

# INTERNATIONAL STANDARD

---

**Electronic displays –  
Part 2-8: Measurements of optical characteristics – Reflective displays**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2025 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 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 It also gives information on projects, replaced and withdrawn publications.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).

**IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)**

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

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

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) Online.

**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 Specifications of illumination.....	12
4.1 General .....	12
4.2 Standard illumination spectra.....	12
5 Light measuring devices (LMDs) .....	13
5.1 General .....	13
5.2 LMD conditions.....	13
5.3 Effects of receiver inclination .....	13
6 Arrangements of illumination source, DUT and LMD .....	14
6.1 General .....	14
6.2 Coordinate system for viewing direction and light source position .....	14
6.3 Directional illumination.....	16
6.4 Ring light illumination.....	16
6.5 Conical illumination.....	17
6.6 Hemispherical diffuse illumination .....	19
6.7 Specular illumination.....	20
6.7.1 Small and extended aperture sources .....	20
6.7.2 Variable aperture source.....	21
6.7.3 Annulus aperture source.....	23
7 Measuring methods.....	24
7.1 General .....	24
7.2 Standard measuring environment conditions.....	24
7.3 Temporal stability .....	24
7.4 Standard test patterns.....	24
7.4.1 General .....	24
7.4.2 Solid colour patterns .....	24
7.4.3 Simple box set.....	24
7.5 Standard locations of measurement field.....	25
7.6 Working standards and references .....	25
7.6.1 Diffuse reflectance standard.....	25
7.6.2 Specular reflectance standard.....	25
7.7 Reflection measurement under defined illumination conditions .....	26
7.7.1 General.....	26
7.7.2 Measurement conditions.....	26
7.7.3 Reflectance factor under hemispherical diffuse illumination .....	28
7.7.4 Off-specular reflectance factor under directional illumination .....	29
7.7.5 Specular reflectance under illumination from an annulus aperture source .....	30
7.7.6 Haze reflectance factor under specular reflection illumination from a variable aperture source .....	33

7.8	Contrast ratio under specified illumination .....	34
7.8.1	General.....	34
7.8.2	Contrast ratio under hemispherical diffuse illumination.....	34
7.8.3	Contrast ratio under off-specular directional illumination .....	35
7.8.4	Contrast ratio under ambient illumination.....	36
7.9	Colour under specified illumination .....	38
7.9.1	General.....	38
7.9.2	Display colour under hemispherical diffuse illumination.....	39
7.9.3	Display colour under off-specular directional illumination .....	41
7.9.4	Display colour under ambient illumination.....	42
7.9.5	CIELAB colour gamut volume.....	44
8	Variations of viewing direction.....	47
8.1	Purpose.....	47
8.2	Viewing direction range .....	48
8.2.1	Measuring method .....	48
8.2.2	Determination methods.....	48
8.2.3	Specified conditions .....	48
8.3	Viewing direction range without grey-level inversion.....	49
8.3.1	Calculation method .....	49
8.3.2	Determination methods.....	49
8.3.3	Specified conditions .....	49
Annex A (informative)	General remarks on illumination and measurement conditions.....	50
A.1	General .....	50
A.2	Illumination and measurement condition .....	50
A.3	Front-surface reflections of the DUT .....	51
Annex B (informative)	Measurement field on a slanted DUT.....	52
Annex C (informative)	Light source.....	55
C.1	General .....	55
C.2	Off-specular (diffuse) reflectance factor under directional illumination (7.7.4).....	55
C.3	Reflectance factor under hemispherical diffuse illumination (7.7.3) .....	55
C.4	Specular characteristics .....	55
Annex D (informative)	Optical characteristic of hemispherical diffuse illumination.....	56
Annex E (informative)	Components of specular illumination .....	58
Annex F (informative)	Substitution method for determining the spectral irradiance and the spectral reflectance factor at the measurement plane .....	61
Annex G (informative)	Chromaticity gamut area in CIE 1931 xy chromaticity diagram .....	63
Bibliography	.....	64
Figure 1	– Shape of measuring spot of LMD .....	14
Figure 2	– Illustration of spherical directions $\theta$ and $\varphi$ for the light source and LMD .....	15
Figure 3	– Polar coordinate system for specification of directions (illumination and measurement).....	15
Figure 4	– Illustration of a directional illumination .....	16
Figure 5	– Examples of conical illumination .....	18
Figure 6	– Example of conical illumination device .....	19
Figure 7	– Examples of hemispherical diffuse illumination (configuration B).....	20
Figure 8	– Example of specular illumination using 1° (a) and 15° (b) uniform sources.....	21

Figure 9 – VAS in specular (a) and off-specular (b) reflection configurations..... 22

Figure 10 – Illustration showing the use of the annulus light source for measuring reflections in the specular direction (a) and the idealized luminance profile (b) ..... 23

Figure 11 – Measurement points of the annulus source with opaque centre for spectral radiance ..... 31

Figure 12 – Input RGB colour cube and corresponding CIELAB gamut volume..... 45

Figure 13 – Tetrahedral tessellation of the RGB colour cube with 5 × 5 samples on each face (from IEC 62977-2-2, Annex B.4) ..... 47

Figure A.1 – Arrangement of illumination of the reflective display under measurement (DUT) and the light measuring device (LMD) ..... 50

Figure A.2 – Illustration of reflection rays from the first surface and the modulated reflection ..... 51

Figure B.1 – Schematic diagram of DUT measurement using a LMD and the shape of the measurement fields on DUT ..... 53

Figure B.2 – Centre shift of the measurement field on the DUT for the data given in Table B.1..... 54

Figure C.1 – Schematic diagram of an example of the opaque centre aperture stop ..... 55

Figure D.1 – Example hemispherical diffuse illumination with gloss trap (G<sub>T</sub>) opposite to LMD inclination..... 56

Figure D.2 – Normalized illuminance at the location of the measuring spot..... 56

Figure D.3 – Contour plot drawn with lines of equal colour difference  $\Delta E^*_{ab}$  ..... 57

Figure E.1 – Example of a BRDF obtained for a display surface that shows light scattering components: specular, haze and Lambertian ..... 58

Figure E.2 – One-dimensional simulation of the reflectance distribution from 1° (a) and 0,25° to 15° (b) subtense light sources using the BRDF from Figure E.1..... 59

  

Table 1 – Measurement structure from optical quantities, to evaluations and to results (top down) ..... 8

Table 2 – Summary of symbols ..... 11

Table 3 – Reference illuminant conditions ..... 12

Table 4 – Colour code ..... 24

Table 5 – The reference parameters for calculating ambient contrast ratio..... 37

Table 6 – Number of sample colours and corresponding image levels (in 8 bit code space) when subdividing each face of the RGB colour cube into *n* divisions..... 46

Table 7 – Definitions and examples of viewing direction ranges..... 48

Table B.1 – Numerical values for the measurement field on a plane and slanted DUT..... 54

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ELECTRONIC DISPLAYS –

Part-2-8: Measurements of optical characteristics –  
Reflective displays

## 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 Publications”). 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62977-2-8 has been prepared by IEC technical committee 110: Electronic displays. It is an International Standard.

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

Draft	Report on voting
110/1745/FDIS	110/1764/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 62977 series, published under the general title *Electronic 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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

Currently in preview, click buy full version

## INTRODUCTION

All documents published by IEC TC 110 that are written on the measurement for electronic displays refer to a set of methods and procedures that are similar to one another. These measurement methods are sometimes identical. This document is written for reflective displays by referring to IEC 62977-2-2 and is intended to identify these methods and to describe them together with suitable precautions and diagnostics. Therefore, this document can be a reference for forthcoming standards to make the work of the involved experts more efficient and to avoid reduplication of efforts.

Introduction of the common optical measurement methods (COMM) 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 standards production easier, faster and thus more effective.

This document describes the common optical measurement methods applicable to the reflective displays. However, the contents overlap with some parts of the existing standards which are developed in TC 110 (IEC 61747-6-2:2011 and IEC 62679-3-1:2014), in which the documents describe the optical measurement methods of the individual display technologies, such as LCD and E-paper. This document is intended to be used as common optical measurement methods for the reflective direct view type and a reference document for future standards. In addition, the present document can be used in the revisions of the existing standards (IEC 61747-6-2:2011 and IEC 62679-3-1:2014) in their maintenance time by referring to this document to the largest extent possible.

The characteristics and the measurement methods of electronic displays in the IEC 62977 series are summarized in Table 1.

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

Variables	Time		Location ( $x, y$ )	Direction ( $\theta, \varphi$ )	Test pattern, electrical driving, input signal	Illumination conditions	Temperature, humidity
	Fast	Slow					
<b>Data sampling condition</b>	Fast	Slow	Slow	<b>Slow<sup>a</sup></b>	<b>Slow<sup>a</sup></b>		
<b>Results</b>	transitions from one optical state to another state	temporal stability (uniformity)	uniformity	<b>uniformity<sup>a</sup></b>	<b>static pattern<sup>a</sup></b> characteristic function (electro-optic transfer function, EOTF) characteristic values (e.g. threshold, saturation),	darkroom <b>indoor<sup>a</sup></b> <b>outdoor<sup>a</sup></b>	<b>standard environmental conditions<sup>a</sup></b>
<b>Evaluations 1<sup>st</sup> order</b>	turn-on, turn-off, delay (latency) time periods, temporal modulations				luminance <b>reflectance<sup>a</sup></b> <b>contrast<sup>a</sup></b> <b>chromaticity</b> threshold, saturation values, steepness of transitions, etc.		
<b>Evaluations 2<sup>nd</sup> order</b>	flicker prediction, moving picture response time, etc.				EOTF from which the exponent gamma is evaluated <b>chromaticity and colour gamut area<sup>a</sup></b> <b>colour gamut volume<sup>a</sup></b>		

<sup>a</sup> Indicates the characteristic and measurement methods which are written in this document

## ELECTRONIC DISPLAYS –

### Part-2-8: Measurements of optical characteristics – Reflective displays

#### 1 Scope

This part of IEC 62977 specifies standard measurement conditions and methods for determining the optical characteristics of reflective direct view displays that render real 2D images on a flat panel. This document applies to flat panel displays operated in a reflective mode with any integrated light sources turned off during measurement. The input signal is unbounded and encodes either monochrome or colour images.

#### 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 62977-2-1:2021, *Electronic displays – Part 2-1: Measurement of optical characteristics – Fundamental measurements*

IEC 62977-2-2:2020, *Electronic displays – Part 2-2: Measurement of optical characteristics – Ambient performance*

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

ISO/CIE 11664-2, *Colorimetry – Part 2: CIE standard illuminants*

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

ISO/CIE 23539, *Photometry – The CIE system of physical photometry*

CIE 015, *Colorimetry*

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

##### 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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>