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INTERNATIONAL STANDARD

Eyewear display –
Part 20-20: Fundamental measurement methods – Image quality

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FOREWORD

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International Standard IEC 63145-20-20 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
110/1110/FDIS	110/1139/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- withdrawn,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
- amended.

A bilingual version of this publication may be issued at a later date.

EYEWEAR DISPLAY –

Part 20-20: Fundamental measurement methods – Image quality

1 Scope

This part of IEC 63145 specifies the standard measurement conditions and measurement methods for determining the image quality of eyewear displays. This document is applicable to non-see-through type (virtual reality "VR" goggle) 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.

NOTE See IEC TR 63145-1-1 [1][1] for eyewear displays, ISO 9241-302:2008, 3.5.45, for see-through types.

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 63145-20-10:–[2], *Eyewear display – Part 20-10: Fundamental measuring methods – Optical properties*

ISO 9241-302:2008, *Ergonomics of human-system interaction – Part 302: Terminology for electronic visual displays*

3 Terms, definitions, abbreviated terms and letter symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 63145-20-10 and ISO 9241-302 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

NOTE 1 Terms related to eyewear displays will be defined in specific projects.

NOTE 2 Some terms relating to eyewear displays are given in IEC TR 63145-1-1 [1].

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1 Numbers in square brackets refer to the Bibliography.

2 Under preparation. Stage at the time of publication: IEC FDIS 63145-20-10:2019.

3.2 Abbreviated terms

AR augmented reality

CCD charge-coupled device detector

CPD cycles per degree

DUT device under test

FOV field of view

LMD light measuring device

VR virtual reality

3.3 Letter symbols (quantity symbols/unit symbols)

The letter symbols for eyewear displays are shown in Table 1

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

Quantities	Symbols and units	
Measuring point (i = 0: centre)	P_i	
Luminance at P_i	L_{vi}	(cd/m^2)
Distortion at the corner	δ_{vh}	(%)
Colour registration error for primary colour	$\varepsilon_{vh,\ colour}$	(degree)
Michelson contrast	C_m	
Maximum luminance	L_{vM}	(cd/m^2)
Minimum luminance	L_{vm}	(cd/m^2)
Spatial frequency (CPD)	f_{CPD}	(1/degree)
Focal distance at P_i	r_i	(m)
Dioptre at P_i	D_i	(1/m)

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 DUTs are affected by the transient temperature behaviour of the device. It takes a certain time for the luminance output of the DUT to reach the 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 measuring 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 conditions

The luminance contribution from the background of the test room reflected off the measurement space shall be less than 1/20 of the minimum luminance output from the DUT. If this condition is not satisfied, then background luminance can be subtracted and it shall be reported.

5 Measurement systems

5.1 Standard coordinate system

To indicate the size and position of a virtual image, 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 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.

To indicate the positional relationship among the eye-box, reference point on the DUT, eye point and eye relief of the DUT, entrance pupil of the LMD and so on, a three-dimensional Cartesian coordinate system (x, y, z) shall be used, as shown in Figure 2. Unless specified otherwise, the eye point of the DUT is placed in the centre of the entrance pupil of the eye, which is in the centre of the iris. The eye point defines the origin of the coordinate system. The manufacturer or supplier of the DUT shall specify the distance between a reference point on the DUT and the eye point. The eye relief is defined as the distance from the cornea of the eye to the closest optical element of the DUT.

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

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

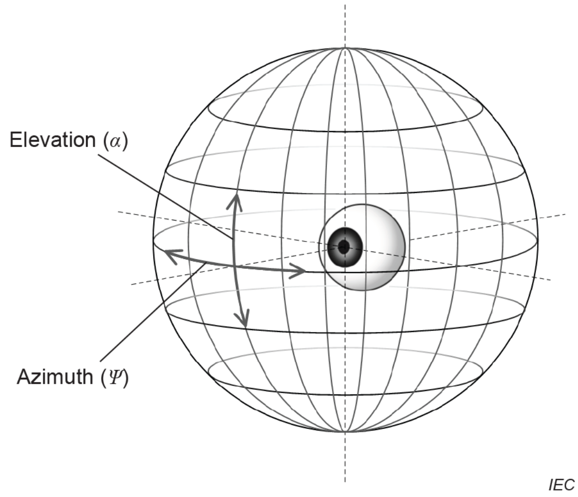
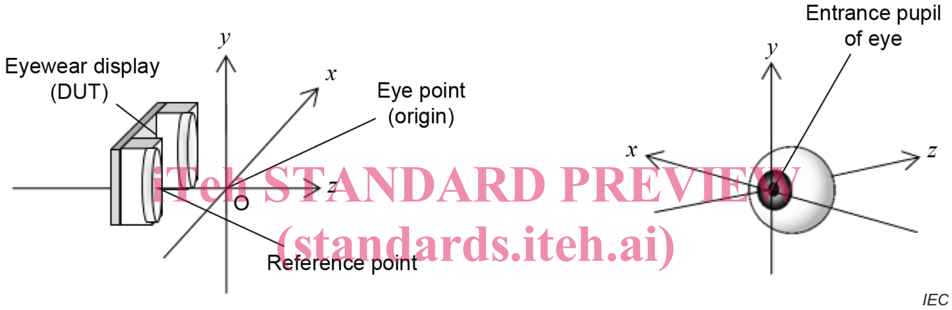


Figure 1 – Spherical coordinate system



NOTE This figure is an example of the eye pupil adjusting to the eye point, which is the origin position.

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 [4] describes the LMD evaluation procedures.

The optics of an 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 an optical finder or a digital viewfinder. The position of the entrance pupil (aperture) of the LMD shall be provided by the manufacturer or the supplier. The entrance pupil size of the LMD should be set between 2 mm and 5 mm, and shall be smaller than the light ray 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 the 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, 6.2 [1].

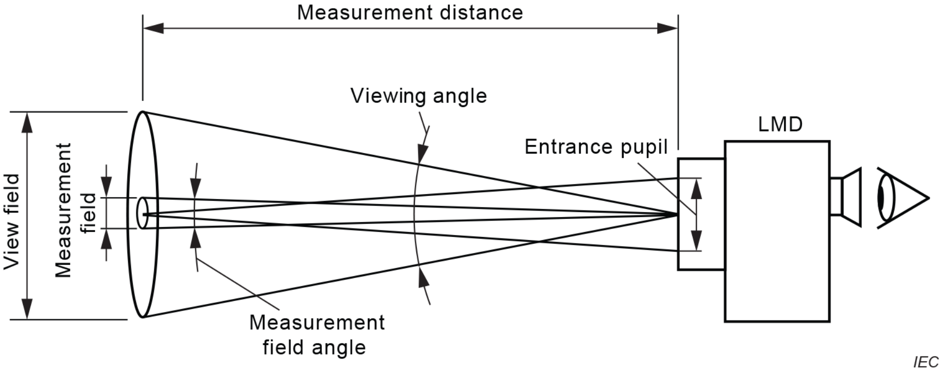


Figure 3 – Example of LMD structure

5.2.1.2 Spectrometer-type LMD

When a spectrometer-type LMD such as a spectroradiometer is used, the wavelength range shall be at least 380 nm to 780 nm, the spectral bandwidth shall be 5 nm or smaller, and the wavelength accuracy shall be 0,3 nm or smaller.

5.2.1.3 Filter-type LMD for measuring luminance

When a filter-type LMD such as a luminance meter is used, to ensure the luminance accuracy for the intended DUT light sources, its spectral responsivity should comply with the spectral luminous efficiency for CIE photopic vision or it should be compared with a calibrated spectrometer. The spectral mismatch correction factor can be applied, if necessary.

NOTE CIE-f_1' indicates the spectral mismatch function between the spectral responsivity of the filter-type LMD and the CIE photopic luminous efficiency function. Details of the spectral mismatch correction factor are given in ISO19476 [4].

5.2.1.4 Filter-type LMD for measuring colour

When a filter-type LMD such as a colorimeter is used to ensure the colour accuracy for the intended DUT light sources, its spectral responsivity should comply with the CIE colour-matching functions for the CIE 1931 standard colorimetric observer (see ISO 11664-1 [3]) or it should be compared with a calibrated spectrometer. The colour correction factors can be applied, if necessary. The filter-type LMD shall not be used for absolute colour quantities, but for relative colour quantities such as colour uniformity.

5.2.1.5 2D imaging LMD

The 2D imaging LMD (using a two-dimensional sensor such as a CCD) is a kind of a filter-type LMD. The performances of the 2D imaging LMD shall comply with 5.2.1.3 and 5.2.1.4. The valid measurement field angle of the 2D imaging LMD shall be confirmed and the peripheral image of the 2D imaging LMD shall confirm the absence of vignetting. The number of pixels of the 2D imaging LMD should not be less than four times the sub-pixels number within the measurement field.

NOTE 1 The measurement field of some 2D imaging LMDs is affected by the smaller entrance aperture.

NOTE 2 The 2D imaging LMD using a colour filter array might cause moiré.