

SEMI D75-0524

TEST METHOD FOR COLOR REPRODUCTION AND PERCEPTUAL CONTRAST OF DISPLAY

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1 Purpose

1.1 This Standard specifies measurement conditions and methods for describing the visual color quality in three-dimensional (3D) color space, and the perceived contrast with perceptual parameters in color electronic display devices.

1.2 The CIE XYZ color space is derived from the experimental results and it has been used to set color performance of displays in CIE xy or $u'v'$ chromaticity diagram without brightness.

1.3 For measurement, setting test patterns, images based on average picture level (APL) of IEC 62087:2011 and IEC TR 63274:2020 are required. The full screen box patterns are not suitable for emissive displays which of luminance are adjusted with contents.

1.4 The contrast ratio has been widely used although the calculated value is dramatically changed by dark state luminance. This metric does not consider human visual characteristics. Therefore, it is more reliable to consider the perceptual indices.

2 Scope

2.1 This Standard applies to color electronic display devices, except on the transparent display and HDR display.

2.2 This Standard includes the measurement for physical data, analysis, and calculation methods which have perceptual factors.

2.3 The term 'perceptual' is subject to CIE 248 (CIECAM16, color appearance model) in this Standard.

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3 Limitations

3.1 Measurements are subject to errors or imprecision due to the user, environmental factors, and miscalibration of measurement system or measurement system limitations.

3.2 Results may vary with ambient illumination conditions or in the presence of uncontrolled stray light reflections.

4 Referenced Standards and Documents

4.1 *CIE Standards*¹

CIE 248:2022 — The 2016 Colour Appearance Model for Colour Management Systems: CIECAM16

¹ Commission Internationale De L'eclairage (International Commission On Illumination), Kegelgasse 27, A-1030 Vienna/AUSTRIA. Telephone: +43.1.714.31.87.0, Fax: +43.1.714.31.87.18; <http://www.cie.co.at>

4.2 IEC® Standards²

IEC 62087:2011 — Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment

IEC TR 63274:2020 — Power Consumption of High Dynamic Range Television Sets

4.3 SID Standards³

IDMS — Information Display Measurement Standard

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 *DUT* — device under test

5.1.2 *LMD* — light measurement device

5.1.3 *PCL* — perceptual contrast length

5.1.4 *VCRC* — volume color reproduction capability

5.2 Definitions

5.2.1 *brightness* — the attribute of a human visual sensation according to which an area appears to emit more or less light.

5.2.2 *color gamut boundary* — the outer surface determined by a color gamut form.

5.2.3 *perceptual contrast length* — the difference of black and white brightness of the screen.

5.2.4 *volume color reproduction capability* — the volume of the perceived color gamut obtained in 3D color space which is composed of colorfulness, hue and brightness.

6 Standard Measurement Condition

6.1 Measuring Conditions

6.1.1 Environmental Conditions

6.1.1.1 In order to obtain accurate measured data, the following environmental conditions are required.

- Temperature: 25°C ± 2°C
- Humidity: 25% to 85% relative humidity
- Pressure: 86 kPa to 106 kPa
- Air flow: no wind
- Vibration/Shock: no influence

6.1.2 Dark Room Condition

6.1.2.1 The luminance contribution from the background illumination shall be less than 0.01 cd/m² when device under test (DUT) is turned off. When a different illuminance or ambient illumination condition is used, it shall be noted in the report.

6.1.3 Measuring Equipment Conditions

6.1.3.1 In this Standard, a light measurement device (LMD) to measure a spot area less 10° or 2D area such as spectral radiometer, at least from 380 nm to 780 nm wavelength ranges or a filter photometer shall be used.

² International Electrotechnical Commission, 3 rue de Varembe, Case Postale 131, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.919.02.11, <http://www.iec.ch>. IEC trademark is owned by International Electrotechnical Commission.

³ The Society for Information Display, 1475 S. Bascom Ave. #114, Campbell, CA 95008-4006, USA. Telephone: +1.408.879.3901, Fax: +1.408.879.3833, <http://www.sid.org>

6.1.3.2 The luminance accuracy of the instrument shall be within $\pm 2\%$. And the chromaticity accuracy of the instrument shall be below:

Table 1 Chromaticity Accuracy of the Instrument

x, y	± 0.002 (0.001 to 0.05 cd/m ²)
x	± 0.0015 (0.05 cd/m ² or more)
y	± 0.001 (0.05 cd/m ² or more)

6.1.4 Measurement Equipment Configuration

6.1.4.1 The equipment of this measurement can be configured with two types of LMDs: one is to measure spot area using a spot LMD, and the other is to measure 2D area using an imaging LMD. The user can select one of these methods.

6.1.4.2 In the case of a spot area measurement, the measuring distance can be calculated and set so that an LMD should include over 500 pixels of display at 2 degrees field of view (FOV). The calculated distance should be noted in a report.

6.1.4.3 In the case of 2D area measurement, the measuring distance could be set so that an imaging LMD should focus on the designated surface of the DUT. Measurement areas of the imaging LMD should be clear not blurred without any distortions, like moiré, line misaligned, etc.

6.1.4.4 LMD, pattern generator, and a control PC as an optional part would be prepared to measure display color properties. An example of measurement equipment configuration of this test is shown in Figure 1. The placement of the LMD should be located in the center of display. For 2D area measurement, if other areas would be pointed, the point shall be reported.

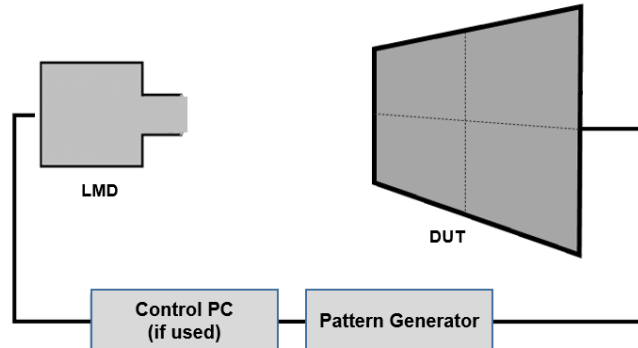


Figure 1
Example of Measurement Equipment Configuration

7 Summary of Test Method

7.1 Test Patterns

7.1.1 Window Patterns

7.1.1.1 A centered window box occupying 10% of the screen area is used. The 100% intensity (e.g., 255 gray levels in 8 bits and 1023 gray levels in 10 bits) for window box and the 0% intensity (e.g., 0 gray levels in 8 and 10 bits) for background are applied. One of the test patterns is shown in Figure 2.

7.1.1.2 Each of the following eight colors in the 10% box window box at the center of the screen is applied in 8 bits.

- Red: (255, 0, 0)
- Green: (0, 255, 0)
- Blue: (0, 0, 255)
- Yellow: (255, 255, 0)
- Magenta: (255, 0, 255)
- Cyan: (0, 255, 255)
- Black: (0, 0, 0)
- White: (255, 255, 255)

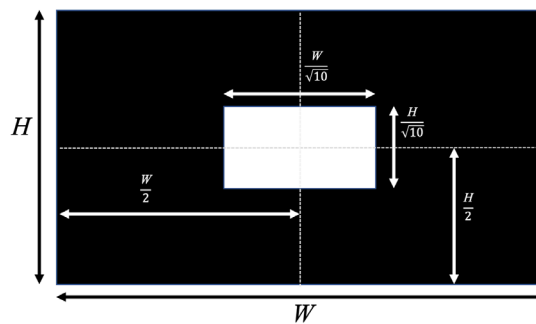


Figure 2
Test Pattern of 10% Window Box with 0% Gray Background

7.1.2 Black Measurement Pattern

7.1.2.1 Only for the black data, the black measurement pattern should be used and it is shown in Figure 3. Two white window boxes with $H/3 \times W/3$ size are located in the top left corner and the bottom right corner of the pattern. The center of the pattern should be the measurement point. As the display size is very small, the mask or tube would be used for avoiding the white luminance interference.

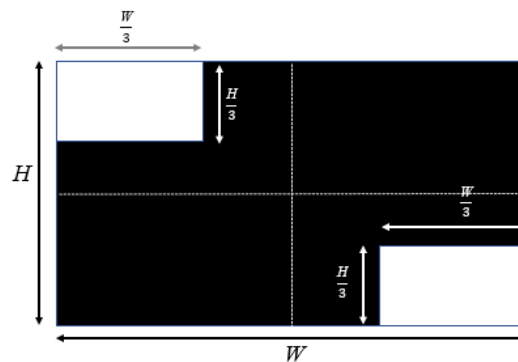


Figure 3
Black Measurement Pattern

NOTE 1: It may be necessary to use some kind of a mask or stray-light-elimination tube to avoid veiling glare in the detector when measuring 10% window box colors.