

SEMI D31-1102

DEFINITION OF MEASUREMENT INDEX (SEMU) FOR LUMINANCE MURA IN FPD IMAGE QUALITY INSPECTION

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1 Purpose

1.1 This standard will define the index of measurement for mura in FPD image quality inspection.

1.2 Conventionally, inspection of FPD image quality has been sensory, mainly conducted via the human eye, and among the items detected, there has been no common standard for mura and other associated defects. For this reason, when panel makers and their users who conduct business with a fixed quality level set a mura acceptance level, limit samples are used as necessary.

1.3 Operational problems with limit samples include:

- Level of mura cannot be determined without viewing the sample. Due to this, it is not possible to express the level via written documentation or telephone.
- The sample settings are subjectively decided by the setter, and lack objectivity.
- It is difficult to setup and maintain a consistent sample level at multiple locations.

1.4 *Etc.* — Above all, in a market complicated by multiple panel makers and multiple users, where presently there is no fixed standard for expressing mura level, we have to say that it is extremely difficult to ensure a fixed level for panel quality.

1.5 In this standard, using ergonomics approach, we will investigate the human eye's sensitivity regarding mura, and by expressing the relation between mura area and contrast, propose an index to express the level of mura.

2 Scope

2.1 This standard is applicable to FPD (Flat Panel Displays) excluding CRT and HMD (Head Mount Displays). The display sizes targeted are typically from Type 8 (8" (20.3 cm) diagonal) to Type 30 (30" (76.2 cm) diagonal).

2.2 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 health practices and determine the applicability or regulatory limitations prior to use.

3 Limitations

3.1 In the first edition of this standard, the target of measurement, mura, is limited as below.

3.1.1 Line defects narrower than 300 μm and pixel dot defects are not the subject of this standard.

3.1.2 Mura background display is limited to monochrome displays/intermediate gray scale level; RGB, etc. color background and L0/L63 background are not the subject of this standard.

4 Referenced Standards

None.

5 Terminology

5.1 Definitions

5.1.1 *Gray Scale* — Gray scale on image display. In this standard, indicates level 32 out of 64 level gray scale.

5.1.2 *L0 Display* — Gradation 0 out of 64. (Pitch Black)

5.1.3 *L63 Display* — Gradation 63 out of 64 (Completely white)

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, j.n.d.

5.2.2 *Semu* — Semi Mura, Measurement index for mura, defined in this standard.

6 Semu Definition

6.1 Under specific conditions, the below regressive relationship can be seen between area and contrast for Human Mura JND. (Refer to Related Information.)

$$\begin{aligned} C_{jnd} &= F(S_{jnd}) \\ &= 1.97/S_{jnd}^{0.33} + 0.72 \end{aligned}$$

C_{jnd} : Contrast of mura at JND (Unit: % relative to background = 100%)

S_{jnd} : Area of mura at above contrast (Units: mm²)

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

6.2 For the subject mura, the mura level, Semu, can be calculated using the below formula.

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

C_x : Average contrast of mura being measured (Unit: % relative to background = 100%)

S_x : Surface area of mura being measured (Units: mm²)

7 Notation

7.1 Semu is a comparison ratio between contrast of the measurement target and contrast in a JND, and thus has no unit.

7.2 It is recommended that significant digits be displayed to one decimal place.

NOTE 1: Notation uses this following methodology. Notation Example 1: The level of JND mura in this study is Semu = 1.0. Notation Example 2: The level of this mura is Semu 2.5.

8 Test Methods

8.1 *Comparative Measurement and Direct Measurement* — The two methods for determining Semu levels on panels are comparative measurement and direct measurement.

8.1.1 Comparative Measurement

8.1.1.1 The comparative measurement method involves a panel and software which can simulate Semu level, to which a person compares a mura on an actual panel, making adjustments, until a level which appears similar is determined. This is a method that can be used in the actual production site easily using the Semu simulation panel as the variable level limit sample.

8.1.2 Direct Measurement

8.1.2.1 The direct measurement method captures the actual panel with a CCD camera, or the like, and is a

method of measuring the Semu level of the mura section, making it possible to directly determine the Semu from the area and contrast of the mura section that is captured.

8.2 Measurement Equipment

8.2.1 Semu measurement consists of measurement of the area of mura on the display surface and contrast measurement, and needs to be appropriately calibrated.

8.3 Measurement Environment

8.3.1 Semu measurement will be conducted in a darkroom environment.

8.4 Display Conditions

8.4.1 Background luminance for Semu measurement shall be 50 ± 10 cd/m².

8.5 Contrast Measurement

8.5.1 The average contrast of the mura section shall be measured, and the contrast ratio of the mura section will be expressed as a percentage, for when the background = 100%.

9 Related Documents

9.1 Experiment Overview for Calculation of Measurement Index for Mura in FPD Image Quality Inspection. R. Yositate IBM Japan, T. Tamura Tokyo Institute of Polytechnics Oct. 23/2001

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