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colour inside

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

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 62341-6-1 has been prepared by IEC technical committee 110: Electronic display devices.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

a) extends the applicability of the measuring methods to include OLED displays that have multi-primary or red, green, blue and white sub-pixels;
b) adds a method to characterize how the luminance is affected by the amount of content on the screen;
c) adds a method to determine the dark room colour gamut volume in the CIELAB colour space.

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

FDIS	Report on voting
110/816/FDIS	110/830/RVD

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

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

Part 6-1: Measuring methods of optical and electro-optical parameters

1 Scope

This part of IEC 62341 specifies the standard measurement conditions and measuring methods for determining optical and electro-optical parameters of organic light-emitting diode (OLED) display modules and, where specified, OLED display panels~~, in the following areas~~. These methods are limited to flat displays measured in a dark room.

~~a) luminance and uniformity;~~

~~b) dark room contrast ratio;~~

~~c) chromaticity, colour uniformity, colour gamut and white field correlated colour temperature;~~

~~d) power consumption.~~

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 60050-845, *International Electrotechnical Vocabulary – Part 850: Lighting* (available at www.electropedia.org)

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

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

IEC 62341-6-2:2015, *Organic light emitting diode (OLED) displays – Part 6-2: Measuring methods of visual quality and ambient performance*

CIE 15~~.2~~:~~1986~~ 2004, *Colorimetry, ~~(second~~ 3rd edition~~)~~*

CIE S 014-1~~/E:2006~~, *Colorimetry – Part 1: CIE Standard Colorimetric Observers*

3 Terms, definitions, and ~~units~~ abbreviated terms

3.1 Terms and definitions

For the purposes of this document, ~~most of the definitions and units used comply with~~ the terms and definitions given in IEC 60050-845, IEC 62341-1-2, 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
signal pixel
smallest encoded picture element in the input image

3.1.2
pre-gamma average picture level
average input level of all signal pixels relative to an equivalent white pixel driven by a digital RGB input

Note 1 to entry: Unless otherwise stated, the pre-gamma average picture level (APL) will simply be referred to as average picture level in this document.

Note 2 to entry: The APL will normally be expressed as a percentage, where a full white screen at maximum drive level would be 100 % APL.

3.2 Abbreviated terms

APL	average picture level
CCT	correlated colour temperature
CIE	Commission internationale de l'éclairage (International Commission on Illumination)
CIELAB	CIE 1976 ($L^*a^*b^*$) colour space
CMY	cyan, magenta, and yellow
DUT	device under test
LMD	light-measuring device
LUT	look-up table
PMOLED	passive matrix organic light-emitting diode
RGB	red, green, and blue
RGBCMY	red, green, blue, cyan, magenta, and yellow
sRGB	standard RGB colour space as defined in IEC 61966-2-1
UCS	uniform chromaticity scale
WRGB	white, red, green, and blue

4 Structure of measuring equipment

The system diagrams and/or operating conditions of the measuring equipment shall comply with the structure specified in each item.

5 Standard measuring conditions

5.1 Standard ~~measuring~~ environmental conditions for measurements

Measurements shall be carried out under standard environmental conditions at a temperature of 25 °C ± 3 °C, at a relative humidity of 25 % to 85 %, and at an air pressure of 86 kPa to 106 kPa. When different environmental conditions are used, they shall be noted in the report.

5.2 Standard ~~measuring~~ dark room conditions for measurements

~~With the OLED display turned off, the ambient illuminance at all points on the screen shall be less than 0,3 lx. When a higher ambient illuminance on the display is present, the background luminance measured when the display is OFF shall be subtracted from subsequent luminance measurements of the display, and shall be reported.~~

The luminance contribution from unwanted background illumination reflected off the test display shall be less than 1/20 of the display's black state luminance. If these conditions are

not satisfied, then background subtraction is required and it shall be noted in the test report. In addition, if the sensitivity of the LMD is inadequate to measure 1/20 of the black level, then the lower limit of the LMD shall be noted in the test report.

5.3 Standard setup conditions

5.3.1 General

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

5.3.2 Adjustment of OLED display modules

~~The luminance, contrast, correlated colour temperature of the white field, and other relevant parameters have to be adjusted to nominal values and they shall be reported in detail in the specifications of the measurement. For a full colour display, the chromaticity of the white field shall also be adjusted to match the product specification. When no levels are specified, the maximum contrast and/or luminance level shall be used and the settings reported.~~ The display shall be measured at its factory default settings. If other settings are used, they shall be noted in the test report. These ~~adjustments~~ settings shall be held constant for all measurements, unless stated otherwise. It is important, however, to make sure that not only the adjustments are kept constant, but also that the resulting physical quantities remain constant during the measurement. This is not automatically the case because of, for example, warm-up effects.

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 min after starting. The luminance variations shall also not exceed 5 % during the total measurement.~~

Measurements shall be started after the OLED display and the measuring instruments achieve stability. It is recommended that, when the display is first turned on, it be operated for at least 30 min with a loop of colour patterns rendered on the screen. Sufficient warm-up time has ~~to be allowed for the OLED displays to reach luminescence stability~~ been achieved when the luminance of the test feature to be measured varies by less than ±3 % over the entire measurement method for a given display image.

5.3.4 ~~Conditions of~~ Measuring equipment requirements

5.3.4.1 General conditions

Light measurements shall generally be measured in terms of photometric or colorimetric units for a CIE 1931 standard colorimetric observer as defined in CIE S 014-1. Luminance can be measured by a photometer, and 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]). Non-contact LMD, where the LMD is not in direct contact with the screen, shall be used without an illumination source. The following ~~general conditions apply~~ requirements are given for these instruments:

a) ~~The standard measurement setup is shown in Figure 1. The light measuring device (LMD) may be any of the following meters:~~

   ~~1) a luminance meter with a spectral response approximating the spectral luminous efficiency function for photopic vision;~~

1 Numbers in square brackets refer to the Bibliography.

~~2) a colorimetric meter with the spectral sensitivity as colour-matching functions for the CIE 1931 standard colorimetric observer (specified in CIE S 014-1);~~

~~3) a spectroradiometer with a wavelength range from 380 nm to 780 nm;~~

~~4) an imaging photometer or colourimeter with the spectral sensitivity as colour-matching functions for the CIE 1931 standard colorimetric observer.~~

The LMD shall be a luminance meter, a colorimeter, or a spectroradiometer. The spectroradiometer shall be capable of measuring spectral radiance over at least the 380 nm to 780 nm spectral range, with a maximum bandwidth of 10 nm for smooth broadband spectra. For OLED primaries with bandwidth ≤ 25 nm, the maximum bandwidth shall be ≤ 5 nm. The spectral bandwidth of the spectroradiometer shall be an integer multiple of the sampling interval. For example, a 5 nm sampling interval can be used for a 5 nm or 10 nm bandwidth.

Care shall be taken to ensure that the ~~device is capable~~ LMD has enough sensitivity and dynamic range to perform the required task. The measured LMD signal shall be at least ten times greater than the dark level (noise floor) of the LMD, and no greater than 85 % of the saturation level.

b) The LMD shall be focused on the image plane of the display and generally aligned perpendicular to the ~~area to be measured on the image generating surface of the OLED display~~ display surface at the centre of the measurement field, unless stated otherwise.

c) The relative uncertainty and repeatability of all the measuring devices shall be maintained by following the instrument supplier's recommended calibration schedule.

d) The LMD ~~lens shall be focused on the light emitting plane of the display~~ integration time shall be an integer number ~~(≥10)~~ of frame periods, synchronized to the frame rate, or the integration time shall be greater than one hundred frame periods. ~~Shorter integration times are acceptable if the detector is synchronized with the display frame rate.~~

e) If LMD measurements are taken for displays with impulse driving or duty driving, the high peak luminance of these displays can cause detector saturation errors. The accuracy of these measurements can be checked by attenuating the light with a neutral-density filter. If the change in signal amplitude of the detector is proportional to the transmittance of the neutral-density filter, then there are no detector saturation errors. This method is for measuring the maximum time-averaged full-screen luminance.

When using LMDs, stray light within the LMD (e.g. lens flare, veiling glare) and non-uniformities of sensitivity across the detector area should be considered.

In addition to LMDs that form an average value for the measured quantity over the measurement field under consideration (i.e. spot photometers, Figure 1), there are imaging LMDs which give a value (or an array of values, e.g. R, G and B) for each individual area-element on the DUT. Such LMDs can replace a sequential mechanical scan of the surface of a display by an image of the entire active area of the DUT, and a subsequent evaluation of the data.

When imaging LMDs are used, a flat-field correction shall be applied to the LMD at the measuring distance.

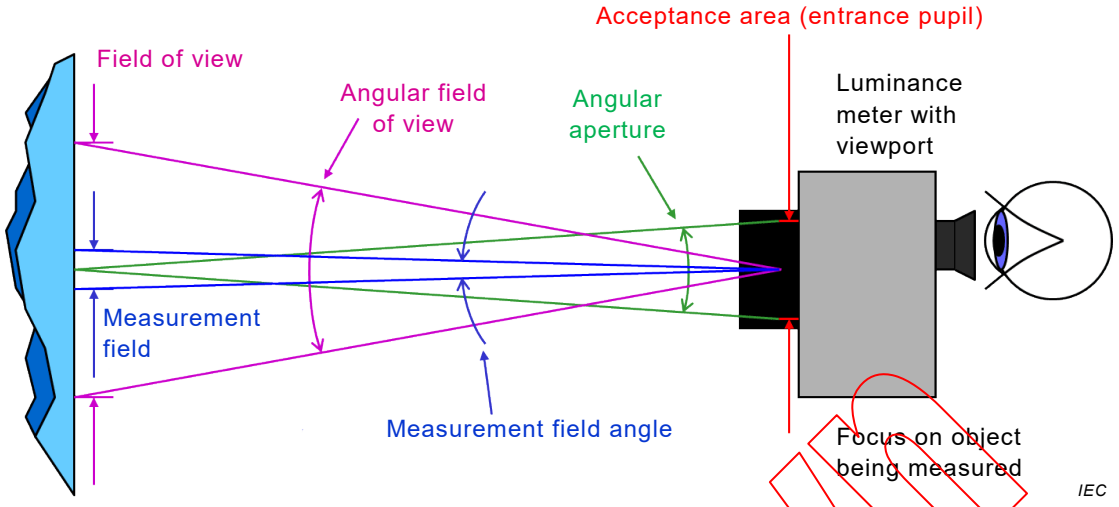

Figure 1 – Layout diagram of measurement setup

5.3.4.2 High pixel count matrix displays (≥ 320 × 240 pixels)

The following applies for high pixel count matrix displays.

a) When measuring matrix displays, the ~~measurement field shall~~ light-measuring devices should be set to a measurement field that includes more than 500 pixels. For LMDs with a circular measurement field, this would be equivalent to a disk with a diameter greater than 25 display pixels. If smaller measurement areas are necessary, photometric and colorimetric equivalence to 500 pixels shall be confirmed and noted in the test report.

b) ~~The standard measuring distance l_{xp} is 2,5V (for $V \geq 20$ cm) or 50 cm (for $V < 20$ cm), where V is the height of the display active area or the shorter of the screen width and height dimensions.~~ For small displays, the recommended measuring distance is between 20 cm to 50 cm. For larger displays, the measurement area shall contain at least 500 pixels. The measuring distance shall be noted in the report.

c) The angular aperture shall be less than or equal to 5°, and the measurement field angle shall be less than or equal to 2° (see Figure 1). ~~The measuring distance and the measurement field angle may be adjusted to achieve a measuring field greater than 500 pixels area if setting the above aperture angle is difficult.~~

d) The display shall be operated at its design field frequency. When using separate driving signal equipment to operate a panel, the drive conditions shall be noted in the report.

5.3.4.3 Low pixel count matrix displays (< 320 × 240 pixels) and segmented displays

The following applies for low pixel count matrix displays.

a) Low pixel count displays may contain fewer than 500 pixels. When the number of pixels in the measurement field is less than 500, it shall be noted in the report. The angular aperture shall be less than or equal to 5°, and the measurement field angle shall be less than or equal to 2°. The measurement conditions used shall be recorded.

b) For segment displays, the angular aperture shall be less than or equal to 5°, and the measurement field angle shall be less than or equal to 2°. All measurements shall be performed at the centre of a segment with the measurement field completely contained within the segment.

c) ~~When the measurement conditions do not satisfy the requirement of ≤2° for the measurement field angle, or the measurement field includes fewer than 500 pixels, the measured values for these parameters shall be reported.~~ For small displays, the recommended measuring distance is between 20 cm to 50 cm. For larger displays, follow the manufacturer's recommended viewing distance. For larger displays, the measurement area shall contain at least 500 pixels. The measuring distance shall be noted in the report.