

# INTERNATIONAL STANDARD



**Electronic displays –  
Part 2-2: Measurements of optical characteristics – Ambient performance**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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 Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### 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.

### About IEC publications

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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

Preview generated by EVS

# INTERNATIONAL STANDARD



---

## Electronic displays – Part 2-2: Measurements of optical characteristics – Ambient performance

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 31.120; 31.260

ISBN 978-2-8322-8816-0

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

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references .....	9
3 Terms, definitions, abbreviated terms and symbols.....	9
3.1 Terms and definitions.....	9
3.2 Abbreviated terms.....	10
3.3 Symbols.....	10
4 Standard measuring conditions.....	11
4.1 Standard measuring environmental conditions .....	11
4.2 Viewing direction and light source coordinate system.....	12
4.3 Standard lighting conditions .....	12
4.3.1 General .....	12
4.3.2 Standard measuring darkroom conditions .....	13
4.3.3 Standard ambient illumination.....	13
4.3.4 Standard illumination geometries .....	14
4.4 Standard setup conditions.....	20
4.4.1 General .....	20
4.4.2 Adjustment of display .....	20
4.4.3 Starting conditions of measurements .....	21
4.4.4 General conditions of measuring equipment .....	21
4.5 Reflection standards .....	22
4.5.1 General .....	22
4.5.2 Diffuse reflectance standard .....	22
4.6 Locations of measurement field.....	23
5 Darkroom luminance and spectra.....	23
5.1 General.....	23
5.2 Test pattern .....	23
5.2.1 General .....	23
5.2.2 Simple box test patterns .....	23
5.2.3 Multi-colour test pattern .....	24
5.2.4 Measuring conditions.....	25
5.2.5 Measuring method .....	25
6 Reflection measurements .....	26
6.1 General.....	26
6.2 Measuring conditions .....	26
6.3 Measuring the hemispherical diffuse reflectance .....	27
6.4 Measuring the reflectance factor for a directed light source.....	28
7 Ambient optical performance .....	30
7.1 General.....	30
7.2 Ambient contrast ratio .....	30
7.2.1 General .....	30
7.2.2 Measuring conditions.....	30
7.2.3 Measuring method .....	30
7.3 Ambient display colour.....	31

7.3.1	General .....	31
7.3.2	Measuring conditions .....	31
7.3.3	Measuring method .....	31
7.4	Ambient colour gamut volume .....	33
7.4.1	General .....	33
7.4.2	Measuring conditions .....	34
7.4.3	Measuring method .....	34
Annex A (normative)	RGB boundary colours for CIELAB gamut volume measurements .....	37
A.1	General .....	37
A.2	Equally-spaced 98 boundary colours on the RGB cube .....	37
A.3	Recommended 602 boundary colours on the RGB cube .....	40
Annex B (informative)	Calculation method for CIELAB gamut volume .....	54
B.1	Purpose .....	54
B.2	Procedure for calculating the colour gamut volume .....	54
B.3	Number of sampled colours .....	55
B.4	RGB cube surface subdivision method for CIELAB gamut volume calculation .....	55
B.4.1	General .....	55
B.4.2	Assumption .....	55
B.4.3	Uniform RGB grid algorithm .....	55
B.4.4	Software example execution .....	57
Bibliography	.....	67
Figure 1	Representation of the viewing direction (direction of measurement) and coordinate system used for light source configuration .....	12
Figure 2	Illustrated examples for directional illumination .....	15
Figure 3	Example of the measuring setup using directional illumination where $\theta_S = 40^\circ$ and $\theta_R = 30^\circ$ .....	16
Figure 4	Example of ring light illumination measuring setup where $\theta_S \pm \Delta = 35 \pm 5$ and $\theta_R = 20^\circ$ .....	17
Figure 5	Detailed schematic of ring light characteristics .....	18
Figure 6	Example of measurement geometries for hemispherical illumination using an integrating sphere (left) or sampling sphere (right) .....	19
Figure 7	Layout diagram of measurement setup .....	22
Figure 8	Example of centre box test patterns using the standard 4 % and 10 % area boxes .....	24
Figure 9	Standard medium APL RGBCMYWx test pattern used for centre luminance and spectra measurements with 25 % APL .....	25
Figure 10	Example of the range in colours produced by a display .....	36
Figure B.1	Analysis flow chart for calculating the CIELAB gamut volume .....	54
Figure B.2	Example of tessellation using $5 \times 5$ grid of surface colours on the RGB cube .....	57
Figure B.3	Example of tessellation for the RGB cube using a $3 \times 3$ grid .....	59
Figure B.4	Example of tessellation for the CIELAB gamut volume using a $3 \times 3$ grid .....	59
Table 1	Measurement structure from optical quantities to evaluation and to results (top down) .....	8
Table 2	Summary of symbols .....	11
Table 3	Eigenvalues $M_1$ and $M_2$ for CIE daylight Illuminants D50, D65, and D75 .....	28

Table A.1 – Equally-spaced 98 RGB boundary colours used for CIELAB gamut volume measurements .....	38
Table A.2 – Recommended RGB boundary colours used for CIELAB colour gamut volume measurements .....	41
Table B.1 – Example RGB boundary colours used to demonstrate how the CIELAB colour gamut volume can be calculated .....	58

This document is a preview generated by EVS

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC DISPLAYS –****Part 2-2: Measurements of optical characteristics –  
Ambient performance****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 62977-2-2 has been prepared by IEC technical committee 110: Electronic displays.

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

FDIS	Report on voting
110/1213/FDIS	110/1232/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 parts in the IEC 62977 series, published under the general title *Electronic displays*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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.

**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.**



## INTRODUCTION

This document describes the common optical measurement methods applicable in the field of electronic display devices, which overlap with some of the parts of existing documents developed inside TC 110 (IEC 61747-6-2 [17]<sup>1</sup>, IEC 62341-6-2 [18], IEC 61988-2-2 [19], IEC 62715-5-1 [20], IEC 62679-3-1 [21]), that describe the optical measurement methods of the individual technologies, such as LCD, OLED, PDP and others. This document on common optical measurement methods is intended to be used as the reference document in future documents and in revisions of existing documents (e.g. IEC 61747-6-2 [17], IEC 62341-6-2 [18], IEC 61988-2-2 [19], IEC 62715-5-1 [20], IEC 62679-3-1 [21]). The existing standards documents will be revised in their maintenance time and they will refer to this document to the largest extent.

All documents in IEC TC 110 that are concerned with the measurement of optical properties of electronic display devices under ambient illumination refer to a set of methods and procedures that are similar to each other, or sometimes even identical. This document is intended to identify these methods and to describe them, together with suitable precautions and diagnostics, as a reference for forthcoming documents to make the work of the involved experts more efficient and to avoid duplication of efforts.

Introduction of the common optical measurement methods (COMMs) is also related to a structure where each kind of optical measurement finds its unambiguous position for identification of similarities to other methods or for clarification of distinctions. This structural classification together with a general taxonomy is supposed to make the process of documents production easier, faster and thus more effective.

The above characteristics are summarized in Table 1. The display characteristics that are addressed in this part of IEC 62977 are indicated by a check mark ✓ in the table.

---

<sup>1</sup> Numbers in square brackets refer to the Bibliography.

**Table 1 – Measurement structure from optical quantities to evaluation and to results (top down)**

Variables	Time		Location ( $x, y$ )	Direction ( $\theta, \phi$ )	Test pattern, electrical driving, input signal	Illumination conditions	Temperature, humidity
Data sampling condition	Fast	Slow	Slow	Slow	Slow √		
Evaluation							
Results	Transitions from one optical state to another state (for example from test-pattern-1 to test-pattern-2)	Temporal stability (uniformity)	Lateral uniformity	Directional uniformity	Static pattern, √ Characteristic function (electro-optic transfer function, EOTF) Characteristic values (e.g. threshold, saturation)	Darkroom, √ Indoor, Outdoor	Standard environment √
Evaluation 1st order	Turn-on, turn-off, delay (latency) time periods, temporal modulations				Luminance, √ Contrast, √ chromaticity, √ Threshold, saturation values, steepness of transitions, etc.		
Evaluation 2nd order	Flicker prediction, moving picture response time, etc.				EOTF from which the exponent $\gamma$ is evaluated Chromaticity/ colour gamut area, Colour gamut volume, √		

## **ELECTRONIC DISPLAYS –**

### **Part 2-2: Measurements of optical characteristics – Ambient performance**

#### **1 Scope**

This part of IEC 62977 specifies standard measurement conditions and measuring methods for determining the optical characteristics of electronic displays under indoor and outdoor illumination conditions. Standard illumination geometries are specified and the reflection properties of flat screens are determined under those conditions. Reference illumination levels and spectra are used to estimate the photometric and colorimetric characteristics of electronic displays under the same conditions. These methods apply to emissive, transmissive, and reflective displays, or combinations thereof, that render real 2D images on a flat screen.

#### **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 (IEV) – Part 845: Lighting*

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

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

ISO/CIE 11664-4, *Colorimetry – Part 4: CIE 1976 L\*a\*b\* colour space*

ISO 15076-1:2010, *Image technology colour management – Architecture, profile format and data structure – Part 1: Based on ICC.1:2010*

CIE 15, *Colorimetry*

CIE 168, *Criteria for the evaluation of extended-gamut colour encoding*

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

##### **3.1 Terms and definitions**

For the purposes of this document, the terms and definitions given in IEC 60050-845 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>