
**Characterization of the performance of
illuminance meters and luminance meters**

*Caractérisation des performances des luxmètres et des
luminancemètres*





COPYRIGHT PROTECTED DOCUMENT

© ISO/CIE 2014

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 ISO or CIE at the respective address below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

CIE Central Bureau
Babenbergerstraße 9/9A • A-1010 Vienna
Tel. + 43 1 714 3187

E-mail ciecb@cie.co.at
Web www.cie.co.at

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

ISO/CIE 19476 was prepared by CIE Technical Committee 2-40: *Characterizing the performance of illuminance and luminance meters*, as CIE S 023. The committee responsible for this document is ISO/TC 274, *Light and lighting*.



International Standard

COMMISSION INTERNATIONALE DE L'ÉCLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

Characterization of the Performance of Illuminance Meters and Luminance Meters

Caractérisation des performances des luxmètres et des luminancemètres

Kennzeichnung der Güte von Beleuchtungsstärke- und Leuchtdichtemessgeräten

CIE International Standards are copyrighted and shall not be reproduced in any form, entirely or partly, without the explicit agreement of the CIE.

CIE Central Bureau, Vienna
Babenbergerstraße 9/9A • A-1010 Vienna

CIE S 023/E:2013

UDC: 535.24
535.241.5
535.241.535

Descriptor: Photometry
Quantities related to photometric and
other measurements
Calibration

© CIE 2013

This document is a CIE International Standard and is copyright-protected by CIE.

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 CIE Central Bureau at the address below.

CIE Central Bureau
Babenbergerstraße 9/9A
A-10F0 Vienna
Austria
Tel.: +43 1 714 3187
e-mail: ciecb@cie.co.at
www.cie.co.at

Foreword

International Standards produced by the Commission Internationale de l'Eclairage are concise documents on aspects of light and lighting that require a unique definition. They are a primary source of internationally accepted and agreed data which can be taken, essentially unaltered, into universal standard systems.

This CIE International Standard has been prepared by CIE Technical Committee 2-40¹ "Characterizing the Performance of Illuminance and Luminance Meters". It has been approved by the Board of Administration and Division 2 of the Commission Internationale de l'Eclairage as well as by the CIE National Committees. It is supposed to supersede CIE Publication 69-1987.

¹ This TC was chaired by R. Rattunde † (DE) and P. Blattner (CH).

Members were: R. Austin (US), J. Bastie (FR), T. Bergen (AU), G. Czibula (DE), G. Dezsi (HU), T. Goodman (GB), K.C. Khandelwal (IN), T.Q. Khanh (DE), U. Krüger (DE), J. Mahidharia (IN), Y. Ohno (US), J. Pan (CN), J. Pietrzykowski (PL), I. Saito (JP), G. Sauter (DE), J. Schanda (HU), H. Shitomi (JP), A. Sperling (DE), W. Steudtner (DE), R. Stolyarevskaya (RU), H.-G. Ulrich (DE), G. Vandermeersch (BE), P. Vukadin (RS), X. Gan (SG), R. Young (GB).

CONTENTS

Foreword.....	vii
1 Scope	1
2 Normative References	1
3 Definitions	2
3.1 General Definitions	2
3.2 Quality Indices.....	4
4 Calibration.....	7
4.1 Conditions	7
4.2 Illuminance Meters	7
4.2.1 General	7
4.2.2 (Planar) Illuminance E	7
4.2.3 Spherical Illuminance E_0	8
4.2.4 Cylindrical Illuminance E_c	8
4.2.5 Semi-Cylindrical Illuminance E_{sc}	8
4.2.6 Semi-Spherical Illuminance $E_{2\pi}$	9
4.3 Luminance Meters	9
4.4 Calibration Uncertainties.....	9
4.5 Initial Adjustment.....	10
4.6 Checking of Photometers.....	10
5 Properties of Illuminance Meters and Luminance Meters	11
5.1 General Considerations	11
5.2 Spectral Properties	11
5.2.1 General	11
5.2.2 Measurement.....	11
5.2.3 Luminous Responsivity	12
5.2.4 Relative Luminous Responsivity and Spectral Mismatch Correction Factor.....	12
5.2.5 Colour Correction Factor and Mismatch Exponent.....	13
5.2.6 Specific Mismatch Index	13
5.2.7 General $v(\lambda)$ Mismatch Index f_1'	13
5.3 UV Response	14
5.3.1 General	14
5.3.2 Measurement.....	14
5.3.3 Characterization.....	15
5.4 IR Response.....	16
5.4.1 General	16
5.4.2 Measurement.....	16
5.4.3 Characterization.....	16
5.5 Directional Response for Illuminance Meters	17
5.5.1 General	17
5.5.2 Measurement.....	17
5.5.3 Characterization for (Planar) Illuminance Meters.....	17
5.5.4 Characterization for Spherical Illuminance Meter	18
5.5.5 Characterization for Cylindrical Illuminance Meter.....	19

5.5.6	Characterization for Semi-Cylindrical Illuminance Meter	20
5.5.7	Characterization for Semi-Spherical Illuminance Meter	21
5.6	Directional Response for Luminance Meter	22
5.6.1	General	22
5.6.2	Measurement	22
5.6.3	Characterization	22
5.6.4	Measurement of the Effect of the Surrounding Field	24
5.7	Linearity	25
5.7.1	General	25
5.7.2	Measurement	25
5.7.3	Characterization	25
5.8	Display-Unit	26
5.8.1	General	26
5.8.2	Characterization	26
5.9	Fatigue	27
5.9.1	General	27
5.9.2	Measurement	27
5.9.3	Characterization	27
5.10	Temperature	27
5.10.1	General	27
5.10.2	Measurement	28
5.10.3	Characterization	28
5.11	Humidity Resistance	28
5.11.1	General	28
5.11.2	Measurement	28
5.11.3	Characterization	29
5.12	Modulated Light	29
5.12.1	General	29
5.12.2	Measurement	29
5.12.3	Characterization	30
5.13	Polarization Dependence	30
5.13.1	General	30
5.13.2	Measurement	30
5.13.3	Characterization	31
5.14	Spatial Non-Uniformity Response	31
5.14.1	General	31
5.14.2	Measurement	31
5.14.3	Characterization	31
5.15	Range Change	32
5.15.1	General	32
5.15.2	Measurement	32
5.15.3	Characterization	32
5.16	Focusing Distance (luminance meter only)	32
5.16.1	General	32
5.16.2	Measurement	33
5.16.3	Characterization	33
6	Acronyms	33

Annex A (normative) Sources and Filters Used for the Determination of the UV and IR Response.....	34
Annex B (informative) General Comments	36
B.1 General.....	36
B.2 Quality Indices.....	36
B.2.1 $V(\lambda)$ Mismatch f'_1	36
B.2.2 UV Response f_{UV}	36
B.2.3 IR Response f_{IR}	36
B.2.4 Cosine Response f_2 (illuminance meter only).....	36
B.2.5 Directional Response $f_{2,g}$ and Surround Field $f_{2,u}$ (luminance meter only).....	37
B.2.6 Linearity f_3	37
B.2.7 Display-Unit f_4	37
B.2.8 Fatigue f_5	37
B.2.9 Temperature Dependence $f_{6,T}$	37
B.2.10 Humidity Resistance $f_{6,H}$	37
B.2.11 Modulated Light f_7	37
B.2.12 Polarization f_8	37
B.2.13 Spatial Non-Uniformity Response f_9	38
B.2.14 Range Change f_{11}	38
B.2.15 Focusing Distance f_{12} (luminance meter only).....	38

Characterization of the Performance of Illuminance Meters and Luminance Meters

1 Scope

This CIE International Standard is applicable to illuminance and luminance meters. The Standard defines quality indices characterizing the performance of such devices in a general lighting measurement situation, as well as measurement procedures for the individual indices and standard calibration conditions.

Measurements of illuminance or luminance and their accuracy are influenced by various parameters, such as operational conditions, properties of light sources, as well as characteristics of the applied photometers. The characteristics of these photometers alone do not allow the determination of the measurement uncertainty for a specific measurement task. Nevertheless, it is generally true that instruments with “better” characteristics in most cases produce smaller uncertainties than instruments with “worse” properties. This Standard has been written to:

- give clear and unambiguous definitions for the individual quality indices;
- define measurement procedures and methods for numerical evaluation of these quality indices;
- define calibration conditions for illuminance meters and luminance meters.

Where different, the definitions of the quality indices and the associated measurement procedures and methods for numerical evaluation given in this Standard supersede those given in CIE Publication 53-1982. CIE publication 69-1987 shall be superseded by this Standard.

2 Normative References

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CIE 202:2011 Spectral Responsivity Measurement of Detectors, Radiometers and Photometers

CIE S 017/E:2011 ILV: International Lighting Vocabulary

ISO 11664-2:2007/CIE S 014-2:2006 Colorimetry – Part 2: CIE Standard Illuminants

ISO 23539:2005/CIE S 010:2004 Photometry – The CIE System of Physical Photometry

CIE 198:2011 Determination of Measurement Uncertainties in Photometry

CIE 114/4-1994 CIE Collection in Photometry and Colorimetry - Distribution Temperature and Ratio Temperature

IEC 60051-1:1997 Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts

ISO/IEC Guide 98-3:2008¹ Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

ISO/IEC Guide 99:2007² International Vocabulary of Metrology — Basic and General Concepts and Associated Terms (VIM).

¹ Also referred as JCGM 100:2008, available from BIPM webpage.

² Also referred as JCGM 200:2008, available from BIPM webpage.