



Edition 3.0 2022-10

# INTERNATIONAL STANDARD



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





#### THIS PUBLICATION IS COPYRIGHT PROTECTED Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat 3, rue de Varembé CH-1211 Geneva 20

Tel.: +41 22 919 02 11 info@iec.ch

www.iec.ch

### Switzerland About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

#### IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



Edition 3.0 2022-10

# 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 978-2-8322-5856-9

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

## CONTENTS

F	DREWO	RD	5
1	Scop	e	7
2	, , , , , , , , , , , , , , , , , , ,	native references	
3		s, definitions, and abbreviated terms	
J		Terms and definitions.	
	3.1 3.2		
4		Abbreviated termsture of measuring equipment	
5		dard measuring conditions	
	5.1	Standard measuring environmental conditions	
	5.2	Standard measuring dark room conditions	
	5.3	Standard setup conditions	
	5.3.1		
	5.3.2	, , , , , , , , , , , , , , , , , , , ,	
	5.3.3	J. Company of the com	
	5.3.4		
	5.4	Standard locations of measurement field	
	5.5	Standard test patterns	
6	Meas	suring methods for optical parameters	17
	6.1	Primary luminance, colour, and uniformity of full-colour high-resolution	
		modules	
	6.1.1		
	6.1.2	S .	
	6.1.3		
	6.1.4		
	6.1.5		
	6.1.6		
	6.1.7		
	6.1.8		
	6.1.9		
	6.2	Primary luminance, colour, and uniformity of low-resolution modules	
	6.2.1		
	6.2.2	3	
	6.2.3		
	6.3	Signal loading	
	6.3.1	Purpose	
	6.3.2		
	6.3.3	9	
	6.4	Dark room contrast ratio	
	6.4.1	Purpose	
	6.4.2	ğ	
	6.4.3	· · · · · · · · · · · · · · · · · · ·	
	6.5	Display colour gamut, colour gamut area, and colour gamut volume	
	6.5.1	•	
	6.5.2	· · · · · · · · · · · · · · · · · · ·	
	6.5.3	3	
	6.5.4	Display colour gamut	24

	6.5.5	Display colour gamut area in the CIE 1976 chromaticity diagram	25
	6.5.6	Colour gamut volume	25
7	Meas	suring methods for power consumption	27
	7.1	Purpose	27
	7.2	Measuring conditions	
	7.3	Measuring methods	27
	7.3.1	, v	
	7.3.2		
		embedded video connection terminal with a signal decoding process	29
Anr	nex A (	(normative) Response time of passive matrix display panels	31
	A.1	Purpose	31
	A.2	Measuring conditions	31
	A.3	Measuring methods	
Anr	nex B (	normative) Luminance current efficiency	33
	B.1	Purpose	33
	B.2	Measuring conditions	
	B.3	Measuring methods	
		(informative) Veiling glare frustum	
		(informative) Methods to obtain the correlated colour temperature (CCT) from	
		ity coordinates	36
	D.1	Method 1: Use of McCamy's approximate formula	
	D.1 D.2	Method 2: Use of Javier Hernandez-Andres's approximate formula	
	D.3	Method 3: Graphical determination of correlated colour temperature	
		(informative) Measuring performance of modern colour-managed displays	07
		s	40
	Е.1	Legacy displays	40
	E.2	Modern displays	
	E.3	Results	
	E.4	Conclusion	
Anr	nex F (	informative) Simple window luminance and colour measurements	
	F.1	Background	
	F.2	Measuring conditions	
	F.3	Maximum full screen luminance	
	F.4	4 % window luminance	
	F.5	Sampled luminance non-uniformity	
	F.6	4 % window centre colour	
	F.7	Sampled colour non-uniformity	
		phy	
٥٥	og.ar	,	
<b>⊏:</b> ~.	1	Levent discuss of management actus	4.0
		- Layout diagram of measurement setup	
		- Standard measurement positions in the display active area	12
		- Test pattern scaling used to define the area size of the coloured rectangles ive area of the display	12
		- Low APL loading series of red, green, blue, and white test patterns used for	
bas	ic lum	inance, colour, and uniformity measurements	13
Fia	ure 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	5
Figure 7 – Optional medium signal loading RGBCMY test pattern used for centre luminance and colour measurements1	6
Figure 8 – Sequence for measuring luminance and colour at the nine standard display positions for all coloured tile patterns	8
Figure 9 – Colour of blackbody source at various temperatures as represented on the CIE 1931 chromaticity diagram2	1
Figure 10 – Example of representation of the same primary colours in the CIE 1931 (left) and CIE 1976 (right) chromaticity diagrams	5
Figure 11 – Example of range in colours produced by a given display as represented by the CIELAB colour space	7
Figure 12 – Example of measurement setup of power consumption	8
Figure 13 – Example of measurement setup of power consumption with embedded video terminal	9
Figure A.1 – Relationship between driving signal and optical response times3.	2
Figure B.1 – Example of a measurement configuration for measuring luminance current efficiency	4
Figure C.1 – Pattern for veiling glare frustum3	5
Figure D.1 – CIE 1931 XYZ chromaticity diagram	8
Figure D.2 – Blackbody locus (Planckian locus) and isotemperature lines in CIE 1931 chromaticity diagram3	9
Figure E.1 – Legacy model where the independent drive electronics provide a direct correlation between the input RGB signals and the display's colour primaries4	0
Figure E.2 – Examples of modern drive models using multi-dimensional LUTs for RGB (top) and multi-primary (bottom) displays4	1
Figure E.3 – Example of signal loading behaviour for an RGBW display (top) and RGB (bottom) OLED display4	3
Figure E.4 – Low APL loading test pattern with small box size (1/9 of the screen size dimensions)4	4
Figure E.5 – Signal loading profiles for several input colours measured at the centre of the test pattern using Figure 84	5
Figure F.1 – Example of simple 4 % white window pattern at the centre of the screen4	7
Table 1 – Standard digital-equivalent input signals for rendering the white, primary and secondary colours in test patterns1	6
Table 2 – Example of luminance measured for the same colour at the standard nine screen positions and the resulting luminance non-uniformity1	8
Table 3 – Example of the same colour measured at the nine standard screen positions and the resulting chromaticity non-uniformity1	9
Table 4 – Scaling the size of the colour boxes in the APL loading pattern relative to the screen dimensions	3
Table 5 – Example of a module power consumption measurements summary sheet2	8
Table 6 – Example of module power consumption measurements with contents3	0
Table 7 – Example of module power consumption measurements with images3	
Table D.1 – $x_e$ , $y_e$ , $A_i$ and $t_i$ for Formula(D.3) and Formula (D.4)	7
Table E.1 – Example of luminance data for an RGB display and an RGBW OLED display4	2

#### 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.

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

This third edition cancels and replaces the second edition published in 2017. This edition constitutes a technical revision.

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

- a) measuring methods for power consumption of displays that have an embedded video connection terminal are added:
- b) the contents description including video signal for power consumption is modified.

The text of this International Standard is based on the following documents:

Draft	Report on voting
110/1454/FDIS	110/1471/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at <a href="https://www.iec.ch/members\_experts/refdocs">www.iec.ch/members\_experts/refdocs</a>. The main document types developed by IEC are described in greater detail at <a href="https://www.iec.ch/standardsdev/publications">www.iec.ch/standardsdev/publications</a>.

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 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.

IMPORTANT – The "colour inside" logo on the cover page of this document 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 measuring conditions and measuring methods for determining the 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

IEC 62087-3, Audio, video, and related equipment – Determination of power consumption – Part 3: Television sets

CIE 15:2004, Colorimetry, 3rd edition

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

#### 3 Terms, definitions, and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, 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 https://www.electropedia.org
- ISO Online browsing platform: available at https://www.iso.org/obp