Background Statement for SEMI Draft Document 4858C
New Standard: TEST METHOD FOR MEASURING THE SPATIAL
CONTRAST RATIO OF FLAT PANEL DISPLAY

Note: This background statement is not part of the balloted item. It is provided solely to assist the recipient in reaching an informed decision based on the rationale of the activity that preceded the creation of this document.

Note: Recipients of this document are invited to submit, with their comments, notification of any relevant patented technology or copyrighted items of which they are aware and to provide supporting documentation. In this context, “patented technology” is defined as technology for which a patent has issued or has been applied for. In the latter case, only publicly available information on the contents of the patent application is to be provided.

Background
For several decades, contrast metrics such as Contrast Ratio (CR) and Contrast Modulation (CM) have been widely used to quantify the contrast performance of display devices. Normally, they use a sequential test pattern which includes full screen of black and white to fill the screen at each time to measure the contrast.
A sequential full screen test pattern does not give constant results for the new display technologies that dynamically adjust gray levels based on image contents.
The test pattern where region of various APL exists inside one image, therefore, is more reliable to assess the display device in terms of contrast ratio. Consequently, a new metrology including test pattern which is considered the APL is required to evaluate contrast ratios of display devices.
This document was initially issued as ballot 4858 in Cycle 4 of 2010 to the FPD Metrology Committee, and subsequently failed technical committee review. It also issued as ballot 4585A in Cycle 5 and 4858B in Cycle 7 of 2010. For 4858B, there were several opinions on the document and the committee decided to take them. So the 4858B ballot failed the committee review at the committee meeting on January 28, 2011.

Ballot Voting Information
SEMI Standards Regulations requires a 60% return rate from the total number of registered voting members. There are three valid ways to vote on this letter (yellow) ballot:

1 Accept Vote (Including Accept with Comments) – If you are in agreement that this document should be approved, vote accept. If you are in agreement that this document should be approved, but have suggestions for editorial clarification or wish to offer related items for future consideration (new business), please vote accept and include your suggestions at the bottom of the voting sheet.

2 Reject Vote – If you are not in agreement that this document should be approved, vote reject. A reject vote must be accompanied by a written explanation of your objections to the document.

3 Abstaining Vote – If you are not sufficiently familiar with the topic area or have insufficient interest to provide a technical opinion on this document, vote abstain. If you wish to provide editorial clarification on some point or make a general observation on this document, you may include a comment with an abstention.

The result of this ballot will be discussed at the next Korea FPD Metrology Committee meeting (April 1, 2011 at SEMI Korea office, Seoul, Korea)
Please note that the voting deadline for document 4858C and other Cycle 2 ballots is Wednesday, March 23, 2011. Therefore, we kindly request that you submit your votes in a timely manner for this to move on to the next stage of review.
1 Purpose

1.1 Contrast has a significant influence on the perceived image quality in display devices.

1.1.1 For several decades, physical contrast metrics such as contrast ratio (CR) and contrast modulation (CM) have been widely used to quantify the contrast performance of display devices.

1.1.2 A robust standardized test method for measuring the APL (average picture level) contrast ratios of flat panel display (FPD) systems is required to enable quality control in high volume manufacturing.

1.1.3 Existing international standards use full screen sequential test patterns that are not suitable for modern FPD systems that dynamically adjust gray levels based on image contents. International standards (IEC, ISO and VESA FPDM) define the contrast ratio (CR) and contrast modulation (CM).

1.1.3.1 Sequential full screen test pattern does not give constant results for the new display technologies that dynamically adjust gray levels based on image contents.

1.1.3.2 The test pattern where regions of various APL exist inside one image, therefore, is more reliable to assess the display device in terms of contrast ratio. APL values of various images, therefore, should be considered

1.2 Consequently, this test method requires a pair of specified test patterns with APL variation, rather than sequential APL variation, used to evaluate the APL contrast ratio of a display device under test.

2 Scope

2.1 This standard is applicable to flat panel displays (FPD).

2.2 The scope of the term “contrast” is only related to the luminance contrast in this standard.

2.3 The test method in this standard uses APL test patterns with the APL specified for both the region under test and the background region to determine the APL contrast ratio.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitation

3.1 This test method does not apply to perceptual contrast measurement.

3.2 Measurements of FPD contrast ratio that do not adhere to this test method may report different results than those obtained using this test method.

3.3 Measurements are subject to errors or imprecision due to the user, environmental factors, and mis-calibration of measurement system or measurement system limitations.

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

4 Referenced Standards and Documents

4.1 Referenced Standards

4.2 VESA1 Standards

4.2.1 VESA Flat Panel Display Measurement Standard (FPDM) 2.0

1 Video Electronics Standards Association, 39899 Balentine Dr., Suite 125, Newark, California 94560. Telephone: 510.651.5122; Fax: 51.651.5127; http://www.vesa.org
4.3 CIE Standards

4.3.1 CIE 87 — Colorimetry of Self-Luminous Displays - A Bibliography
4.3.2 CIE 15.3 —Colorimetry

4.4 ISO Standards


4.5 IEC Standards

4.5.1 IEC 61947-1 — Electronic projection — Measurement and documentation of key performance criteria -- Part 1: Fixed resolution projectors
4.5.2 IEC 62087- Methods of measurement for the power consumption of audio, video and related equipment.

4.6 Other Documents


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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 ACR — average picture level contrast ratio
5.1.2 APL — average picture level.
5.1.3 CM — contrast modulation
5.1.4 CR — contrast ratio
5.1.5 DUT — display under test
5.1.6 LMD — light measurement device
5.1.7 SCR — spatial contrast ratio

5.2 Definitions

5.2.1 average picture level – the average level of the picture signal during active scanning time intergrated over frame period; defined as a percentage of the range between blanking and reference white level

5.2.2 contrast ratio — the ratio of the luminance of the brightest gray on the center point of the screen to that of the darkest gray on the same point of the screen. The metric is shown in Equation (1)

\[ CR = \frac{L_{\text{max}}}{L_{\text{min}}} \]  

(1)

5.2.3 APL contrast ratio – the contrast ratio obtained using a pair of test patterns with APL specified both for the region under test and the background region.

5.2.4 average picture level – the average level of the picture signal during active scanning time integrated over a frame period; defined as a percentage of the range between blanking and reference white level.

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3 International Organization for Standardization, ISO Central Secretariat, 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30; www.iso.ch

4 International Electrotechnical Commission, 3 rue de Varembé, Case Postale 131, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.919.02.11; Fax: 41.22.919.03.00; http://www.iec.ch
5.2.5 *spatial contrast ratio* – the contrast ratio using APL considered test pattern which includes a maximum luminance area and a minimum luminance area displayed on a screen simultaneously.

5.2.6 warm-up time - the period from power-on to stable state of the light intensity.

### 6 The Optical Measurement Method

#### 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±2 °C
- Humidity: 25-85 % relative humidity
- Air flow: no wind

**6.1.2 Measuring Distance**

6.1.2.1 Measuring distance is 3H (where H is the height of the measured display device) at field aperture 1°.

6.1.2.2 If the angle to be measured is not specified, the viewing directions of all tests are 0°±1° (perpendicular to the FPD surface).

6.1.2.3 This distance is applied for all measurements in this standard.

**6.1.3 Instrument for Optical Measurement**

6.1.3.1 In this standard, a light measuring device such as spectroradiometer or a filter photometer shall be used.

6.1.3.2 The photometric accuracy of the instrument shall be within ±2 %.

**6.1.4 Viewing Direction**

6.1.4.1 The basic viewing direction of this test is perpendicular to the display as shown in Figure 1. However, for a specific case such as TV application, other viewing directions can be used.

6.1.4.2 The angle and measuring directions are selected by the user.

6.1.4.3 In figure 1, the elevation angle is given the symbol Θ, while the azimuth angle is given the symbol Φ.

![Figure 1](image-url)  
*Figure 1*  
*Measuring Configuration of Contrast Ratio Test*
6.1.5 Warm-up time

6.1.5.1 Warm-up time can be determined between manufacturer and customer.

6.1.5.2 Since the luminance values of black and white strongly affect the contrast ratio, the measurement shall be processed after the display reaches the stable region as shown in Figure 2.

6.1.5.3 This warm-up time is different for each display device; therefore, this time shall be determined by manufacturer. The example of warm-up time measured results are shown in Figure 2.

Figure 2
Example of Warm-up Time Measured Results

6.1.6 Ambient Illumination Condition

6.1.6.1 Ideally the APL contrast ratio is measured in a completely darkened room. However, various ambient illumination conditions may be specified for different applications, such as work floor ambient or outdoor ambient simulated tests.

6.2 Measuring Method

6.2.1 Test Patterns

6.2.1.1 Two test patterns are required, each with a rectangular box for the central test region (black or white), a rectangular box for the peripheral contrast region (white or black), and a specified APL background everywhere else within the test pattern.

6.2.1.2 The specified test patterns have a background of approximately 34% APL (This number is calculated APL of standard images from IEC 62087).

6.2.1.3 The test region box is centered in the test pattern and has dimensions that are 1/5 of the horizontal (H) by 1/5 of the vertical (V) size of display. The area of the test region box is 4% of the whole screen.

6.2.1.4 The peripheral contrast region box is the same size as the test region box but of opposite contrast. It is positioned, to avoid any interferences during measurements, such that the contrast region box’s lower right corner is approximately 1/20 H and 1/20 V inside and above the lower right corner of the test pattern (see Fig. 3).

6.2.1.5 The two test patterns are simply named by the color of their test region box either as white or black test pattern, (left or right test pattern of Fig. 3, respectively).

6.2.1.6 User shall measure each white and black test region box from the perpendicular and any other specified angles. It is recommended that the aperture size of the measuring instrument is 1 degree, and the distance between the screen and the measuring instrument is 3H. With consensus between companies, a mask to reduce stray light may be used.
6.2.2 Measuring Procedure

6.2.2.1 The following measuring procedure is recommended for the measuring of contrast ratio.
- Check and measure the room temperature, humidity, and the illumination of the measuring room.
- Install and drive the measured display unit.
- Determine the distance by the manufacturer.
- Install the light measurement device at perpendicular angle against the display devices.
- Display the white boxed test pattern on the screen.
- Measure the luminance values at the center of the white box.
- Measure the luminance values at the center of the black box.
- Record the data.
- Additional contrast ratios can be measured from different angle conditions at the user’s preference.

6.2.3 Metric of APL Contrast Ratio and its reporting

6.2.3.1 APL Contrast Ratio (ACR) is calculated using Equation (1), and the example result is shown in Table 1. SCR shall be reported with the following parameter information such as azimuth angle, elevation angle and illumination information. For example, ACR ($\Theta=0$, $\Phi=0$, $a=100\text{l}x$) = 100:1.

6.2.3.2 Measuring at perpendicular angle is essential. However, the contrast ratio additionally can be measured at other angles as agreed to by parties to the test.

6.2.3.3 The worked example is shown in Table 1 including the results of 4 difference viewing directions.

<table>
<thead>
<tr>
<th>Table 1 Worked Example for the Suggested APL Contrast Ratio Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (cd/m²)</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>perpendicular angle</td>
</tr>
<tr>
<td>left 45°</td>
</tr>
<tr>
<td>right 45°</td>
</tr>
<tr>
<td>up 45°</td>
</tr>
<tr>
<td>down 45°</td>
</tr>
</tbody>
</table>
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