



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 × 5 grid of surface colours on the RGB cube	57
Figure B.3	– Example of tessellation for the RGB cube using a 3 × 3 grid	59
Figure B.4	– Example of tessellation for the CIELAB gamut volume using a 3 × 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

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]¹, 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.

¹ 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	Direction	Test pattern, electrical driving, input signal	Illumination conditions	Temperature, humidity
	Fast	Slow	(x, y)	(θ, ϕ)			
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 γ 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*