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colour inside

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

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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International Standard IEC 62341-5-3 has been prepared by IEC technical committee 110: Electronic displays.

This second edition replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the measurement vehicle for lifetime is only for the module;
b) the measurement method for monitor or TV devices is modified;
c) the digital signage display is included as an example of OLED devices;
d) the measurement method with HDR (high dynamic range) for image sticking is added;
e) the analysis method with CIEDE 2000 is added for image sticking;
f) the information method for evaluating image sticking is modified.

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

FDIS	Report on voting
110/1134/FDIS	110/1154/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

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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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~~ measuring methods for determining the image sticking and lifetime of organic light emitting diode (OLED) display panels and modules, except finalized display products for end customers, such as TV sets, monitor sets and mobile phones. ~~It~~ The measuring method for the lifetime mainly applies to modules.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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 60050-845, *International Electrotechnical Vocabulary (IEV) – Part 845: Lighting* (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~~2017, *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*~~

ISO 11664-1, *Colorimetry – Part 1: CIE standard colorimetric observers*

CIE 15~~:2004~~, *Colorimetry*

3 Terms, definitions and abbreviated terms

3.1 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~~ and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/

- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
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.

3.1.2
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~~ specified opto-electronic transfer function (OETF)

Note 1 to entry: See Annex A.

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

APL	average picture level
CIELAB	CIE 1976(L*a*b*) colour space
DUT	devices under test
EOTF	electro-optical transfer function
FWHM	full-width-at-half-maximum
HDR	high dynamic range
LMD	light measuring device
OETF	opto-electronic transfer function
OLED	organic light emitting diode
PQ	perceptual quantizer
SDR	standard dynamic range

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 given in Clause 5.

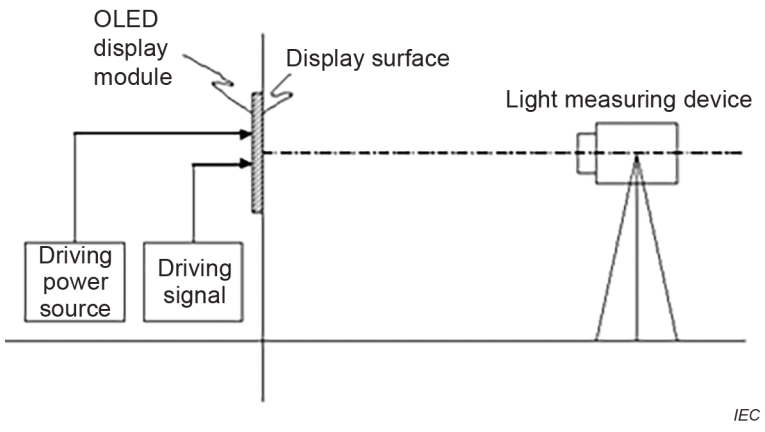


Figure 1 – Measuring system and arrangement

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%.~~

The optical properties of displays shall generally be expressed in photometric or colorimetric units using the CIE 1931 standard colorimetric two-degree observer (see ISO 11664-1). Luminance can be measured by a photometer, and the CIE tristimulus values (X, Y, Z) or CIE chromaticity coordinates by a colorimeter. A spectroradiometer can also obtain photometric and colorimetric values through a numerical conversion of the measured spectral radiance data (see, for example, [1][1]). The following requirements are given for these instruments:

The LMD shall be a luminance meter, colorimeter, or a spectroradiometer. For DUTs that have sharp spectral peak full-width-at-half-maximums (FWHMs) smaller than 20 nm, a spectroradiometer should be used. A filter colorimeter should generally not be used for light sources with sharp spectral peaks. If they are used, the colorimeter shall be calibrated with a narrow bandwidth spectroradiometer to give the same results for the specific spectrum. Report the characteristics of the spectroradiometer which is used for calibration. For light sources with sharp spectral peaks, the maximum bandwidth of the spectroradiometer shall be ≤ 5 nm. The higher resolution spectroradiometer produces a more accurate colour measurement. In those cases, the wavelength accuracy shall be within ±0,5 nm. The spectroradiometer shall be capable of measuring spectral radiance over at least the 380 nm to 780 nm wavelength range, with a maximum bandwidth of 10 nm for smooth broadband spectra (i.e. broad spectrum with no sharp spikes).

Care shall be taken to ensure that the LMD has enough sensitivity and dynamic range to perform the required task. Before measuring the DUT, the LMD specification shall be checked.

5 Standard measuring conditions

5.1 Standard measuring environmental conditions

The standard measuring environmental conditions specified in IEC 62341-6-1:~~2009~~2017, 5.1, shall be applied. For image sticking measurements, the environmental temperature shall be controlled at 25 °C ± ~~2~~ 3 °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 darkroom conditions

The standard measuring darkroom conditions specified in IEC 62341-6-1:~~2009~~2017, 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.~~

[1] Numbers in square brackets refer to the Bibliography.

~~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~~

Standard setup conditions are given below. Any deviations from these conditions shall be recorded.

5.3.2 Adjustment of OLED display ~~modules~~

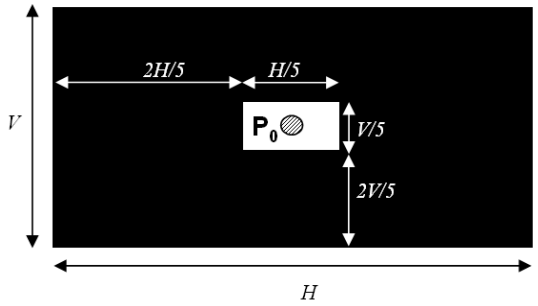
The adjustment of the OLED display ~~modules~~ specified in IEC 62341-6-1:~~2009~~2017, 5.3.~~1~~2, shall be applied.

5.3.3 Starting conditions of measurements

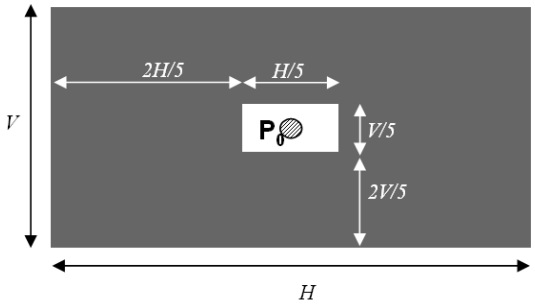
Warm-up time is defined as the time elapsed from the moment of switching on the supply voltage until repeated measurements of the display show a variation in luminance of less than 2 %/min. Repeated measurements shall be taken for a period of at least 15 min after starting. The luminance variations shall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

5.3.4 Test patterns

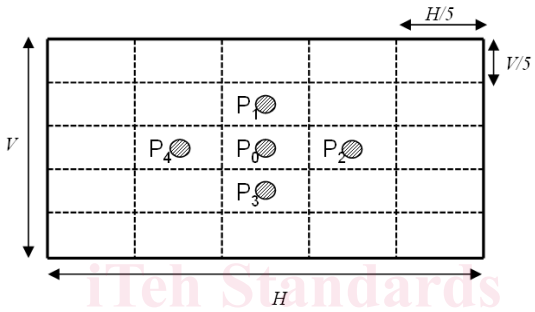
~~The test patterns for display devices such as mobile phones, table PCs, monitors and TVs are shown in Figure 2. In the case of mobiles and tablet PCs, depending on the size of the OLED display panels or modules and measurement distance between the display and the LMD, if the pattern size is a smaller 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

5.3.4.1 SDR displays

The test patterns for SDR display devices such as mobile phones, tablet PCs, monitors, TVs and digital signage are shown in Figure 2. The test pattern for SDR displays is divided into two groups.

1) Test pattern for mobiles and tablet PC displays

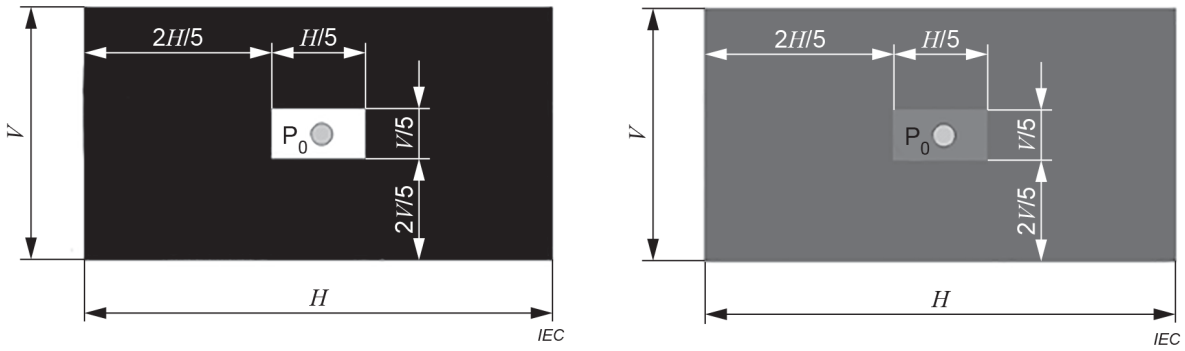
In the case of mobiles and tablet PCs, the measurement distance between the display and the LMD depends on the size of the OLED display panels or modules. The measuring distance and the aperture angle may be adjusted to achieve a measuring field greater than 500 pixels if the setting of the measurement field angle is not applied. For display devices except monitors, TVs and digital signage, the test pattern with a white level at the 4 % window box located in the centre and a black level in the background, is used in Figure 2a).

2) Test pattern for monitors, TVs and digital signage displays

For monitors, TVs and digital signage, the test pattern is extracted by video analysis to reflect the characteristics of the video sample. For the test pattern, the maximum code value is allocated at the 4 % window box in the centre and the average code value is in the background. The examples of the maximum and average gray code values are shown in Table 1. The example of the test pattern is shown in Figure 2b). The maximum and average code values between 0 and 255 (in the case of 8 bits) could be extracted from the accumulating image for all frames of the video sample, which is converted as equivalent grayscale from each colour channel.

NOTE 1 Image sticking is influenced by the characteristics of the OLED displays [5], [7]. Some manufacturers of OLED displays apply various algorithms to optimize the quality of each device, and this also influences the image

sticking. To consider the characteristics of an OLED display, the method in Annex A is used for the test pattern reflecting the characteristics of the OLED display.



a) Test pattern for mobiles and tablet PC displays

b) Test pattern for monitors, TVs and digital signage displays

Figure 2 – Test pattern for SDR displays

Table 1 – Examples of maximum and average code value extracted from video samples

Examples of test video	Maximum code value	Average code value
IEC 62087:2011	107	84
Broadcast video sample	183	102

NOTE 2 For the test pattern, any video samples could be selected as needed. Table 1 shows two kinds of representative examples. The broadcast video sample example is constructed by considering the viewing ratio of the content of TV programmes based on the Korea broadcast media use environmental survey report: entertainment (30,9%), news (20,2 %), drama (16,8 %), and so on [4]. The average gray level and test pattern size are different between SDR and HDR in TVs. Depending on the purpose of the test, Figure 2b) or Figure 4a) would apply.

3) Measuring area

In order to get repeatability of measurement, the measuring area from P_0 to P_4 for displays is set to consider the uniformity of the OLED display panels or modules, as shown in Figure 3. If the centre window size is changed, then it should be reported in Table 2.

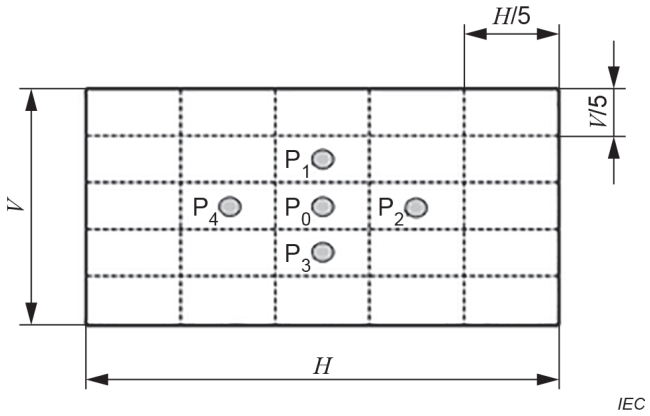


Figure 3 – Image sticking measuring area

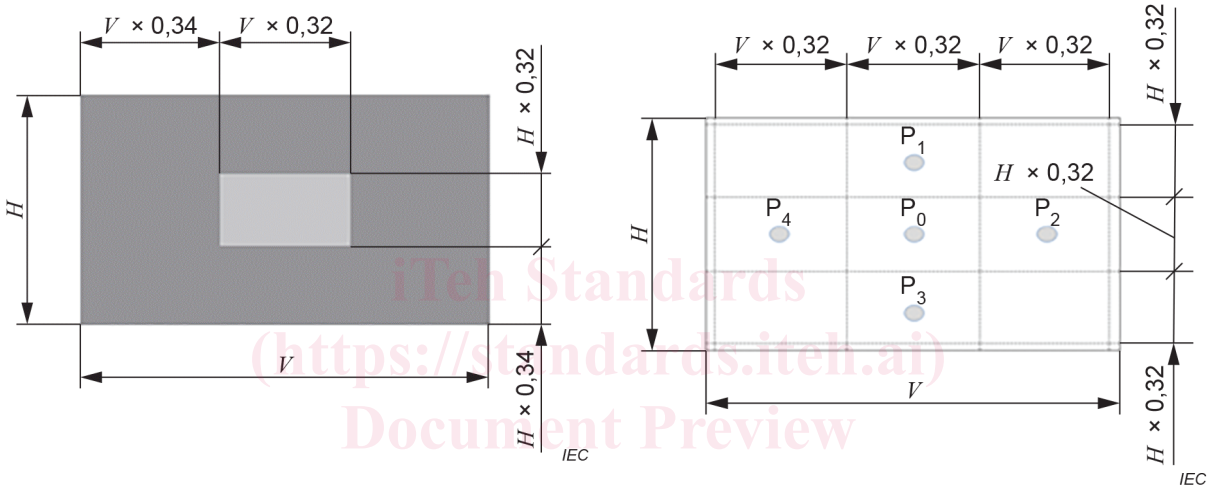
4) Checking the test pattern

For SDR displays, the output luminance can be different although they have the same digital code value inputs. To check the brief information of the selected test pattern, the output luminance for the test pattern should be measured and reported.

Apply the test pattern on OLED displays and measure the output luminance on the measuring area from P_0 to P_4 as shown in Figure 3. The results of the output luminance of the test pattern should be reported in Table 2.

5.3.4.2 HDR displays

In 5.3.4.1, the test pattern for SDR displays is described. The test pattern for HDR displays is shown in Figure 4a). It is based on the PQ curve and 10 bits. The test pattern for HDR displays is proposed separately because the characteristics of the contents of the SDR and HDR are different. The test pattern for SDR or HDR can be used as needed. The background code value should be 510. The size of the box window should be 10 %, which is located in the centre. The code value of the 10 % box window should be 710. The measured luminance of the box window and the background luminance should be reported. To get repeatability of the measurement data, the measuring area from P_0 to P_4 is the centre of the boxes, as shown in Figure 4b). The measurement data should be reported in Table 2.



a) HDR test pattern b) Measurement area

Figure 4 – Test pattern for HDR displays

NOTE The code value of the 10 % box window and background is the result of the analysed data of HDR contents which are HDR games, drama and documentary.

5.3.5 Conditions of measuring equipment

The general conditions in IEC 62341-6-1:~~2009~~2017, Clause 5, shall be applied.

6 Measuring methods of image sticking

6.1 Purpose

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

6.2 Measuring method

6.2.1 Measuring equipment

The following equipment defined in IEC 62341-6-1:~~2009~~2017, ~~6.1.2~~ 5.3.4, shall be used:

a) power supplies and signal sources for driving,

b) LMD.