IEC 63145-20-10

Edition 1.0 2019-08

INTERNATIONAL STANDARD

colour inside

Eyewear display –
Part 20-10: Fundamental measurement methods – Optical properties

IEC 63145-20-10:2019-08(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 17.180.99; 31.120

ISBN 978-2-8322-7269-5

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FOREWORD

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International Standard IEC 63145-20-10 has been prepared by IEC technical committee TC 110: Electronic displays.

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

FDIS	Report on voting
110/1105/FDIS	110/1131/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 63145 series, published under the general title *Eyewear display*, 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 "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- withdrawn,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
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EYEWEAR DISPLAY –

Part 20-10: Fundamental measurement methods – Optical properties

1 Scope

This part of IEC 63145 specifies the standard measurement conditions and measurement methods for determining the optical properties of eyewear displays. This document applies to non-see-through type (virtual reality “VR” goggles) and see-through type (augmented reality “AR” glasses) eyewear displays using virtual image optics.

Contact lens-type displays and retina direct projection displays are out of the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, abbreviated terms 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
entrance pupil of the LMD
optical image of the physical aperture stop, as ‘seen’ through the front of the LMD lens system

Note 1 to entry: If there is no lens in front of the aperture, the entrance pupil’s location and size are identical to that of the aperture stop.

3.1.2
eye-box
qualified viewing space
three-dimensional space within which users place their eye so as to be able to properly see the entire virtual image without moving the head or making any other adjustment (other than the natural rotation of the eye)

Note 1 to entry: “Able to properly see” means that the display image fulfils all the requirements indicated in the product specification.

3.1.3
eye point
design location at which the entrance pupil of the eye is placed to achieve the optimal performance when using an eyewear display and which serves as the origin location of the measurement

Note 1 to entry: An estimating example is shown in Annex A.

3.1.4
eye relief
distance from the cornea of the eye to the closest optical element of the virtual-image display

3.1.5
field of view
angular region subtending the proper active area of the virtual image as observed from the eye point of the eyewear display

Note 1 to entry: "Proper" means that the display image fulfils all the requirements indicated in the product specification, for example the limits of luminance, resolution, etc.

3.1.6
measurement direction
direction from which the eye point views the virtual image, as measured relative to the optical axis of the eyewear display using spherical coordinates

Note 1 to entry: See Figure 1.

3.1.7
pixel angular density
pixel number per unit degree

3.2 Abbreviated terms

AR augmented reality
CCD charge-coupled device detector
DUT device under test
FOV field of view
LMD light measuring device
VR virtual reality

3.3 Letter symbols (symbols for quantities and units)

The letter symbols for eyewear displays are shown in Table 1.

Table 1 – Letter symbols (symbols for quantities and units)

Quantities	Symbol	Unit
Measuring point (i = 0: centre)	P_i	
Arbitrary luminance of a position (x, y, z) and direction (α, Ψ) on the 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	%
Angle of horizontal FOV	A_h	degree
Angle of vertical FOV	A_v	degree
Angle of diagonal FOV	A_d	degree
Width of eye-box	W_{box}	mm
Height of eye-box	H_{box}	mm
CIE 1976 chromaticity coordinates at P_i	u'_i, v'_i	
Chromaticity difference in CIE 1976 uniform-chromaticity-scale diagram	$\Delta u'v'$	
Contrast ratio	CR	
Pixel angular density	D_L	pixel per degree (ppd)
Solid angle of measurement field	Ω	sr

4 Standard measurement conditions

4.1 Standard environmental conditions

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

– temperature 22 °C to 28 °C,
– relative humidity 25 % to 85 %, and
– atmospheric pressure 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 a battery, it is less susceptible to power supply fluctuations.

4.3 Warm-up time

The optical performances of DUT are affected by the transient temperature behavior of the device. It takes a certain time for the luminance output of the DUT to achieve a steady state.

If the luminance output is not within a ±3 % variation, it shall be reported. All measuring conditions shall be kept constant during the measurements.

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

4.4 Dark room condition

The luminance contribution from the background in the test room reflected off the measurement space shall be less than 1/20 of the minimum luminance output from the DUT. If the condition is not satisfied, then background subtraction is required and it shall be noted in the report.

5 Measurement systems

5.1 Standard coordinate system

To indicate the spatial positions of virtual images, a spherical coordinate system of elevation (latitude) and azimuth (longitude) shall be used in the measurements; the polar axis is vertically oriented as shown in Figure 1. The angles measured in the vertical half plane of the data are elevation angles, denoted as α, and the horizontal angles to the half plane are azimuth angles, denoted as Ψ. The origin direction (α = 0, Ψ = 0) of the spherical coordinate system shall be coincident with the optical axis of the DUT.

NOTE 1 The spatial positions of the virtual image can be expressed in a geographic coordinate chart, as shown in Annex B.

A three-dimensional Cartesian coordinate system (x, y, z) is used to indicate the positional relationship among the eye-box, eye point, eye relief of the DUT, entrance pupil of the LMD and so on, as shown in Figure 2. Unless specified otherwise, the eye point of the DUT is placed at the centre of the entrance pupil of the eye, and defined as the origin of the coordinate system. The manufacturer or supplier of the DUT shall specify the eye point position or the eye relief.

The origins of both the spherical coordinate system and the Cartesian coordinate system shall be located at the eye point.

NOTE 2 In the case of a binocular eyewear display, the left ocular can be used as the origin of the Cartesian coordinate system.

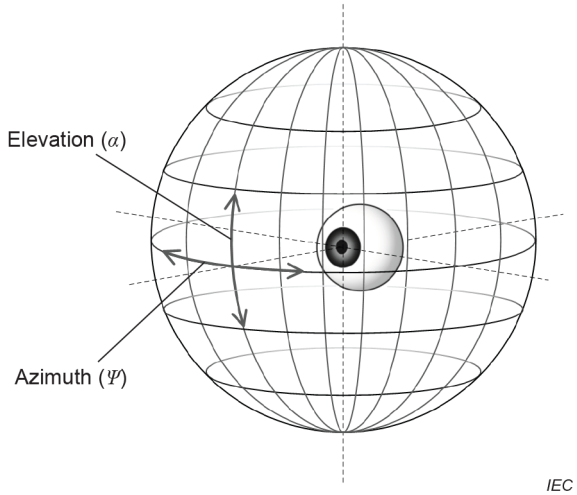
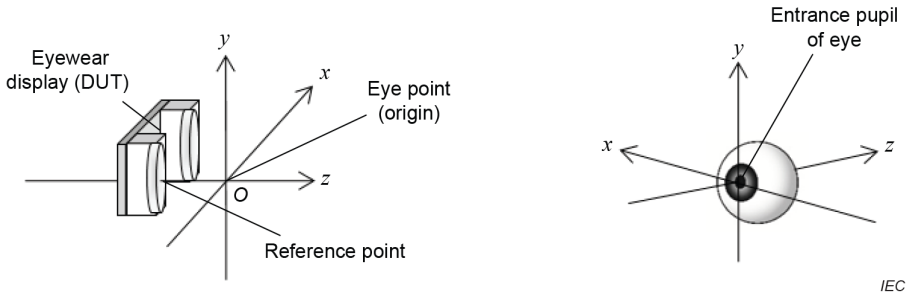


Figure 1 – Spherical coordinate system



NOTE This figure is an example of the entrance pupil of the eye located at the eye point of the DUT.

Figure 2 – Three-dimensional Cartesian coordinate system

5.2 Measurement equipment

5.2.1 Light measuring device (LMD)

5.2.1.1 General

The configurations and operating conditions of the equipment should comply with the structures specified in each item. To ensure accurate measurements, the following requirements shall be applied. Otherwise, the differences shall be noted in the report. ISO/CIE 19476 [8][1] describes the LMD evaluation procedures.

The optics of the LMD (a spot LMD or a 2D imaging LMD) shall be equivalent to the human eye, as shown in Figure 3. The LMD shall be equipped with a finder. The position of the entrance pupil (aperture) of the LMD shall be provided by the manufacturer or the supplier. The size of the entrance pupil of the LMD should be set between 2 mm and 5 mm, and shall be smaller than the output light field of the DUT. The LMD to measure the optical characteristics such as luminance and colour shall be calibrated with the appropriate photometric or spectrometric standards. The LMD should be carefully checked before measurements, considering the following points:

– sensitivity of the measured quantity to measuring light;
– errors caused by the veiling glare and lens flare (i.e., stray light in the optical system);
– timing of data-acquisition, low-pass filtering and aliasing-effects;
– linearity of detection and data conversion;
– measurement field size.

NOTE See IEC TR 63145-1-1:2018 [1], 6.2.

1 Numbers in square brackets refer to the Bibliography.