

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.260

ISBN 978-2-8322-3845-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Terms, definitions, and abbreviated terms	7
3.1 Terms and definitions.....	7
3.2 Abbreviated terms.....	8
4 Structure of measuring equipment	8
5 Standard measuring conditions.....	8
5.1 Standard environmental conditions for measurements	8
5.2 Standard dark room conditions for measurements.....	8
5.3 Standard setup conditions.....	9
5.3.1 General	9
5.3.2 Adjustment of OLED display modules	9
5.3.3 Starting conditions of measurements	9
5.3.4 Measuring equipment requirements	9
5.4 Standard locations of measurement field.....	11
5.5 Standard test patterns.....	11
6 Measuring methods for optical parameters.....	16
6.1 Primary luminance, colour, and uniformity of full-colour high-resolution modules.....	16
6.1.1 Purpose.....	16
6.1.2 Measuring conditions.....	16
6.1.3 Measuring method for high-resolution full-colour modules.....	16
6.1.4 Maximum luminance of white and RGB primaries.....	18
6.1.5 Average colour of white and RGB primaries.....	18
6.1.6 Luminance uniformity of white and RGB primaries	19
6.1.7 Colour non-uniformity of white and RGB primaries.....	19
6.1.8 Colour additivity of white and RGB primaries	20
6.1.9 White correlated colour temperature	20
6.2 Primary luminance, colour, and uniformity of low-resolution modules	21
6.2.1 Purpose.....	21
6.2.2 Measuring conditions.....	21
6.2.3 Measuring method for low-resolution modules and segmented displays.....	21
6.3 Signal loading.....	21
6.3.1 Purpose.....	21
6.3.2 Measuring conditions.....	21
6.3.3 Measuring methods	21
6.4 Dark room contrast ratio	22
6.4.1 Purpose.....	22
6.4.2 Measuring conditions.....	22
6.4.3 Measuring method	23
6.5 Display colour gamut, colour gamut area, and colour gamut volume	23
6.5.1 Purpose.....	23
6.5.2 Measuring conditions.....	23
6.5.3 Measuring method	23
6.5.4 Display colour gamut	24

6.5.5	Display colour gamut area in CIE 1976 chromaticity diagram	24
6.5.6	Colour gamut volume	24
7	Measuring methods for power consumption	26
7.1	Purpose	26
7.2	Measuring conditions	26
7.3	Measuring method	26
Annex A (normative)	Response time of passive matrix display panels	28
A.1	Purpose	28
A.2	Measuring conditions	28
A.3	Measuring method	28
Annex B (normative)	Luminance current efficiency	30
B.1	Purpose	30
B.2	Measuring conditions	30
B.3	Measuring method	30
Annex C (informative)	Veiling glare frustum	32
Annex D (informative)	Methods to obtain the correlated colour temperature (CCT) from chromaticity coordinates	33
D.1	Method 1: using McCamy's approximate formula	33
D.2	Method 2: using Javier Hernandez-Andres's approximate formula	33
D.3	Method 3: graphical determination of correlated colour temperature	34
Annex E (informative)	Measuring the performance of modern colour-managed displays and panels	36
E.1	Legacy displays	36
E.2	Modern displays	36
E.3	Results	38
E.4	Conclusion	41
Annex F (informative)	Simple window luminance and colour measurements	42
F.1	Background	42
F.2	Measuring conditions	42
F.3	Maximum full-screen luminance	42
F.4	4 % window luminance	42
F.5	Sampled luminance non-uniformity	42
F.6	4 % window centre colour	43
F.7	Sampled colour non-uniformity	44
Bibliography	45
Figure 1	– Layout diagram of measurement setup	10
Figure 2	– Standard measurement positions in the active area of the display	11
Figure 3	– Test pattern scaling used to define the area size of the coloured rectangles in the active area of the display	12
Figure 4	– Low APL loading series of red, green, blue, and white test patterns used for basic luminance, colour, and uniformity measurements	13
Figure 5	– Medium (top) and high (bottom) APL loading versions of CTR pattern	14
Figure 6	– Standard low APL RGBCMY test pattern used for centre luminance and colour measurements	15
Figure 7	– Optional medium APL RGBCMY test pattern used for centre luminance and colour measurements	16

Figure 8 – Sequence for measuring luminance and colour at the nine standard display positions for all coloured tile patterns.....	17
Figure 9 – Colour of blackbody source at various temperatures as represented on the CIE 1931 chromaticity diagram	20
Figure 10 – Example representation of the same primary colours in the CIE 1931 (left) and CIE 1976 (right) chromaticity diagrams.....	24
Figure 11 –Example of the range of colours produced by a given display as represented by the CIELAB colour space	25
Figure 12 – Example of measurement setup of power consumption	27
Figure A.1 – Relationship between the driving signal and the optical response times	29
Figure B.1 – Example of a measurement configuration for measuring luminance current efficiency	31
Figure C.1 – Pattern for veiling glare frustum.....	32
Figure D.1 – CIE 1931 XYZ chromaticity diagram	34
Figure D.2 – Blackbody locus (Planckian locus) and isothermperature lines in CIE 1931 chromaticity diagram.....	35
Figure E.1 – Legacy model where the independent drive electronics provide a direct correlation between the input RGB signals and the display’s colour primaries.....	36
Figure E.2 – Example of modern drive models utilizing multi-dimensional LUTs for RGB (top) and multi-primary (bottom) displays.....	37
Figure E.3 – Example of APL loading behaviour for a WRGB (top) and RGB (bottom) OLED display.....	39
Figure E.4 – Low APL loading test pattern with small box size (1/9 the screen size dimensions)	40
Figure E.5 – APL loading profiles for several input colours measured at the centre of the test pattern using Figure E.4.....	41
Figure F.1 – Example of a simple 4 % white window pattern at the centre of the screen.....	43
Table 1 – Standard digital-equivalent input signals for rendering the white, primary and secondary colours in test patterns.....	15
Table 2 – Example of luminance measured of the same colour at the nine standard screen positions and the resulting luminance non-uniformity.....	18
Table 3 – Example of the same colour measured at the nine standard screen positions and the resulting chromaticity non-uniformity	18
Table 4 – Scaling the size of the colour boxes in the APL loading pattern relative to the screen dimensions	22
Table 5 – Example of a summary sheet for module power consumption measurements	27
Table D.1 – x_e , y_e , A_i and t_i for Formula (D.3) and Formula (D.4)	33
Table E.1 – Example of luminance data for an RGB and WRGB OLED display	38

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

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

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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. These methods are limited to flat displays measured in a dark room.

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 15:2004, *Colorimetry, 3rd edition*

CIE S 014-1, *Colorimetry – Part 1: CIE Standard Colorimetric Observers*