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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



110/1787/CD

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Mr Yoshi SHIBAHARA

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TC 100

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

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TITLE:

Eyewear display - Part 40-10: Specific measurements of eyewear displays with ambient light sensors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Eyewear display -
Part 40-10: Specific measurements of eyewear displays with ambient light
sensors**

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/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 [change language if necessary].

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/publications.

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, or
- revised.

1 Scope

This document specifies the standard measurement conditions and measuring methods for determining specific characteristics of eyewear displays with ambient light sensors which are mainly embedded into eyewear displays (mostly the optical see-through type), including illuminance-based sensors and luminance-based sensors. The camera is included as one of the luminance-based sensor.

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.

ISO 9241-305, *Ergonomics of human-system interaction — Part 305: Optical laboratory test methods for electronic visual displays*

ISO 11664-2:2022, *Colorimetry — Part 2 CIE standard illuminants*

IEC 63145-1-2, *Eyewear display - Part 1-2: Generic - Terminology*

IEC 63145-20-10, *Eyewear display - Part 20-10: Fundamental measurement methods - Optical properties*

IEC 63145-20-20, *Eyewear display - Part 20-20: Fundamental measurement methods - Image quality*

CIE 110-1994, *Spatial Distribution of Daylight - Luminance Distributions of Various Reference Skies*

ISO/CIE 11664-1:2019, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO/CIE 19476, *Characterization of the Performance of Illuminance Meters and Luminance Meters*

ISO/CIE DIS 23603.2, *A Method for Assessing the Quality of Daylight Simulators for Colorimetry*

3 Terms, definitions, abbreviations and letter symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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>

3.1.1

color distortion

color differences between the displayed image and the reference image

3.1.2**luminance response factor**

ratio of the luminance variation of the virtual image for an eyewear display under ambient light to the ambient illumination level (luminance or illuminance)

3.1.3**chromaticity constancy**

constancy of color display characteristics of the virtual image of an eyewear display integrated with **ALS** under variable ambient light

3.1.4**response time**

time period between the change in ambient light and the virtual image making the adjustment

3.2 Abbreviations

AR	augmented reality
ALS	ambient light sensor
DUT	device under test
FOV	field of view
LMD	light measuring device
OST	optical see-through
VR	virtual reality

3.3 Letter symbols (quantity symbols and units)

The letter symbols for eyewear displays are shown in [Table 1](#).

Table 1 – Letter symbols (quantity symbols and units)

Quantities	Symbols	Units
Measuring point ($i = 0$: centre)	P_i	
Arbitrary luminance of a position (x, y, z) and a direction (α, ψ) on eyewear display	$L_v(x, y, z, \alpha, \psi)$	cd/m ²
Maximum luminance	L_{VM}	cd/m ²
Minimum luminance	L_{vm}	cd/m ²
Average luminance (spatial)	L_{va}	cd/m ²
Centre luminance	L_{vC}	cd/m ²
Luminance uniformity	U	%
Luminance non-uniformity	NU	%
CIE 1976 chromaticity coordinates at P_i	u'_i, v'_i	
Colour uniformity in CIE 1976 chromaticity system (Chromaticity difference)	$\Delta u'v'$	
Contrast ratio	CR	

4 Standard measurement conditions

4.1 Standard environmental conditions

Unless otherwise specified, all measurements for eyewear displays shall be carried out after sufficient warm-up time for illumination sources(light sources), LMDs and DUT (see 4.3), under the standard environmental conditions as follows:

- temperature of 22 °C to 28 °C,
- relative humidity of 25 % to 85 %, and
- atmospheric pressure of 86 kPa to 106 kPa.

When different environmental conditions are used, they shall be reported in detail in the specification.

4.2 Power Supply

In order to stabilize the performances of the DUT, the power supply for driving the DUT shall be adjusted according to the specification of the DUT.

NOTE When the DUT is driven by the battery, it is less susceptible to power supply fluctuations.

4.3 Warm-up time

The optical characteristics of DUT are affected by the transient temperature behavior of the DUT. It takes a certain time for the luminance output of the DUT to achieve a steady state. If the luminance output is not within ± 3 % variation, it shall be reported. All measuring conditions shall be kept constant during the measurements.

NOTE 1 The temperature stability of illuminating sources and LMDs is specified in Clause 5.

NOTE 2 If the measuring result does not become steady state, it might be influenced by output fluctuation of DUT and/or fluctuation of LMD such as noise.

4.4 Darkroom conditions

The test room should be structured with black matte surfaces to minimize the stray light. The reflectance of the surfaces shall be less than 10 %, and appropriate settled baffles are necessary for eliminating the direct reflection of surrounding surfaces from intended display light emissions and illumination sources. The luminance contribution from the unintended background in the test room reflected off the measurement field shall be less than 1/20 of minimum luminance of the target to be measured. If the condition is not satisfied, then background subtraction is required and it shall be noted in the report.

5 Standard ambient light conditions

5.1 Light source simulators

5.1.1 General

For evaluating the optical characteristics of eyewear displays with light sensors to response the ambient light, the illumination light source should simulate indoor or outdoor ambient illumination. The recommended the illumination sources in outdoor are CIE standard illuminant D65, which simulates outdoor daylight, and the lighting sources indoor are CIE standard illuminant D65, illuminant LED-B3 and CIE standard illuminant A, which simulate daytime and nighttime lighting circumstances. The spectra of the light source simulators are referenced in Annex A. The spectrum of light source simulator used for the measurement and its mismatch factor should be reported.

5.1.2 CIE A light simulator

The light simulator of CIE standard illuminant A with a colour temperature of 2 856 K is used to measure the sensor response characteristics of eyewear displays in indoor warm light scenarios. A tungsten halogen lamp powered by a DC constant current source can be used to simulate the spectrum of CIE standard illuminant A. The spectral mismatch factor should be no greater than 0,05 in the wavelength range 380 nm to 780 nm (see [Annex A](#)).

5.1.3 CIE D65 light simulator

The light simulator of the CIE standard illuminant D65 with a colour temperature of 6 500 K is used for eyewear displays in outdoor daylight applications, as well as indoor daytime applications such as offices, manufacturing workshops and school classrooms. The spectrum of the CIE standard illuminant D65 can be mimicked by xenon discharge lamps or a combination of spectra from multiple LED light sources. The spectral mismatch factor should be no larger than 0,08 in the wavelength range 380 nm to 780 nm (see [Annex A](#)).

5.1.4 Illuminant LED-B3 light simulator

The light simulator of the illuminant LED-B3 with a colour temperature of 4 103 K is used for eyewear displays in indoor applications. The spectrum of the illuminant LED-B3 can be mimicked by a spectra of LED light sources. The spectral mismatch factor should be no larger than 0,08 in the wavelength range 380 nm to 780 nm (see [Annex A](#)).

5.1.5 Infrared light source

The ambient light sensors used in eyewear displays are generally silicon-based detectors with infrared response up to 1 100 nm. An infrared light source is used to evaluate the infrared response cutoff of the ambient light sensors. A short-wave cutoff filter (IR filter) with a wavelength of 780 nm is added in front of a 2 856K light source which is simulated as CIE standard illuminant A for wavelength range from 380 nm to 1 100 nm. Only the long-wave infrared spectrum is emitted. The typical characteristics of the IR filter are specified in [Annex B](#) and illustrated in [Figure 1](#). If a different spectral distribution of the light source or spectral transmittance of a filter is used, the difference shall be reported.

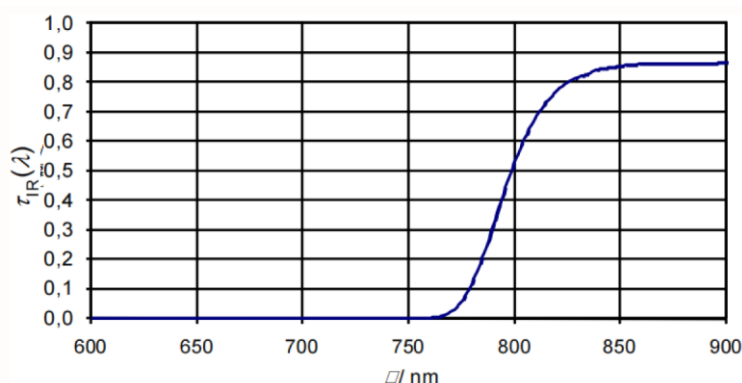


Figure 1 – Spectral transmittance $\tau_{IR}(\lambda)$ of the IR filter

The applied lamp shall be without reflector, will have an untreated envelope and shall not be changed in respect of infrared spectra. The illumination of the [DUT](#) without the filter shall cause a signal at least 10 000 times as large as the smallest resolvable luminance signal.

5.2 Standard ambient illumination geometries

5.2.1 Ambient diffuse illumination

Concerning different fields of view of the eyewear displays used for specific applications, a diffuse illumination background shall be applied. For example, a hemispherical diffuse illumination source is constructed as shown in [Figure 2 a\)](#), provides a constant luminance over 2π FOV for the light sensor which is integrated in the eyewear display. The diameter of an integrating sphere or a hemisphere constructed for the hemispherical diffuse illumination should be larger than five times of the size of the light output port to reduce the [DUT](#) influence.

The light sensor of the [DUT](#) is located at the output centre of the diffuse illumination source. If the light sensor is mounted at other sides than the front of the [DUT](#), the direction of the illumination shall be adjusted accordingly, overriding the FOV of the ambient light measurements for the actual sensor. Some sensors in the [DUT](#) only respond to a certain FOV of the ambient illumination (less than 2π radians), and the FOV of the ambient diffuse illumination can be smaller, but shall be greater than the light sensor's FOV, e.g., [Figure 2 b\)](#). The FOV of the ambient diffuse illumination and the direction of the optical axis of the light received by the sensor are provided by the manufacturer or supplier and noted in the report.

For optical see-through eyewear displays, A light trap black shield shall be placed in front of the DUTs in the see-through direction to eliminate the background illumination in the measurement of the virtual images.

The ambient diffuse illumination level shall be adjustable to meet required value for the measurement, which depend on the application. An example for adjusting the intensity of the light source, such as setting the source on the outside of the hemisphere (or integrating sphere) and adjusting the size of the opening in the wall of the sphere to achieve change in the illumination level.

The relative spectral power distribution of the illumination source shall be matched to the CIE illuminant as specified in [5.1](#).

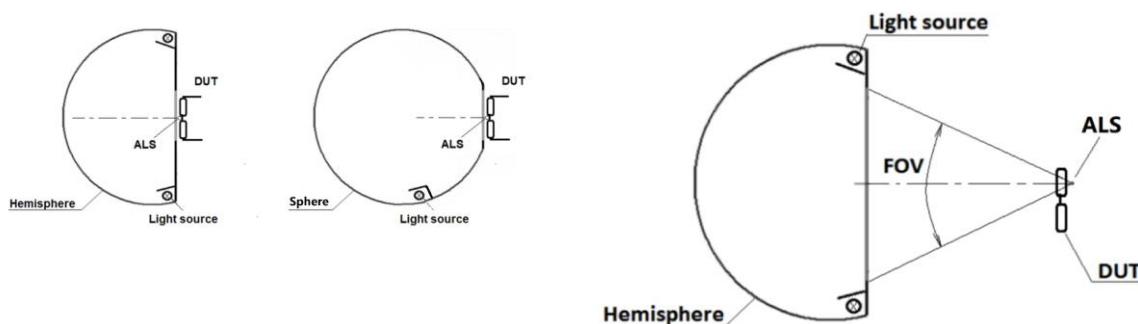


Figure 2 a) Hemispherical diffuse illumination

Figure 2 b) Diffuse illumination with a smaller FOV

Figure 2 – Examples of ambient diffuse illumination

5.2.2 Directional illumination

A Light source that provides directional illumination for the [DUT](#) is applied for measurements of illuminance based ALSs. The azimuth and elevation angles of the directional illumination depend on the measurement requirements of the [DUT](#). The aperture angle of the illumination beam does not exceed 1,0 degree and the illuminance uniformity on the sensor is not less than 0,95.

The aperture angle of the illumination beam, the illuminance uniformity on the [ALS](#), and the spectra shall be noted in the report. An example is shown in [Figure 3](#).