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INTERNATIONAL STANDARD

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colour inside

Organic light emitting diode (OLED) displays – Part 5-3: Measuring methods of image sticking and lifetime

Afficheurs à diodes électroluminescentes organiques (OLED) – Partie 5-3: Méthodes de mesure de la durée de vie et de la rémanence d'images

IEC 62341-5-3:2013

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The text of this standard is based on the following documents:

FDIS	Report on voting
110/474/FDIS	110/501/RVD

Full information on the voting for the approval on this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62341 series, under the general title *Organic light emitting diode (OLED) displays*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

Part 5-3: Measuring methods of image sticking and lifetime

1 Scope

This part of IEC 62341 specifies the standard measurement conditions and measurement methods for determining the image sticking and lifetime of organic light emitting diode (OLED) display panels and modules. It mainly applies to modules.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 62087:2011, *Methods of measurement for the power consumption of audio, video and related equipment*

IEC 62341-1-2:2007, *Organic light emitting diode (OLED) displays – Part 1-2: Terminology and letter symbols*

IEC 62341-6-1:2009, *Organic light emitting diode (OLED) displays – Part 6-1: Measuring methods of optical and electro-optical parameters*

IEC 61966-2-1:1999, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management –Default RGB colour space – sRGB*

CIE 15-2004, *Colorimetry*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62341-1-2:2007 and IEC 60050-845:1987, as well as the following apply.

3.1
equivalent current density
average current density of a certain pixel calculated from a varying luminance per frame image in a moving picture so that luminance degradation becomes similar at the same time

Note 1 to entry: See Annex A.

3.2
equivalent signal level
digital code value from 0 to 255 (in the case of 8 bits) transformed from the normalized luminance of a certain pixel by a gamma function

Note 1 to entry: See Annex A.

4 Measuring configuration

4.1 General

The system diagrams and/or operating conditions of the measuring equipment shall comply with the structure specified in each item. The measuring system and its arrangement are shown in Figure 1. The details are referred to in Clause 5.

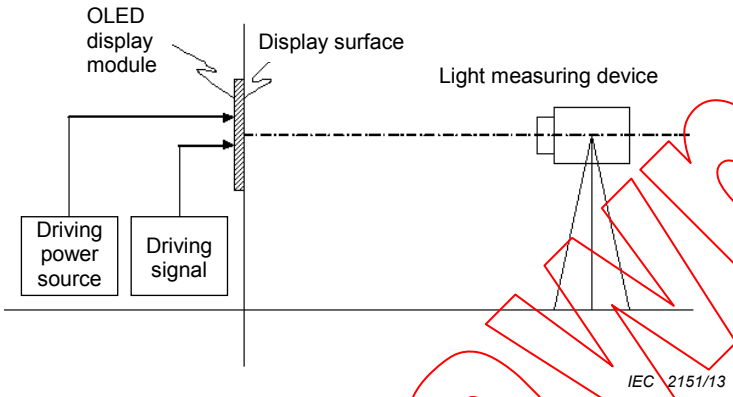


Figure 1 – Measuring system and arrangement

4.2 Light measuring device (LMD)

The LMD as defined in IEC 62341-6-1:2009 shall be used. Specifically, the accuracy of the LMD at 1 degree of the measurement field angle is recommended as being ≤ ±3%, and with a repeatability ≤ ±0,5%.

5 Standard measuring conditions

5.1 Standard measuring environmental conditions

The standard measuring environmental conditions specified in IEC 62341-6-1:2009, 5.1, shall be applied. For image sticking measurements, the environmental temperature shall be controlled at 25 °C ± 2 °C, otherwise a temperature controlled detector shall be used. (The stability of the LMD shall be less than 1/5 of the intended detecting difference levels of luminance and colour.)

5.2 Standard measuring dark-room condition

The standard measuring dark-room conditions specified in IEC 62341-6-1:2009, 5.2, shall be applied.

5.3 Standard setup conditions

5.3.1 General

For the measurement area, the minimum radius for measurement with the distance and aperture angle is explained in Table 1.

Table 1 – An example of measuring distance and radius size

Distance (mm)	**Aperture angle** (degree)	**Radius of measurement field** (mm)
500	2	10
	1	5
	0,2	1
	0,1	0,5

5.3.2 Adjustment of OLED display modules

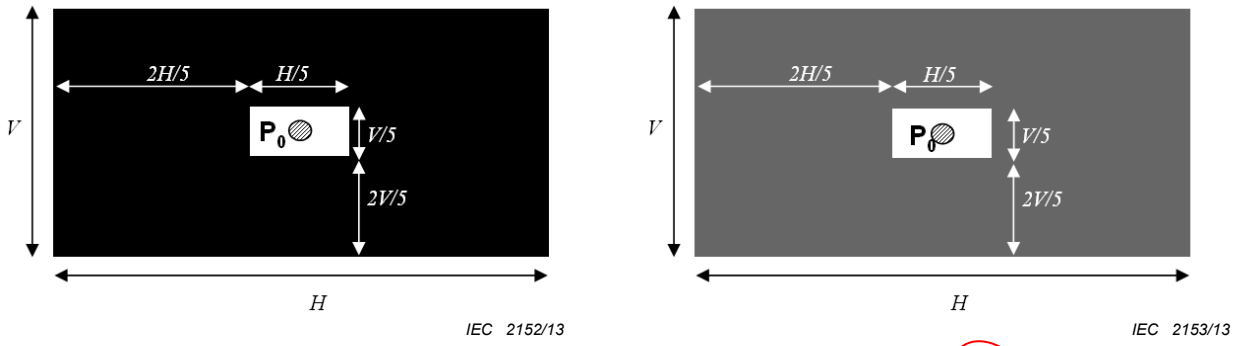
The adjustment of OLED display modules specified in IEC 62341-6-1:2009, 5.3.1, shall be applied.

5.3.3 Starting conditions of measurements

Warm-up time is defined as the time elapsed from the moment of switching on the supply voltage until repeated measurements of the display show a variation in luminance of less than 2 % per minute. Repeated measurements shall be taken for at least a period of 15 minutes after starting. The luminance variations shall also not exceed 5 % during the total measurement.

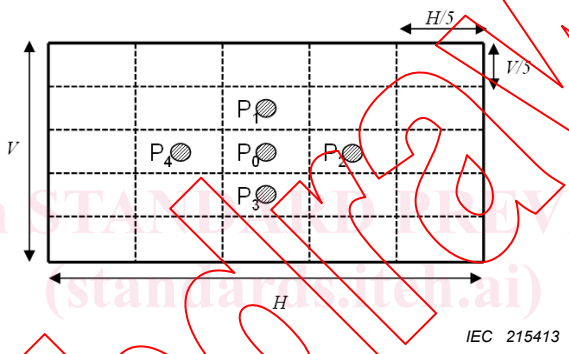
5.3.4 Test patterns

The test patterns for display devices such as mobile phones, table PCs, monitors and TVs are shown in Figure 2. In the case of mobiles and tablet PCs, depending on the size of the OLED display panels or modules and measurement distance between the display and the LMD, if the pattern size is a smaller area than a 10 mm radius at a 500 mm measurement distance with a 2-degree aperture angle of the LMD, then the aperture angle of the LMD should be set to cover the pattern area as set in Table 1. The measuring distance and the aperture angle may be adjusted to achieve a measuring field greater than 500 pixels if the setting of the aperture angle is difficult. For all applications, the test pattern is used in Figure 2a), and usage method case for monitors and TVs such as Figure 2b) may be used. In order to get repeatability of measurement, the measuring location from P_0 to P_4 for TVs type as shown in Figure 2c) are set, considering the uniformity of the OLED display panels or modules.



a) – The test pattern for display devices except monitors and TVs

b) – The test pattern for monitor and TV devices



c) – Image sticking measuring location

Figure 2 – Test pattern for image sticking

5.3.5 Conditions of measuring equipment

The general conditions in IEC 62341-6-1:2009, 5.3.3.1, shall be applied.

6 Measuring methods of image sticking

6.1 Purpose

The purpose of this method is to measure the image sticking of OLED display panels or modules.

6.2 Measuring method

6.2.1 Measuring equipment

The following equipment defined in IEC 62341-6-1:2009, 6.1.2, shall be used:

a) power supplies and signal sources for driving,

b) LMD.

6.2.2 Measuring procedure

The OLED display modules shall be set in dark-room conditions for measurement.

1) Initial measurements on full screen pattern

Apply a full white screen driving signal to the OLED display modules over the full screen, and set all power supplies to the standard operation conditions. However, for some display applications, the full screen luminance can be reduced, according to 7.3.1 of IEC 62341-6-1:2009.

Measure the initial spectral radiance or tristimulus values of white at P_0 to P_4 as shown in Figure 2c). The initial spectra radiance or tristrimulus values of the primary colours may also be measured individually.

2) Image burn-in using test pattern

For the test pattern for display devices (except monitors and TVs), set the test input signal to the OLED display modules to generate a 0 % luminance level over the full screen and a peak luminance at the test pattern which is located at the centre of the display as shown in Figure 2a). For monitor and TV, set the peak luminance level over the 4 % window pattern located in the centre of the display with a 15 % luminance level of the peak luminance over the background area. For information about guidance, see Annex C of IEC 62087:2011. If the other pattern is used, it should be based on Annex A of this document and reported.

Keep the test pattern until the specified time, considering the luminance degradation curve. For example, the measurement time can be every 1 hour during the first 6 hours, and every 24 hours during the first 120 hours; then every 72 hours until the target time in the standard measurement condition. Alternatively keep the test pattern until the target time in the standard measurement condition.

3) Measurements on full screen pattern

Apply a full white screen driving signal to the OLED display modules over the full screen. Measure the spectral radiance or the tristimulus values at the same measuring location as the initial measurement. The initial and final spectra radiance or tristrimulus values of the individual primary colours may also be measured and reported.

All measurements shall be done at the target time of 400 and 500 hours and shall be reported. In Figure 3, an example of the burn-in image is shown.

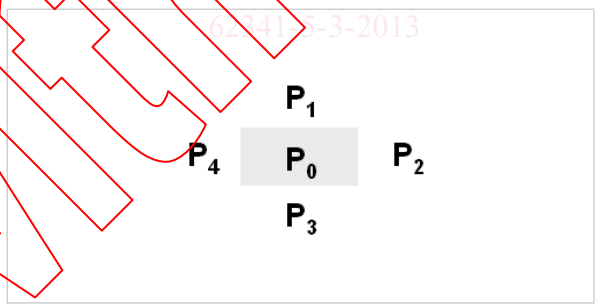


Figure 3 – An example of the burn-in image

6.3 Analysis and report

6.3.1 Analysis

6.3.1.1 Luminance and chromatic deviation method

Image sticking can be characterized by luminance and chromatic deviation.

The image sticking of luminance $IS(t)$ for white is calculated as follows:

$$IS(t) = \left| 1 - \frac{\left\{ \sum_{i=1}^{4} L_i t) \right\} / L_0(t)}{\left\{ \sum_{i=1}^{4} L_i(t_0) \right\} / L_0(t_0)} \right| \times 100(\%) \quad (1)$$

where

t is the specified measurement time;

t_0 is the initial measurement time;

L_i is the luminance of measurement location from P_i.

Chromatic deviation $\Delta u'v'(t)_0$ caused by image sticking at P_0 over time for white is calculated as follows:

$$\Delta u'v'(t)_0 = \sqrt{\{u'(t) - u'(t_0)\}^2 + \{v'(t) - v'(t_0)\}^2} \quad (2)$$

where

t is the specified measurement time;

t_0 is the initial measurement time;

$(u'(t), v'(t))$ is the white chromaticity value at the specified time;

$(u'(t_0), v'(t_0))$ is the white chromaticity value at the initial time.

The average of chromatic deviation $\Delta u'v'(t)_{AVG}$ caused by image sticking between different measuring locations from P_1 to P_4 for white is calculated as follows:

$$\Delta u'v'(t)_{AVG} = \left(\sum_{i=1}^{4} \sqrt{\{u'_i(t) - u'_0(t)\}^2 + \{v'_i(t) - v'_0(t)\}^2} \right) / 4 \quad (3)$$

where

t is the specified measurement time;

$(u'_i(t), v'_i(t))$ is the chromaticity coordinates of measuring locations of P_i (i = 1, 2, 3, 4).

The value of u' and v' can be calculated from the tristimulus value X, Y, and Z using the following equations:

$$\begin{aligned} u' &= 4X/(X + 15Y + 3Z) \\ v' &= 9Y/(X + 15Y + 3Z) \end{aligned} \quad (4)$$

6.3.1.2 Colour difference method

The image sticking shall be analyzed with ΔE^*_{ab} of the three-dimensional, CIE 1976 $L^*a^*b^*$ colour space (see CIE 15-2004) following the procedure in 6.2.2. Additional three-dimensional uniform colour spaces and colour spaces may also be used and identified in the test report. Each colour point can be plotted on the L^*, a^*, and b^* axes of the CIE $L^*a^*b^*$ colour space by referencing the peak white tristimulus value (X_n, Y_n, Z_n) in measuring location P_0 at initial time t_0 and using the following transformation equations:

$$
\begin{aligned}
L^*_i(t) &= 116 f(Y_i(t)/Y_n) - 16 \\
a^*_i(t) &= 500\left[f(X_i(t)/X_n) - f(Y_i(t)/Y_n)\right] \\
b^*_i(t) &= 200\left[f(Y_i(t)/Y_n) - f(Z_i(t)/Z_n)\right]
\end{aligned} \tag{5}
$$

where

$$
f(x) = \begin{cases} x^{1/3} & x > (6/29)^3 \\ \frac{1}{3}\left(\frac{29}{6}\right)^2 x + \frac{4}{29} & \text{otherwise} \end{cases}
$$

t is the specified measurement time;

$L^*a^*b^*_i$ is the CIELAB colour coordinates of measuring locations of P_i (i = 0, 1, 2, 3, 4);

(X_n, Y_n, Z_n) is the tristimulus value of reference white in measuring location P_0 at initial time t_0.

Colour difference formula $\Delta E^*_{ab}(t)_0$ caused by image sticking at P_0 over time for white is calculated as follows:

$$
\Delta E^*_{ab}(t)_0 = \sqrt{\{L^*_0(t) - L^*_0(t_0)\}^2 + \{a^*_0(t) - a^*_0(t_0)\}^2 + \{b^*_0(t) - b^*_0(t_0)\}^2} \tag{6}
$$

where

t is the specified measurement time;

t_0 is the initial measurement time;

$L^*a^*b^*_0$ is the CIELAB colour coordinates of measuring locations of P_0.

Average of colour difference formula $\Delta E^*_{ab}(t)_{AVG}$ caused by image sticking between different measuring locations from P_1 to P_4 for white is calculated as follows:

$$
\Delta E^*_{ab}(t)_{AVG} = \left(\sum_{i=1}^{4} \sqrt{\{L^*_i(t) - L^*_0(t_0)\}^2 + \{a^*_i(t) - a^*_0(t_0)\}^2 + \{b^*_i(t) - b^*_0(t_0)\}^2}\right) / 4 \tag{7}
$$

where

t is the specified measurement time;

$L^*a^*b^*_i$ is the chromaticity coordinates of measuring locations of P_i (i = 1, 2, 3, 4).

6.3.2 Report

6.3.2.1 General

The typical value of image sticking can be reported with specified time, as shown in Table 2. If other primary colours are used such as red, green and blue, it should be reported.

Table 2 – An example of typical value

time (hour)	Colour	Measurement data					
		P_0			Average of P_1~ P_4		
		X	Y	Z	X	Y	Z
0	White						
1	White						

6.3.2.2 Image sticking time

The estimated time of image sticking can be reported with the result of the comparison between the reference luminance ratio, the chromatic deviation, and the colour difference, as shown in Table 3.

Table 3 – An example of the image sticking time with reference

Factor	Threshold	Estimated time
Luminance ratio (IS)	3 %	
Chromatic deviation $\Delta u'v'(t)_0$ at P_0	0,004	
Average of chromatic deviation $\Delta u'v'(t)_{AVG}$		
Colour difference $\Delta E^*_{ab}(t)_0$ at P_0	5	
Average of colour difference $\Delta E^*_{ab}(t)_{AVG}$		

6.3.2.3 Image sticking data

The image sticking can be reported after target time, as shown in Table 4.

Table 4 – An example of the image sticking data at target time

Time (hours)	Factor	Result data
400	Luminance ratio (IS)	
	Chromatic deviation $\Delta u'v'(t)_0$ at P_0	
	Average of chromatic deviation $\Delta u'v'(t)_{AVG}$	
	Colour difference $\Delta E^*_{ab}(t)_0$ at P_0	
	Average of colour difference $\Delta E^*_{ab}(t)_{AVG}$	

7 Measuring methods of the luminance lifetime

7.1 Purpose

The purpose of this method is to measure the luminance lifetime of the OLED display panels or modules. The lifetime is the elapsed time required for the luminance to decrease to the specified fraction of the initial luminance in operation. Unless otherwise specified, the half luminance lifetime shall be used for lifetime measurements.

7.2 Measuring method

7.2.1 Measuring equipment

The following equipment shall be used:

a) power supplies and signal sources for driving,

b) LMD

7.2.2 Measuring procedure

The OLED display panels or modules shall be set in the standard measuring conditions. The dark-room conditions shall be applied when the luminance is measured. Apply a full white screen driving signal to the OLED display panel or module at 100 % grey level, and set all