔	✔
	Ideally the display pipeline can operate at true 10-bit throughout the entire pipeline; however, for cost saving, this tier permits conversion down to a minimum of 8-bit, but not 6b + 2b FRC. The requirement is that the video data is maintained at a minimum of 8 bits through the scaler (if present), TCON, and driver IC.	✔		

Minimum Requirement	Description	DisplayHDR PerformanceTier		
		400	500/ 600/ 1000	True Black
Temporal or spatial dithering	Ideally, the display pipeline can operate at true 10-bit throughout the entire pipeline; however, for cost saving, these tiers permit simulated 10-bit using a minimum of 8-bit plus dithering, typically referred to as "8b + 2b FRC," which simulates an additional two bits of resolution within the display pipeline. Typically, the 8b + 2b FRC will be implemented in the TCON for display pipelines that do not have a scaler, or the dithering could be done by the GPU outputting 8 bits to the TCON. However, for display pipelines that have a scaler, 8b + 2b FRC will typically be implemented in the scaler; the TCON and driver IC could operate at 8 bits.		✔	✔
Minimum 8-bit digital-to-analog conversion	The driver IC, which is responsible for converting the digital video signal to an analog voltage to drive the liquid crystal, is required to operate at a minimum of 8-bit resolution, with 256 discrete values, represented at sufficient voltage accuracy to record each unique value.	✔	✔	✔
Backlight control	To eliminate checkerboard patterning that may occur on segmented local dimming panels, backlight control needs be driven to an 8-bit accuracy level, but does not necessarily need to implement all 256 potential levels of dimming. This high level of backlight power control accuracy is **not** required for panels without segmented backlights.	✔	✔	✔

1.7 New section 3.7 Methodology for Black Level Testing

Test implementers should follow standard dark room conditions for measurements prescribed in IEC 62341-6-1, which states.

> *"the luminance contribution from unwanted background illumination reflected off the test display shall be less than 1/20 of the display's black state luminance".*

Refer to the cited procedure document for further dtails to calibrate black level measurements.

A colorimeter should be positioned such that a soft frustum that prevents ambient light entering the test area. If the black level measured meets the required performance level no further preparation is needed.

Item 2 – Add DisplayHDR True Black level in a new Clause 10

2.1 Add the text and new table after the end of the Section 9:

10. True Black performance level

10.1 True Black performance level usage

This section specifies the required performance for products to meet a “True Black” qualification. All tests called for in DisplayHDR Section 2 are required, unless waived or modified by new limits defined in section 10.2. A product shall pass all of the tests in Table 10-2 to carry a “True Black” performance designation.

10.2 Test Modifications

The Full Screen Flash, and Full Screen Long Duration tests are adjusted accordingly. The Max Luminance 10% patch tests remain unchanged.

Table 10-1 DisplayHDR “True Black” Performance Test Adjustments

Test	400 Tier	500 Tier	600 Tier	1000 and Future Higher Tiers	Section reference
Minimum white luminance full screen flash	250 cd/m^2	300 cd/m^2	350 cd/m^2	Per Tier Specifications	5.1.2
Minimum full screen luminance 30 minutes	250 cd/m^2	300 cd/m^2	(350 cd/m^2) This is per Tier Spec	Per Tier Specifications	5.1.3

10.3 True Black Quality level tests

Table 10-2 denotes normative tests that shall be met for a product to be designated DisplayHDR True Black. Within this table, the CTS Section reference points to the applicable test method. If new test limits are not designated in Table 10-1, the test limit for the base performance tier applies to the Premium Quality Level.

Table 10-2 DisplayHDR True Black Performance Level test limits

Test	Minimum	Maximum	Section reference
Maximum black luminance Corner Box Test		0.0005 cd/m^2	5.2.1
Maximum black luminance for tunnel test		0.0005 cd/m^2	5.2.2
Color Gamut Coverage BT.709	99%		6
Color Gamut Coverage DCI-P3-D65	90%		6

Test	Minimum	Maximum	Section reference
Sum of luminance of Color components in test 6a (EDID based 100% full screen color: R, G, B tests)	Sum of Lr+Lg+Lb matches the tier based Full Screen white luminance requirement as stated per the tiers in Table 10-1.		6
Bit depth	8+2		7.2.1
Rise time		2 frames at 60 Hz (33 ms)	8.2, 8.4

Follow the dark room environment for measurement procedure in IEC 62341-6-1 to assure acceptably low unwanted incident light on the display under test. After the test begins, record 10 measurements with a minimum of time between measurements as determined by hardware and practical execution. Average the 10 readings and report as the measured black luminance after accommodation for the room environment, if required.

- End of Document -

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235F, Section 5):

TITLE:	Updates to recommended test tool location & OS versions
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0.pdf
REVISION CATEGORY:	Provides useful updates to end users for where to obtain the test tools and the versions involved.
SUBMITTED TO:	Task Group
SPONSOR:	Roland Wooster, Intel Corp.

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/19/2018	**Initial Submission of SCR**
10/25/2018	Fixed cut and paste error in the summary of changes and minor grammatical improvements made.

(add more rows as needed)

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/19/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	12/22/2018 Adopted

1 Summary of the Proposed Change(s)

- Update to the OS versions, GPU drivers, and test tools.

1.1 IPR (Intellectual Property Rights) declaration, if any

- None.

1.2 Benefits as a Result of the Changes

- Corrects the location of where to download the DisplayHDR test tool, and updates the references to various GPU and OS versions required for usage of the tool.

1.3 Assessment of the Impact

- None.

1.4 Analysis of the Device Hardware Implication

- None.

1.5 Analysis of the Device Software Implications

- No impact to test routines

1.6 Analysis of the Compliance Test & Interop Implications

- None

1.7 New Referenced Documents Resulting from Change

- None

1.8 Attachments

None.

2 Proposed Document Change(s) or Addition(s)

Delete the current section 3.5, shown in red.

Replace it with the text in blue.

3.5 Hardware and Software for Semi-automated Testing

An HDR10-ready PC using DisplayPort™ or HDMI® can be used to connect to the HDR10-enabled monitor and/or display hardware. The display will not be considered

HDR10-compliant unless there are *CTA-861.3*-conformant DisplayID (or legacy EDID+CTA) data blocks. A test application is available from Microsoft® for free, by way of the Microsoft Store. Temporarily, the beta version of the test application is available in the VESA Kavi workspace (www.vesa.org/vesa-member/downloads/) in the compressed ZIP file, **DPMTest-2017-*MM-DD*.zip**.

The test application is **not** integrated with colorimeter input and monitoring; thus, a second computer is required to be connected to the colorimeter to record the colorimeter data.

Graphics hardware that supports HDR10 is required. The following suggested options are known to work with Windows®:

- Using discrete graphics (AMD® or NVIDIA® cards):
  - Microsoft Windows Creators Edition (RS2, Version 1703, Build 15063 or higher)
  - AMD Radeon Rx 5xx series and Radeon Rx Vega, –or–
  - NVIDIA GeForce GTX 10-Series video drivers and graphics cards (current versions)
  - HDR Test application, **WindowsDisplayColorPerformance.exe**
- Using integrated graphics (7th Generation Intel® Core™ processors):
  - Using a 7th Generation processor with Intel HD Graphics 630 or higher, this includes all 7th Generation desktop Core i7 and Core i5 processors, and all mobile Core i7 and many Core i5 processors
  - Microsoft Windows Fall Creators Edition (RS3, Version 1709, Build 16299 or higher)
  - Intel Redstone 3 video driver (Version 15.60.4832 or higher)
  - HDR Test application, **WindowsDisplayColorPerformance.exe**

3.5 Hardware and Software for Semi-automated Testing

An HDR10-ready PC using DisplayPort™ or HDMI® can be used to connect to the HDR10-enabled monitor and/or display hardware. The display will not be considered

HDR10-compliant unless there are *CTA-861.3*-conformant DisplayID (or legacy EDID+CTA) data blocks. A test application, called "DisplayHDR Test" is available from Microsoft® for free, by way of the Microsoft Store.

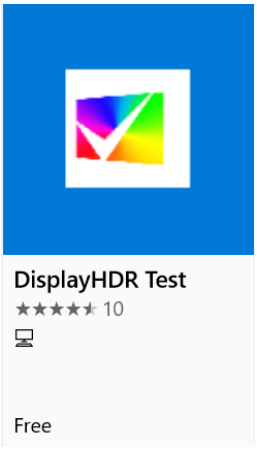


Figure x.x Microsoft Store UI for the DisplayHDR Test tool.

The test application is **not** integrated with colorimeter input and monitoring; thus, a second computer is required to be connected to the colorimeter to record the colorimeter data.

Graphics hardware that supports HDR10 is required. The following suggested options are known to work with Windows®:

- AMD® Radeon Rx 5xx series and Radeon Rx Vega, or later,
- Intel® 7th Generation Core™ processors, or later, with 620 graphics, or higher.
- NVIDIA® GeForce GTX 10-Series graphics cards, or later

It is recommended to use Windows 10, updated to the April 2018 Update (Redstone 4) or later.

- End of Document -

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235F, Section 5):

TITLE:	Introduction of the new 500 level to the DisplayHDR CTS
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0.pdf
REVISION CATEGORY:	New material to create the 500 performance level
SUBMITTED TO:	Task Group
SPONSOR:	Roland Wooster, Intel Corp.

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/19/2018	**Initial Submission of SCR**
10/25/2018	Minor typos fixed.

(add more rows as needed)

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/19/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	12/22/2018 Adopted

1 Summary of the Proposed Change(s)

- Due to the desired introduction of support for OLED with two performance levels at 400 and 500 we need to create a new performance tier at 500 as our current performance levels only include 400, 600, and 1000.

1.1 IPR (Intellectual Property Rights) declaration, if any

- None.

1.2 Benefits as a Result of the Changes

- Creates a second performance level applicable to OLED screens

1.3 Assessment of the Impact

- No downside impact to anyone. We add a new performance tier that introduces more options not just for OLED but also for any other screen type technology such as LCD.
- No impact to test routines
- No impact to existing 400, 600, 1000 tiers, or any certified products.

1.4 Analysis of the Device Hardware Implication

- None.

1.5 Analysis of the Device Software Implications

- No impact to test routines

1.6 Analysis of the Compliance Test & Interop Implications

- None

1.7 New Referenced Documents Resulting from Change

- None

1.8 Attachments

None.

2 Proposed Document Change(s) or Addition(s)

Text removal indicated in Red

Text addition indicated in Blue

1.2 – Introduction

The initial three tiers and their associated label names are listed below. The test criteria for each tier is discussed throughout the remainder of this Specification.

- DisplayHDR-400
- DisplayHDR-600
- DisplayHDR-1000

Initially three tiers were introduced in December of 2017 at 400, 600, 1000. Subsequent to that the 500 tier was added. The four current tiers and their associated label names are listed below. The test criteria for each tier is discussed throughout the remainder of this Specification.

- DisplayHDR-400
- DisplayHDR-500
- DisplayHDR-600
- DisplayHDR-1000

2 Specification Summary (add the following row to table 2-1)

Tier	Minimum-white Luminance Test – 10% Center Patch and Full-screen Flash Tests Minimum Requirement (cd/m^2)[a]	Minimum-white Luminance – Test Full-screen Long-duration Test Minimum Requirement (cd/m^2)[b]	Corner Box Test – Black-level Test Maximum (cd/m^2)[c]	Tunnel Test – Black-level Test Maximum (cd/m^2)[d]	Minimum Color Gamut in *CIE 1976* u', v' Format [e]	Minimum Bit Depth[f]
500	500	320	0.10	0.10	99% ITU-R BT.709 And 90% DCI-P3 D65 (SMPTE RP 431-2)	• 10-bit image processing in dimming processor • 8b + 2b dithering in display pipeline • 8-bit driver IC

5.1.1 Minimum-White Luminance – 10% Center Patch Test (add the entry for 500 level)

DisplayHDR Performance Tier	Minimum Luminance Level (cd/m^2)
500	500

Add this entry to both Tables both 5-2 and 5-3 (10% Patch and 100% Flash)

DisplayHDR Performance Tier	Minimum Luminance Level (cd/m^2)
500	320

Add this entry to Table 5-4 (Full Screen long duration)

Table 5-6 (add the row in blue, and add the text in blue to the footnote "a") (corner box)

DisplayHDR Performance Tier	Video Signal Corner Box Luminance Level (cd/m^2)	Corner (Full Range) Code Value	MaxCLL (Full Range) Code Value	Screen Center, Maximum Luminance Level (cd/m^2)
400	400	668	668	0.40
500	500	692	692	0.10
600	600	712	712	0.10
1000	600	712	712	0.05

a. *Listed values are code values for systems with DisplayID (or legacy EDID+CTA) values indicating a Maximum Luminance of 400, 500, 600, or 1000cd/m^2.*

Table 5-7 (tunnel test)

DisplayHDR Performance Tier	Maximum Luminance Level (cd/m^2)
500	0.10

Table 6-1 (color)

DisplayHDR Performance Tier	*ITU-R BT.709* Coverage (*CIE 1976* u', v' Format)		DCI-P3 D65[a] Coverage (*CIE 1976* u', v' Format)	
400	95%	Minimum	Not specified	
500	99%		90%	Minimum
600	99%		90%	

1000	99%		90%	

a. Defined in SMPTE RP 431-2.

Table 7-1 (Bit depth)

Add a new column for 500 that matches both the existing 600 and 1000 columns. In fact, given we will have three identical columns, perhaps even better to collapse into one column.

Minimum Requirement	Description	DisplayHDR Performance Tier	
		400	500/600/1000
10-bit video signal, per channel	Required of HDR10, and is required as the input video signal to the local or global dimming processing unit. Depending on the system design, this may be the scaler, GPU, TCON, or alternative chip; however, the requirement is simply that 10-bit input is required of the unit that is calculating the histogram and corresponding video transparency.	✔	✔
Temporal or spatial dithering	Ideally the display pipeline can operate at true 10-bit throughout the entire pipeline; however, for cost saving, this tier permits conversion down to a minimum of 8-bit, but not 6b + 2b FRC. The requirement is that the video data is maintained at a minimum of 8 bits through the scaler (if present), TCON, and driver IC.	✔	
	Ideally, the display pipeline can operate at true 10-bit throughout the entire pipeline; however, for cost saving, these tiers permit simulated 10-bit using a minimum of 8-bit plus dithering, typically referred to as "8b + 2b FRC," which simulates an additional two bits of resolution within the display pipeline. Typically, the 8b + 2b FRC will be implemented in the TCON for display pipelines that do not have a scaler, or the dithering could be done by the GPU outputting 8 bits to the TCON. However, for display pipelines that have a scaler, 8b + 2b FRC will typically be implemented in the scaler; the TCON and driver IC could operate at 8 bits.		✔
Minimum 8-bit digital-to-analog conversion	The driver IC, which is responsible for converting the digital video signal to an analog voltage to drive the liquid crystal, is required to operate at a minimum of 8-bit resolution, with 256 discrete values, represented at sufficient voltage accuracy to record each unique value.	✔	✔
Backlight control	To eliminate checkerboard patterning that may occur on segmented local dimming panels, backlight control needs be driven to an 8-bit accuracy level, but does not necessarily need to implement all 256 potential levels of dimming. This high level of backlight power control accuracy is **not** required for panels without segmented backlights.	✔	✔

8.2 Rise Time Definition

For the purposes of this Specification, “rise time” is the length of time that the display takes to transition from **black** to **white**. More specifically, it is the length of time that the display takes to transition from minimum luminance to the required 10% center patch peak luminance that is specified for the panel (i.e., 400, 500, 600, or 1000cd/m^2).

- End of Document -

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235H, Section 5)

TITLE:	DisplayHDR_Mode_Indicator_SCR
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0
REVISION CATEGORY:	
SUBMITTED TO:	Display Performance Metrics Task Group
SPONSOR:	Jim Choate, VESA CPM

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/23/2018	**Initial Submission of SCR**
10/30/2018	Added clarification that laptop displays do not require mode indicator.

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/23/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	01/13/2019 Adopted

Summary of the Proposed Change(s)

Add subsection 3.7 DisplayHDR OSD Mode Indication Requirements

IPR (Intellectual Property Rights) declaration, if any

Submitter is not aware of any IP associated with this SCR.

Benefits as a Result of the Changes

End users will be able to properly select display settings to enable DisplayHDR.

Assessment of the Impact

Effective October 1, 2019 this requirement will need to be met for DisplayHDR certification.

Analysis of the Device Hardware Implication

None.

Analysis of the Device Software Implications

Device software/firmware may need to be updated to indicate in OSD which mode(s) enable DisplayHDR performance.

Analysis of the Compliance Test & Interop Implications

Compliance testing will include verification that DisplayHDR mode(s) are indicated in OSD.

New Referenced Documents Resulting from Change

None.

Attachments

None

Proposed Document Change(s) or Addition(s)

Section 3 Test Environment

Add:
3.7 DisplayHDR OSD Mode Indication Requirements

Most displays include more than one Mode setting to allow end users to configure the display, using the On-Screen-Display (OSD) menu system, to optimize the display settings for the particular use case. For example, Game Mode.

To ensure Certified DisplayHDR displays can be easily configured to operate in DisplayHDR mode it is important to provide testers and end users unambiguous display settings to enable DisplayHDR.

Certified DisplayHDR displays shall include a profile or mode available through the On-Screen-Display (OSD) menu system which clearly indicates which mode(s) conform to DisplayHDR performance.

For example: “DisplayHDR Mode”

If all modes (including if only one mode exists) support DisplayHDR then indication is optional.

This requirement does not apply to integrated laptop displays.

Addition of a New Table and Figure

VESA STANDARDS CHANGE REQUEST FORM

To be Filled in by Submitter (Refer to VESA Document VP235H, Section 5)

TITLE:	DisplayHDR_DP_Certification_Requirement_SCR D3
AFFECTED DOCUMENT:	DisplayHDR_CTS_v1.0
REVISION CATEGORY:	
SUBMITTED TO:	Display Performance Metrics Task Group
SPONSOR:	Jim Choate, VESA CPM

SCR REVISION HISTORY	
(DATE)	**(CHANGE)**
10/30/2018	**Initial Submission of SCR**
11/8/2018	Added clarification that only DisplayHDR inputs must be DP certified and added reference to DP certification requirements.
11/15/2018	Added reference to DisplayPort Alt Mode over USB Type-C CTS

To be Filled in by VESA Office:

VESA SCR NUMBER:	(To be assigned by VESA office)
SCR ENTRY DATE:	10/30/2018

To be Filled in by Task Group or VESA Office

SCR ADOPTED, REJECTED, or otherwise DISPOSITIONED for other action	SCR is (adopted) or (rejected) or (Dispositioned for other action) If rejected, explain reason for acceptation or rejection If dispositioned, explain action or plan for action (such as including in future draft specification revision, or re-visiting at future date, or other)
DATE SCR ADOPTED or REJECTED or DISPOSITIONED	02/08/2019 - Adopted

Summary of the Proposed Change(s)

Add subsection 3.8 DisplayPort Certification Requirement

IPR (Intellectual Property Rights) declaration, if any

Submitter is not aware of any IP associated with this SCR.

Benefits as a Result of the Changes

End users will experience better interoperability and achieve DisplayHDR performance when using DisplayPort or DP Alt Mode over USB Type-C inputs.

Assessment of the Impact

Effective October 1, 2019 this requirement will need to be met for DisplayHDR certification.

Analysis of the Device Hardware Implication

None.

Analysis of the Device Software Implications

None.

Analysis of the Compliance Test & Interop Implications

Compliance testing will need to be performed and pass on all DisplayPort and DP Alt Mode over USB Type-C ports as a pre-requisite to DisplayHDR certification.

New Referenced Documents Resulting from Change

None.

Attachments

None

Proposed Document Change(s) or Addition(s)

Section 3 Test Environment

Add:
3.8 DisplayPort Certification Requirement

All standard input connectors that (a) claim support for the tests in this document and (b) are either DisplayPort or DP Alt Mode over USB Type-C shall be VESA DisplayPort certified per appropriate VESA licensing policy.

Standard input connectors that may be subject to the above VESA DisplayPort certification are:

- DP Alt Mode over USB Type-C inputs
- Standard DP input(s)
- Mini-DP input(s)

Users should refer to appropriate VESA licensing documents to ascertain compliance rules and the relevant, in-force specifications guiding VESA DisplayPort certification requirements.

Addition of a New Table and Figure