

SEMI D41-0305

MEASUREMENT METHOD OF SEMI MURA IN FLAT PANEL DISPLAY IMAGE QUALITY INSPECTION

This Standard was technically approved by the Flat Panel Display – Factory Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on November 24, 2004. Available at www.semi.org in March 2005.

NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

1 Purpose

- 1.1 This Standard will define the application of the formula derived in SEMI D31 to various test conditions closed to visual inspection for MURA in flat panel display (FPD) image quality inspection.
- 1.2 SEMI D31 has derived a formula to detect defects and blemishes in FPD in comparison with human eyes and CCD based instruments.
- 1.3 In general, the difficulty of implementing instruments to replace human inspector lays on human factor variation with its origin and location.

2 Scope

- 2.1 This Standard is applicable to FPDs. This Standard mainly deals with both the measurement method of Semu and the revised definition of Semu. The target display size is typically from 20.3 cm (8 in.) to 76.2 cm (30 in.) diagonal.

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 In this Standard, the target of measurement, Mura, is limited as below.
- 3.2 Line defects narrower than a pixel and pixel dot defects are not the subject of this Standard. In this issue, this Standard follows SEMI D31.
- 3.3 In this Standard, it is dealt with monochrome displays like gray scale patterns in color patterns. In this issue, this Standard follows SEMI D31.

4 Reference Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI D31 — Definition of Measurement Index (Semu) for Luminance Mura in FPD Image Quality Inspection

4.2 Other Documents

Flat Panel Display Measurement Standard, VESA FPD M 2.0, June 2001, IEC 61747-6.

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

5 Terminology

- 5.1 This Standard follows SEMI D31 in terminology.

5.2 Abbreviations and Acronyms

- 5.2.1 **JND** — abbreviation for Just Noticeable Difference used in the field of Psychophysics; for a certain stimulus, the smallest change in stimulus (luminance, for example) where a difference can be perceived. Specifically, it is often used to indicate a statistical value where the probability of the difference being ‘perceptible’ is 50% and the probability of the difference ‘not being perceptible’ is 50%. Also expressed using lower case letters, jnd.

5.3 Definitions

5.3.1 *dynamic range* — the divided ability from a minimum detecting level to a maximum detection level of a CCD equipment.

5.3.2 *gray scale* — gray scale on an image display. This Standard indicates level 32 out of 64 level gray scale.

5.3.3 *L0 display* — gradation 0 out of 64 (Pitch Black).

5.3.4 *L63 display* — gradation 63 out of 64 (Completely white).

5.3.5 *luminance accuracy* — the error ratio of the luminance.

5.3.6 *measuring points* — the number of CCD sensors.

5.3.7 *Semu* — Semi Mura, Measurement index for Mura, defined in this Standard. (Please refer to SEMI D31.)

5.3.8 *viewing direction* — the angle between the CCD equipment and the test sample.

6 Related Definitions for Mura Measurement

6.1 Mura is a Japanese term meaning blemish and has been adopted in English to provide a name for imperfections of the display pixel matrix surfaces that are visible when the display is in operation. Inspect the display surface while displaying a white full screen, a black full screen, and a dark gray full screen (VESA FPDm 2.0). In many case, the Mura phenomena is detected by human eyes. But this is very confusing in the quality aspect. And it is very difficult to quantify the level.

6.2 The definition in SEMI D31 shows mainly that Luminance Mura is related with the *size of Mura*. Therefore, this Standard will follow the Cjnd concept.

6.3 Semu Definition

6.3.1 Under specific conditions, the below regression function can explain the level of Mura between the area and contrast for Human Mura JND. (Refer to SEMI D31.)

$$C_{jnd} = F(S_{jnd}) = 1.97/S_{jnd}^{0.33} + 0.72$$

Cjnd: Contrast of Mura at JND

(Unit: % relative to background = 100%)

Sjnd: The area of Mura at above contrast (Units: mm²)

6.3.2 In the above equation, contrast at JND is inversely proportional to the area raised to the 0.33 powers. In short, it indicates that as Mura the area gets smaller, only darker Mura can be sensed.

6.3.2.1 For the subject Mura, the Mura level, Semu, can be calculated using the below formula.

$$\begin{aligned} \text{Semu} &= |C_x| / C_{jnd} \\ &= |C_x| / F(S_x) \\ &= |C_x| / (1.97/S_x^{0.33} + 0.72) \end{aligned}$$

Cx: Average contrast of Mura being measured (Unit: % relative to background = 100%)

Sx: The surface area of Mura being measured (mm²)

7 Measurement Method

7.1 Environment Conditions:

- Temperature: 25 ± 2°C
- Humidity: 65 ± 20% RH
- Illumination of surrounding: in a dark room below 10 lux
- Air flow: no wind