DOLBY

Dolby Vision™ Best Practices Guide

Dolby Vision Certified Mastering Facilities

Colorgrading Systems and Monitors

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Introduction

This document provides the requirements and testing methods for a post-production facility seeking Dolby Vision Certification. The test verifies proper monitoring of an image inclusive of the storage, router, colorgrading system and grading monitor. Facility certification by Dolby is an option available to post production facilities. Certification assures the market that Dolby has provided training to colorists and QC personnel on the best practices for creating Dolby Vision content and the facility has been commissioned by Dolby engineers.

Reference Documents & Files:

> Information Display Measurements Standard ("IDMS"):
> https://www.icdm-sid.org/downloads/idms1.html
>
> EBU User Requirements for Video Monitors in Television Production:
> https://tech.ebu.ch/docs/tech/tech3320.pdf
>
> Certified Facility Test Files:
> https://dolby.box.com/s/4z0rachh0lswhg3wfl71x1dxl470njlh

1. Overview:

   a. The Recommended Specifications in section 2 of this document are highly encouraged by Dolby but are at the discretion of the facility based on their customer's needs.

   b. The Required Specification in section 3 and section 4 will be checked by Dolby during Certification of a post-production facility. A Dolby Vision Certified Facility is required to meet the measurements in section 3 and 4 of this document.

   c. Measurements will use the entire system starting with file storage, loading test images into the colorgrading system and viewing the test images at the color grading monitor. The path should include all routing, signal conversions and LUTs that are part of the system.

2. Recommended Specifications:

   a. The monitor should be classified as an EBU Grade-1a or 1b HDR monitor as defined by EBU Tech 3320.

   b. The monitor should support input color gamut of Rec 709, P3/D65 and Rec2020 (regardless of actual gamut coverage)

3. Required Specifications

a. General Monitor Specifications

	Minimum	Preferred
Peak Luminance (L_w):	1,000 Nits	> 1,000 Nits
Minimum Black (L_k):	0.005 Nits	.001 Nits
Contrast Ratio (CR):	200,000:1	> 1,000,000: 1
Color Gamut Modes:	P3	Rec 709 / P3 & Rec 2020
EOTF:	SMPTE 2084	SMPTE 2084 & Gamma 2.4

b: Signal path & Monitor

Bit depth:	10 bits	12 Bits
Sampling:	RGB 4:4:4	RGB 4:4:4

4. Measuring Peak Luminance, Minimum Black and calculating Contrast Ratio

Refer to IDMS 5.13

DESCRIPTION: We measure the center contrast of the screen with an L32 loading pattern. L32 is a white rectangle centered in black that covers 10% percent of the total screen area. This measurement is compared to a black level measurement using a centered black area with four white boxes placed in each corner, each covering 2.5% of the total screen area). The white boxes should be a full luminance value of 4095 for 12-bit image data.

Note: Please consider that the number associated with the Loading Pattern (e.g. 'L32') refers to the diagonal of the pattern in respect to the display diagonal and is therefore 1D (see also IDMS 5.24: LOADING). The display area is also commonly used and is a 2D property. For example, a 10% area relates to an L32 loading pattern. The conversion between the two properties can be carried out with the following equation:

LoadTargetSize = sqrt(Area/0.01)

PROCEDURE: Consider using a mask (flat or frustum tube) that does not touch the screen when measuring the black center pattern to be sure that there is no veiling-glare from the white corners when making the black measurement. The mask must not touch the screen 'Please refer to the ICDM general measurement guidelines to achieve accurate measurements.

Load the test images into your media storage system. Import the 24 image files as a sequence into the color grading system. Using test image #20 in the sequence measure the luminance (L_W) of the white-center pattern on your monitor. This is your Peak Luminance value

Using test image #24 in the sequence measure the luminance (L_K) of the black-center pattern. This is your Minimum Black value.

Note: Some technologies such as OLED may produce a black level that is beyond the sensitivity of yoru measuring device. If this is the case please refer to the manufacturer spec or use the best measurement you can obtain.

ANALYSIS: Calculate the Contrast Ratio: $CR = L_W/L_K$.

5. Measuring Grey Scale Reproduction

Refer to IDMS: 6.1, 6.15 & EBU Tech 3320: 2.3.5 - 2.3.6

DESCRIPTION: Measure the 20 image code values and verify the following maximum dE ICtCp (see appendix) for each code value.

PROCEDURE: Load the test images into your media storage system. Import the 24 image files as a sequence into the color grading system. Using test images 1 - 21 as a sequence measure and calculate dEICtCp against the reference values provided in Table 1. You can measure x,y,Y values and calculate dE ICtCp or use one of several calibration tools that automatically measure and calculate dE ICtCp. Table 1 below indicates the 21 test images and their associated reference luminance values.

All code values above the peak luminance (L_w) measured in step 2 should result in the same peak measurement (L_w) through code value 4095. There should not be a roll-off of peak luminance. All code values above measured peak luminance (L_w) should result in clipping the luminance level. If the system is a 10 bit system then it should convert the 12 bit images to 10 bit and result in the same Monitor Luminance and Maximum dE ICtCp.

Currently we are only showing measurements to a peak luminance of 4,000 nits. We will update this document when commercial monitors above this peak luminance are available.

Table 1

12 Bit SDI Full Range

Test Image #	*12 bit image code value SDI to Monitor*	*Monitor Luminance (Y)*	*Maximum dE ICtCp*
	0-15	Reserved for SDI Timing	-
1	64	0.005	2.0
2	128	0.022	2.0
3	256	0.101	2.0
4	481	0.500	2.0
5	614	1.000	2.0
6	771	2.002	2.0
7	952	4.006	2.0
8	1069	6.009	2.0
9	1157	8.016	2.0
10	1228	10.02	2.0
11	1462	20.00	2.0
12	1717	40.00	2.0
13	1875	60.08	2.0
14	1990	80.08	2.0
15	2081	100.1	2.0
16	2371	199.7	2.0
17	2672	399.7	2.0
18	2851	599.6	2.0
19	3078	998.4	2.0
20	3388	1999	2.0
21	3696	4000	2.0
	4080-4095	Reserved for SDI Timing	-

6. Assess Additivity of Display

DESCRIPTION: Measure the R, G, B primaries at peak luminance to verify that each primary can deliver the appropriate luminance level for your peak brightness measurement.

EXPECTED BEHAVIOR: To pass this test, the sum of the luminance of R, G and B is approximately equal to the luminance of white ($L_R + L_G + L_B \approx L_W$).

DETAILED PROCEDURE:

Step 1: Load the test images into your media storage system. Import the 24 images files as a sequence into the color grading system. Using test images 21-23 as a sequence

Step 2: Measure the three display primaries Red, Green and Blue ($R_{\{X,Y,Z\}}$, $G_{\{X,Y,Z\}}$, and $B_{\{X,Y,Z\}}$) as well as the White Point $W_{X,Y,Z}$ in CIE XYZ. Please note that this test includes absolute luminance. Therefore, chromaticity alone is not sufficient.

Step 3: Sum the measurements $R_{\{X,Y,Z\}}$, $G_{\{X,Y,Z\}}$, and $B_{\{X,Y,Z\}}$ to achieve the additive white $W_{A\{X,Y,Z\}}$.

$$R_X + G_X + B_X = W_{A,X}$$
$$R_Y + G_Y + B_Y = W_{A,Y}$$
$$R_Z + G_Z + B_Z = W_{A,Z}$$

Step 4: Compare the calculated additive white point $W_{A\{X,Y,Z\}}$ against the measured display white point $W_{X,Y,Z}$.

$$A_{\{X,Y,Z\}} = W_{A,\{X,Y,Z\}} / W_{\{X,Y,Z\}}$$

Where $A_{\{X,Y,Z\}}$ is the additivity ratio. If the display is additive, then all three values are close to 0.0. If the values are substantially larger, then the white luminance level is higher than the sum of the primaries and therefore, the display is not additive. Further, $A_{\{X,Y,Z\}}$ should not be negative as this means that the display white is darker than the sum of the primaries. This likely means that there is some luminance compression happening (e.g. power management).

The accepted tolerance is [-0.01 . . . +0.05] which represents a luminance discrepancy of -1 to 5%.

Further, all three values should match. If there is a discrepancy between the values, then the white points of $W_{A,\{X,Y,Z\}}$ and $W_{\{X,Y,Z\}}$ are not the same. In that case, please recalibrate the display and verify that there are no LUTs or similar signal modifiers enabled influencing the gray-tracking behavior of the displayed image.

Further information can be found in the IDMS, section 5.4: COLOR-SIGNAL WHITE.

7. Appendix A - Monitors available in the market

The chart below shows monitors that are available in the market at the date of this document. The manufacturers published specs shown meet the minimum requirements listed in section 3a of this document. This is not a list of monitors that Dolby has tested or approved. A post-production facility seeking certification from Dolby ensure their monitor passes the certification test in sections 4, 5 & 6 of this document. This document may be shared with monitor manufacturers to test their product and ensure it will pass Dolby Vision certification.

HDR Monitor Landscape

Mfg / Model #	Peak Brightness	Black Levels	C/R	Res	Size (inches)	Type	Recommended Dolby Vision workflow use cases					
							On set	VFX	Editing	Grading	QC	Review Screening
Flanders XM310K	3000	0.003	1,000,000	UHD	31	LCD/Zoned W LED	x	x	x	x	x	x
Canon DP-V3001	2000	0.005	400,000	UHD	30	LCD/Zoned RGB LED	x	x	x	x	x	x
Sony BVMX300	1000	0.001	1,000,000	UHD	31	OLED	x	x	x	x	x	x
Sony BVM HX310	1000	0.001	1,000,000	UHD	31	Dual LCD/W LED	x	x	x	x	x	x
Flanders XM311K	1000	0.0005	2,000,000	UHD	31	Dual LCD/W LED	x	x	x	x	x	x
TV-Logic LUM-310R	1000	0.005	200,000	UHD	31	LCD/Zoned W LED	x	x	x	x	x	x
Canon DP-V2420	1200	0.005	240,000	UHD	24	LCD/RGB LED	x	x	x	x	x	x
Postium OBM X310	1000	0.0005	2,000,000	UHD	31	Dual LCD/W LED	x	x	x	x	x	x
Eizo CG3145	1000	0.0005	2,000,000	UHD	31	Dual LCD/W LED	x	x	x	x	x	x
Flanders XM650U	900	0.0005	1,800,000	UHD	65	OLED	x	x	x		x	x
Canon DP-V2411	600	0.005	120,000	UHD	24	LCD/RGB LED	x	x	x		x	x
Sony PVMX550	600	0.0005	1,200,000	UHD	55	OLED	x	x	x		x	x
Sony BVM E-171	100	0.001	100,000	UJD	16.5	OLED	x					
TV Logic LEM550R	750	0.0005	1,500,000	UHD	55	OLED	x	x	x		x	x
Canon DP-V2410	400	0.005	80,000	UHD	24	LCD/RGB LED	x	x	x		x	x

Estimated from luminance and C/R specs

8. Appendix B Calculating ΔICtCp error

Calculating the ΔICtCp error metric (also known as ΔE_{ITP}) is likely part of your display measurement and assessment package. Nevertheless, as reference, the steps to carry out this metric are provided below. The math closely follows Recommendation ITU-R BT.2100 where applicable in order to maintain consistency and comparability.

DETAILED PROCEDURE:

Step 1: Convert linear *X,Y,Z* to display-referred linear *R,G,B* (in accordance with Table 10 of Recommendation ITU-R BT.2100):

$$R = 1.7167X - 0.3557Y - 0.2534Z$$

$$G = -0.6667X + 1.6165Y + 0.0158Z$$

$$B = 0.0176X - 0.0428Y + 0.9421Z$$

Step 1: Convert display-referred linear *R,G,B* to linear *L,M,S* (in accordance with Table 7 of Recommendation ITU-R BT.2100):

$$L = (1688R + 2146G + 262B)/4096$$

$$M = (683R + 2951G + 462B)/4096$$

$$S = (99R + 309G + 3688B)/4096$$

Note: Mathematically, Steps 1 and 2 can be combined. Nevertheless, to maintain consistency with Recommendation ITU-R BT.2100, the XYZ values are transformed to the Rec.2020 primaries first before further transforming them to LMS.

Step 2: Convert linear *L, M, S* to non-linear *L', M', S'* by applying the PQ non-linearity defined in Table 4 of Recommendation ITU-R BT.2100:

$$\{L', M', S'\} = EOTF^{-1}(F)$$

where:

$$F = \{L, M, S\};$$

$$EOTF^{-1}(F) = \left(\frac{c_1 + c_2 Y^{m_1}}{1 + c_3 Y^{m_1}}\right)^{m_2}$$

$$Y = F/10000;$$

$$m_1 = 2610/16384 = 0.1593017578125;$$

$$m_2 = 2523/4096 \times 128 = 78.84375;$$

$$c_1 = 3424/4096 = 0.8359375 = c_3 - c_2 + 1;$$

$$c_2 = 2413/4096 \times 32 = 18.8515625;$$

$$c_3 = 2392/4096 \times 32 = 18.6875.$$

Step 3: Convert non-linear L', M', S' to I, C_T, C_P as defined in Table 7 of Recommendation ITU-R BT.2100:

$$I = 0.5L' + 0.5M'$$

$$C_T = (6610L' - 13613M' + 7003S')/4096$$

C_P = $(17933L' - 17390M' - 543S')/4096$

Step 4: Scale IC_TC_P to create ITP:

$I = I$

$T = 0.5 \times C_T$

$P = C_P$

Step 5: Calculate **ΔE_{ITP}**:

$$\Delta E_{ITP} = 720 \times \sqrt{(I_1 - I_2)^2 + (T_1 - T_2)^2 + (P_1 - P_2)^2}$$

where:

I, *T*, and *P* are a scaled version of color components for a television signal expressed in the PQ system defined in Table 7 of Recommendation ITU-R BT.2100; subscripts 1, and 2, indicate two signals to be compared; a value of 1 is equivalent to a just noticeable difference when viewed in the most critical adaptation state.

<END>