

SEMI D79-0421

TEST METHOD FOR LOCAL AND OVERALL FLICKER OF FLEXIBLE DISPLAYS

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1 Purpose

- 1.1 This Standard specifies flicker measurement conditions and methods for describing the visual perception in flicker for flexible display.
- 1.2 The flexible display shows green pattern of full screen. The measured conditions include the flat and the curved surface, and the curvature of the curved surface is defined explicitly.
- 1.3 Flicker has been widely used for evaluating display. Follow the calculated procedures in VESA standard, the experimental results are transformed to frequency-domain diagram by fast Fourier transformation (FFT), and further transformed to flicker value. However, the conventional method is applied to a flat display and its local area only. To flexible displays, the potential flicker phenomenon may present when the user operates the display in a flexible mode or a flat mode. Therefore, this Document also addresses the test method for overall flicker of the flexible display.
- 1.4 Flicker is divided into local flicker and overall flicker, both of them are investigated for the flexible display. Overall flicker is the new metric for evaluating the whole visual field of flickering on the flexible display, such as concave or convex, foldable, stretchable form etc. It makes up the deficiency of local flicker. The luminance meter with zoom lens is developed for overall flicker. Local flicker and overall flicker are measured for evaluating the flicker of the specific field and the overall field on the flexible display, respectively. For reliable results, the calibrated procedures of luminance meter are specifically described.

2 Scope

- 2.1 This Standard is applicable to the flexible display, except on the transparent display.
- 2.2 This Standard includes flicker measurement, analysis and calculated methods and equations.
- 2.3 The term 'flicker' is subject to evaluate displays (VESA Flat Panel Display Measurement Standard) in this Standard.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

- 3.1 Measurements are subject to errors or imprecision due to the user, environmental factors, inexplicable calibrations or limitation of measured devices or system.
- 3.2 Some results may vary with uncontrolled luminance deviation of display.

4 Referenced Standards and Documents

4.1 VESA Standards¹

VESA Version 2.0 — Flat Panel Display Measurements Standard

¹ Video Electronics Standards Association, 39899 Balentine Dr., Suite 125, Newark, CA 94560, USA; Telephone: +1.510.651.5122, Fax: +1.510.651.5127, <http://www.vesa.org>

4.2 JEITA Standards²

JEITA ED-2522 — Measuring Methods for Matrix Liquid Crystal Display Modules

4.3 IEEE Standards³

IEEE PAR1789 Update — LED Lighting Flicker and Potential Health Concerns

4.4 IDMS Standards

SID VERSION 1.03 — Information Display Measurements Standard

4.5 Other Documents

4.5.1 KONICA MINOLTA, Color Measurement of Display Devices

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

5 Terminology

5.1 Definitions

5.1.1 *flicker* — temporal changes in light output of display, and that is a widely known temporal artefact. Flicker can be direct or indirect perception with different frequency.

5.1.2 *local flicker* — flicker which is measured specific field of display.

5.1.3 *overall flicker* — flicker which is measured overall field of display.

5.1.4 *relatively significant flicker magnitude* — higher or stronger flicker magnitude in the specific frequency domain.

6 Standard Measurement Condition

6.1 Measuring Conditions

6.1.1 Environmental Conditions

6.1.1.1 Following environmental conditions are required for obtaining accurate and consistent measured data.

- Temperature: $23 \pm 5^{\circ}\text{C}$.
- Humidity: 25% to 85% relative humidity.
- Air flow: No wind.
- Vibration/Shock: No influence.
- Ambient Conditions: Dark room.

6.1.1.2 Dark Room Condition

6.1.1.2.1 Illuminance contribution from ambient illumination shall be less than 0.05 lx.

6.1.2 Measuring Equipment Conditions

6.1.2.1 In this Standard, luminance meter is at least from 0.001 cd/m^2 to $299,900 \text{ cd/m}^2$ ranges, and sample rate is at least 240 Hz.

6.1.2.2 Measurement accuracy of luminance meter shall be within $\pm 2\%$. Accuracy and repeatability of luminance meter are presented below:

² Japan Electronics and Information Technology Industries Association, Ote Center Building, 1-1-3, Otemachi, Chiyoda-ku, Tokyo 100-0004, Japan; <http://www.jeita.or.jp>

³ Institute of Electrical and Electronics Engineers, 3 Park Avenue, 17th Floor, New York, NY 10016-5997, USA; Telephone: +1.212.419.7900, Fax: +1.212.752.4929, <http://www.ieee.org>

Table 1 Accuracy and Repeatability of Luminance Meter

Accuracy	0.001 cd/m ² to 0.999 cd/m ² (or fL)	±2% ± 2 digits of displayed value
	1.000 cd/m ² (or fL) or greater	±2% ± 1 digit of displayed value
Repeatability	0.001 cd/m ² to 0.999 cd/m ² (or fL)	±0.2% ± 2 digits of displayed value
	1.000 cd/m ² (or fL) or greater	±0.2% ± 1 digit of displayed value

6.1.2.3 Measured field and focal length shall be defined in Figure 1. Measured distance can be calculated by 6-1 formula.

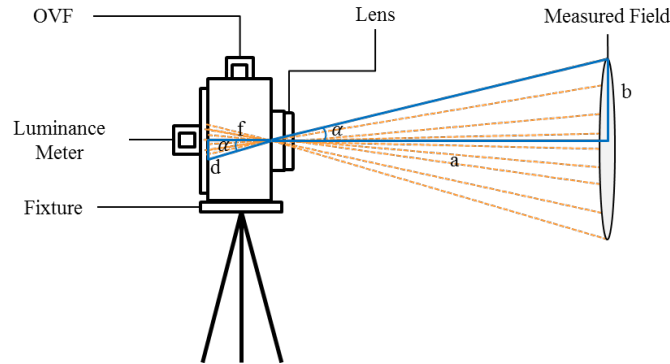


Figure 1
Example of Measured Configuration with Luminance Meter

$$\alpha = 2 \tan^{-1} \frac{d}{2f} \equiv \tan \alpha = \frac{d}{f} = \frac{a}{b} \quad (1)$$

where:

d , a , and f = image height, measured distance and focal length shall be defined respectively, and

b = measured field height can be calculated and dependent on trigonometric identities.

7 Summary of Test Method

7.1 Test Method of Local Flicker

7.1.1 Local flicker is a flicker measurement by a detector, and the measured field is based on the detector coverage.

7.1.2 Set two measured conditions of flexible display, which can be flatted and curved, curved curvature is 0.25. Display curvature can be defined for experimental demand, and curvature shall be presented in resultant table. In this section, display curvature (0.25) is a recommendation, not an enforced value.

7.1.3 Check and set detector of the luminance meter on specific field of flexible display. The luminance meter is necessary to link AD converter for capturing rapidly data. Two measured conditions are shown in Figure 2 and Figure 3, respectively. The detector is set on the flexible display, the coverage is measured field.

7.1.4 Set AD converter parameters that include sample rate and numbers of sample. The recommended sampling rate is more than 240 Hz, and numbers of sample shall be enough to capture completed waveform period. The accuracy and the repeatability of the luminance meter are greater than ±2% ± 2 digits of the displayed value and ±0.2% ± 2 digits of the displayed value.

7.1.5 Analyze measured data by flicker which is described in Appendix 2.

7.1.6 Analyze flicker to define relatively significant flicker magnitude.

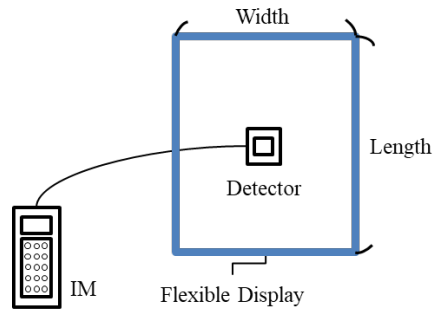


Figure 2
Flat Measurement of Local Flicker

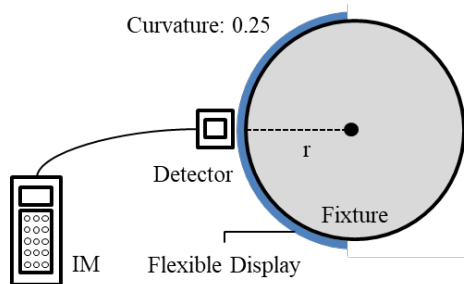


Figure 3
Curved Measurement of Local Flicker

7.2 Test Method of Overall Flicker

7.2.1 Overall flicker is a flicker measurement by a detector and a lens, and the measured field is based on the viewing coverage of lens.

7.2.2 Set measured condition which is described in ¶ 7.2.1.

7.2.3 Check and set measured distance between flexible display and the luminance meter, the lens and focal length are also necessary to be checked and focused on the display center. Measured distance and focal length are calibrated with Luminance Meter Calibration in § 7.1. Two measured conditions are shown on Figure 4 and Figure 5, respectively. The lens focuses on the flexible display, the coverage is measured field.

7.2.4 Set AD converter parameters which are described in ¶ 7.2.3.

7.2.5 Apply formulas which are derived from Luminance Meter Calibration that can correct the measured data.

7.2.6 Analyze measured data by flicker which is described in Appendix 2.

7.2.7 Analyze flicker to define relatively significant flicker magnitude.