



IEC 62341-6-1

Edition 3.0 2022-10
REDLINE VERSION

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 978-2-8322-5895-8

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	9
5.1 Standard measuring environmental conditions	9
5.2 Standard measuring dark room conditions	9
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	12
5.5 Standard test patterns	12
6 Measuring methods for optical parameters	18
6.1 Primary luminance, colour, and uniformity of full-colour high-resolution modules	18
6.1.1 Purpose	18
6.1.2 Measuring conditions	18
6.1.3 Measuring methods for high-resolution full-colour modules	18
6.1.4 Maximum luminance of white and RGB primaries	20
6.1.5 Average colour of maximum white and RGB primaries	20
6.1.6 Luminance uniformity of white and RGB primaries	21
6.1.7 Colour non-uniformity of maximum white and RGB primaries	21
6.1.8 Colour additivity of maximum white and RGB primaries	22
6.1.9 White correlated colour temperature	22
6.2 Primary luminance, colour, and uniformity of low-resolution modules	22
6.2.1 Purpose	22
6.2.2 Measuring conditions	23
6.2.3 Measuring methods for low-resolution modules and segmented displays	23
6.3 Signal loading	23
6.3.1 Purpose	23
6.3.2 Measuring conditions	23
6.3.3 Measuring methods	23
6.4 Dark room contrast ratio	24
6.4.1 Purpose	24
6.4.2 Measuring conditions	24
6.4.3 Measuring method	24
6.5 Display colour gamut, colour gamut area, and colour gamut volume	25
6.5.1 Purpose	25
6.5.2 Measuring conditions	25
6.5.3 Measuring methods	25
6.5.4 Display colour gamut	25

6.5.5	Display colour gamut area in the CIE 1976 chromaticity diagram	26
6.5.6	Colour gamut volume	26
7	Measuring methods for power consumption	28
7.1	Purpose	28
7.2	Measuring conditions	28
7.3	Measuring methods.....	28
7.3.1	Measuring the power consumption relevant to luminance of the OLED display module without a signal decoding process	28
7.3.2	Measuring the power consumption of the OLED display module's embedded video connection terminal with a signal decoding process	30
Annex A (normative)	Response time of passive matrix display panels	33
A.1	Purpose	33
A.2	Measuring conditions	33
A.3	Measuring methods.....	33
Annex B (normative)	Luminance current efficiency	35
B.1	Purpose	35
B.2	Measuring conditions	35
B.3	Measuring methods.....	35
Annex C (informative)	Veiling glare frustum	37
Annex D (informative)	Methods to obtain the correlated colour temperature (CCT) from chromaticity coordinates	38
D.1	Method 1: Use of McCamy's approximate formula	38
D.2	Method 2: Use of Javier Hernandez-Andres's approximate formula	38
D.3	Method 3: Graphical determination of correlated colour temperature	39
Annex E (informative)	Measuring performance of modern colour-managed displays and panels	42
E.1	Legacy displays	42
E.2	Modern displays.....	42
E.3	Results	44
E.4	Conclusion.....	49
Annex F (informative)	Simple window luminance and colour measurements	50
F.1	Background.....	50
F.2	Measuring conditions	50
F.3	Maximum full screen luminance	50
F.4	4 % window luminance.....	50
F.5	Sampled luminance non-uniformity	50
F.6	4 % window centre colour	51
F.7	Sampled colour non-uniformity.....	52
Bibliography	53
Figure 1	– Layout diagram of measurement setup	11
Figure 2	– Standard measurement positions in the display active area.....	12
Figure 3	– Test pattern scaling used to define the area size of the coloured rectangles in the active area of the display	13
Figure 4	– Low APL loading series of red, green, blue, and white test patterns used for basic luminance, colour, and uniformity measurements.....	14
Figure 5	– Medium (top) and high (bottom) APL loading versions of CTR pattern	15

Figure 6 – Standard low APL RGBCMY test pattern used for centre luminance and colour measurements.....	16
Figure 7 – Optional medium-APL signal loading RGBCMY test pattern used for centre luminance and colour measurements	17
Figure 8 – Sequence for measuring luminance and colour at the nine standard display positions for all coloured tile patterns.....	19
Figure 9 – Colour of blackbody source at various temperatures as represented on the CIE 1931 chromaticity diagram	22
Figure 10 – Example of representation of the same primary colours in the CIE 1931 (left) and CIE 1976 (right) chromaticity diagrams	26
Figure 11 – Example of range in colours produced by a given display as represented by the CIELAB colour space	27
Figure 12 – Example of measurement setup of power consumption	29
Figure 13 – Example of measurement setup of power consumption with embedded video terminal	31
Figure A.1 – Relationship between driving signal and optical response times.....	34
Figure B.1 – Example of a measurement configuration for measuring luminance current efficiency	36
Figure C.1 – Pattern for veiling glare frustum.....	37
Figure D.1 – CIE 1931 XYZ chromaticity diagram	40
Figure D.2 – Blackbody locus (Planckian locus) and isothermperature lines in CIE 1931 chromaticity diagram.....	41
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.....	42
Figure E.2 – Examples of modern drive models using multi-dimensional LUTs for RGB (top) and multi-primary (bottom) displays	43
Figure E.3 – Example of-APL signal loading behaviour for-a WRGB an RGBW display (top) and RGB (bottom) OLED display	46
Figure E.4 – Low APL loading test pattern with small box size (1/9 of the screen size dimensions)	47
Figure E.5 –-APL Signal loading profiles for several input colours measured at the centre of the test pattern using-Figure E-4 Figure 8.....	49
Figure F.1 – Example of simple 4 % white window pattern at the centre of the screen	51
Table 1 – Standard digital-equivalent input signals for rendering the white, primary and secondary colours in test patterns.....	17
Table 2 – Example of luminance measured for the same colour at the standard nine screen positions and the resulting luminance non-uniformity.....	19
Table 3 – Example of the same colour measured at the nine standard screen positions and the resulting chromaticity non-uniformity	20
Table 4 – Scaling the size of the colour boxes in the APL loading pattern relative to the screen dimensions	24
Table 5 – Example of a module power consumption measurements summary sheet	30
Table 6 – Example of module power consumption measurements with contents.....	32
Table 7 – Example of module power consumption measurements with images.....	32
Table D.1 – x_e, y_e, A_i and t_i for Formula(D.3) and Formula (D.4)	39
Table E.1 – Example of luminance data for an RGB display and-WRGB an RGBW OLED display.....	44

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62341-6-1:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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 www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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*

INTERNATIONAL STANDARD



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

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	9
5.1 Standard measuring environmental conditions	9
5.2 Standard measuring dark room conditions	9
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	12
6 Measuring methods for optical parameters	17
6.1 Primary luminance, colour, and uniformity of full-colour high-resolution modules	17
6.1.1 Purpose	17
6.1.2 Measuring conditions	17
6.1.3 Measuring methods for high-resolution full-colour modules	17
6.1.4 Maximum luminance of white and RGB primaries	19
6.1.5 Average colour of maximum white and RGB primaries	19
6.1.6 Luminance uniformity of white and RGB primaries	20
6.1.7 Colour non-uniformity of maximum white and RGB primaries	20
6.1.8 Colour additivity of maximum white and RGB primaries	21
6.1.9 White correlated colour temperature	21
6.2 Primary luminance, colour, and uniformity of low-resolution modules	21
6.2.1 Purpose	21
6.2.2 Measuring conditions	22
6.2.3 Measuring methods for low-resolution modules and segmented displays	22
6.3 Signal loading	22
6.3.1 Purpose	22
6.3.2 Measuring conditions	22
6.3.3 Measuring methods	22
6.4 Dark room contrast ratio	23
6.4.1 Purpose	23
6.4.2 Measuring conditions	23
6.4.3 Measuring method	23
6.5 Display colour gamut, colour gamut area, and colour gamut volume	24
6.5.1 Purpose	24
6.5.2 Measuring conditions	24
6.5.3 Measuring methods	24
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	Measuring methods for power consumption	27
7.1	Purpose	27
7.2	Measuring conditions	27
7.3	Measuring methods.....	27
7.3.1	Measuring the power consumption relevant to luminance of the OLED display module without a signal decoding process	27
7.3.2	Measuring the power consumption of the OLED display module's embedded video connection terminal with a signal decoding process	29
Annex A (normative)	Response time of passive matrix display panels	31
A.1	Purpose	31
A.2	Measuring conditions	31
A.3	Measuring methods.....	31
Annex B (normative)	Luminance current efficiency	33
B.1	Purpose	33
B.2	Measuring conditions	33
B.3	Measuring methods.....	33
Annex C (informative)	Veiling glare frustum	35
Annex D (informative)	Methods to obtain the correlated colour temperature (CCT) from chromaticity coordinates	36
D.1	Method 1: Use of McCamy's approximate formula	36
D.2	Method 2: Use of Javier Hernandez-Andres's approximate formula	36
D.3	Method 3: Graphical determination of correlated colour temperature	37
Annex E (informative)	Measuring performance of modern colour-managed displays and panels	40
E.1	Legacy displays	40
E.2	Modern displays.....	40
E.3	Results	42
E.4	Conclusion.....	45
Annex F (informative)	Simple window luminance and colour measurements	46
F.1	Background.....	46
F.2	Measuring conditions	46
F.3	Maximum full screen luminance	46
F.4	4 % window luminance.....	46
F.5	Sampled luminance non-uniformity	46
F.6	4 % window centre colour	47
F.7	Sampled colour non-uniformity.....	48
Bibliography	49
Figure 1	– Layout diagram of measurement setup	10
Figure 2	– Standard measurement positions in the display active area.....	12
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 signal loading 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.....	18
Figure 9 – Colour of blackbody source at various temperatures as represented on the CIE 1931 chromaticity diagram	21
Figure 10 – Example of representation of the same primary colours in the CIE 1931 (left) and CIE 1976 (right) chromaticity diagrams	25
Figure 11 – Example of range in colours produced by a given display as represented by the CIELAB colour space	27
Figure 12 – Example of measurement setup of power consumption	28
Figure 13 – Example of measurement setup of power consumption with embedded video terminal	29
Figure A.1 – Relationship between driving signal and optical response times.....	32
Figure B.1 – Example of a measurement configuration for measuring luminance current efficiency	34
Figure C.1 – Pattern for veiling glare frustum.....	35
Figure D.1 – CIE 1931 XYZ chromaticity diagram	38
Figure D.2 – Blackbody locus (Planckian locus) and isothermperature lines in CIE 1931 chromaticity diagram.....	39
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.....	40
Figure E.2 – Examples of modern drive models using multi-dimensional LUTs for RGB (top) and multi-primary (bottom) displays	41
Figure E.3 – Example of signal loading behaviour for an RGBW display (top) and RGB (bottom) OLED display.....	43
Figure E.4 – Low APL loading test pattern with small box size (1/9 of the screen size dimensions)	44
Figure E.5 – Signal loading profiles for several input colours measured at the centre of the test pattern using Figure 8	45
Figure F.1 – Example of simple 4 % white window pattern at the centre of the screen	47
Table 1 – Standard digital-equivalent input signals for rendering the white, primary and secondary colours in test patterns.....	16
Table 2 – Example of luminance measured for the same colour at the standard nine 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	19
Table 4 – Scaling the size of the colour boxes in the APL loading pattern relative to the screen dimensions	23
Table 5 – Example of a module power consumption measurements summary sheet	28
Table 6 – Example of module power consumption measurements with contents.....	30
Table 7 – Example of module power consumption measurements with images.....	30
Table D.1 – x_e, y_e, A_i and t_i for Formula(D.3) and Formula (D.4)	37
Table E.1 – Example of luminance data for an RGB display and an RGBW OLED display.....	42

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 www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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*