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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	Commend (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.	



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Japan

SECRETARY:

Mr Yoshi SHIBAHARA

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 76, TC 100

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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TITLE:

Laser displays – Part 5-5: Optical measuring methods of raster-scanning retina direct projection laser displays

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LASER DISPLAYS –

**Part 5-5: Optical measuring methods of raster-scanning
retina direct projection laser displays –**

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International Standard IEC 62906-5-5 has been prepared by IEC technical committee 110: Electronic display.

The text of this standard is based on the following documents:

NP	Report on voting
110/XX/NP	110/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.

132 A list of all parts of the IEC 62906 series, under the general title *Laser display devices*, can
133 be found on the IEC website.

134 The committee has decided that the contents of this publication will remain unchanged until
135 the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data
136 related to the specific publication. At this date, the publication will be

- 137 • reconfirmed,
- 138 • withdrawn,
- 139 • replaced by a revised edition, or
- 140 • amended.

141

142 The National Committees are requested to note that for this publication the stability date
143 is 20XX.

144 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE
145 DELETED AT THE PUBLICATION STAGE.

146

LASER DISPLAYS –

Part 5-5: Optical measuring methods of raster-scanning retina direct projection laser displays

1 Scope

This part of IEC 62906 specifies the standard measurement conditions and optical measuring methods for raster-scanning retina direct projection laser displays with light sources such as direct-emitting lasers, optionally equipped with higher-order harmonic generation devices. The hybrid light sources using both lasers and spontaneous emission-based light sources are not applied.

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 62906-1-2: *Laser display devices – Part 1-2: Vocabulary and letter symbols*

IEC 60825-1 Ed.3.0: *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60050: *International Electrotechnical Vocabulary*

IEC 62595-2-4: *DISPLAY LIGHTING UNIT – Part 2-4: Electro-optical measuring methods of laser module*

IEC TR 63145-1-1: *Eyewear displays–Part 1-1: Generic introduction*

IEC 63145-20-10: *Eyewear displays–Part 20-10: Fundamental measurement methods – Optical properties*

IEC 63145-20-20: *Eyewear displays–Part 20-20: Fundamental measurement methods - Image quality*

IEC 62906-5-4: *Laser displays - Part 5-4: Optical measuring methods of colour speckle*

IEC 62906-5-6: *Laser displays - Part 5-6: Measuring methods for optical performance of projection screens*

CIE 233: 2019: *Calibration, Characterization and Use of Array Spectroradiometers*

DIN 5032 Part 7 Class B

3 Terms, definitions and abbreviated terms

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/>

184 • ISO Online browsing platform: available at <http://www.iso.org/obp>

185 **3.1.1**

186 **raster-scanning retina direct projection laser display**

187 RS-RDP laser display

188 laser projector projecting images by raster scanning directly on retina, which does not need an
189 external screen or virtual image optics for observation.

190 Note to entry: For examples, see Annex A

191 **3.1.2**

192 **retinal imaging, <of RS-RDP laser display>**

193 projection and observation of image by the Maxwellian view

194 Note to entry: The Maxwellian view is a method of observation in which a converging lens forms an image of the light
195 source in the plane of the eye's pupil of the observer, instead of looking at the source directly. see Annex B for
196 example.

197 **3.1.3**

198 **effective angular resolution, <of RS-RDP laser display>**

199 ability of display to distinguish small details of an object on human retina expressed as the line
200 pairs per degree

201 **3.1.4**

202 **focal point, <of RS-RDP laser display>**

203 position of smallest beam spot in the vicinity of the exit of the optical system of RS-RDP laser
204 display

205 **3.1.5**

206 **free focus range, <of RS-RDP laser display>**

207 length along the eye-axis, in which more than a certain value of effective angular image
208 resolution can be obtained.

209 **3.1.6**

210 **laser multi-meter**

211 light measuring device based on non-spectrometric methods using absorption filters with linear
212 wavelength ramps capable of measuring centroid wavelength and optical power of laser light
213 sources operating in single or multiple longitudinal mode, from which the tristimulus values *XYZ*
214 are calculated to derive colorimetric and photometric quantities using the CIE colour-matching
215 functions

216 Note to entry :Also defined in IEC 62595-2-4. See Bibliography [1]

217 **3.2 Abbreviated terms**

218 DUT device under test

219 FOV field of view

220 LD laser diode

221 LMD light measuring device

222 MEMS microelectromechanical system

223 IPD inter-pupillary distance

224 RGB red, green, and blue

225 2D two-dimension, two-dimensional

226 3D three-dimension, three-dimensional

4 Standard measuring conditions

4.1 Standard measuring environmental conditions

Optical measurements related to RS-RDP laser display shall be carried out under the standard environmental conditions:

- Temperature: $25\text{ °C} \pm 3\text{ °C}$,
- Relative humidity: 25 % to 85 % RH,
- Atmospheric pressure: 86 kPa to 106 kPa.

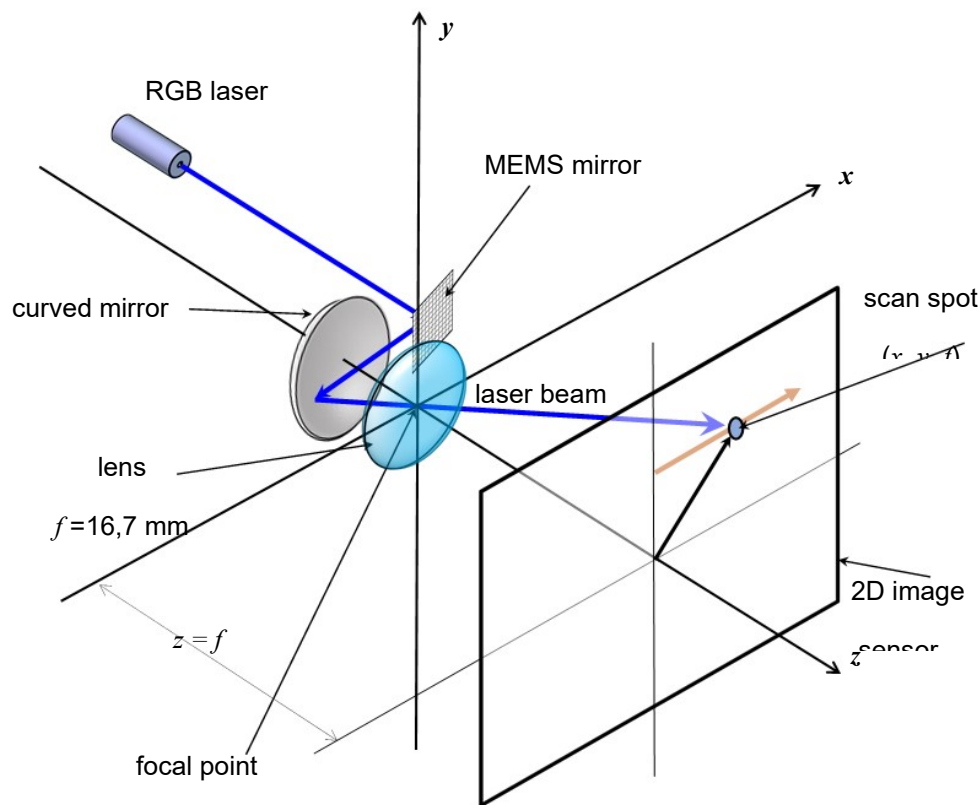
When different environmental conditions are used, they shall be noted in the report. The dark room illuminance at the focal point shall be less than 0,01 lx, or the luminance contribution from the background in the test room reflected off the measurement space shall be less than 1/20 of the minimum luminance output from the DUT. If the condition is not satisfied, then background subtraction is required, and it shall be noted in the report

4.2 Coordinate systems

The measurement coordinate systems are shown in Figure 1 for illuminance or irradiance measurements. The origin of the coordinate systems is placed at the focal point of the RS-RDP laser display. In the Cartesian system, the horizontal x axis and the vertical y axis lie on a plane (x - y plane) parallel to the line between the two eyes. The z axis is normal to the x - y plane. The optical measurements shall be carried out on a planar sensor parallel to the x - y plane if noted. The coordinate conversion between the retinal screen and the planar screen is shown in Annex C. It should be noted that the focal point usually does not coincide exactly with the centre of the pupil as well as the focal position can also be inside the vitreous body.

The length from the focal point to the 2D image sensor L shall be 16,7 mm when $f=16,7\text{ mm}$ lens is applied in the measurement, reflecting the lens power of the human eye (60 m^{-1}) in air. See Annex C in detail.

For spectral radiance and luminance measurements, the paraxial lens is not needed and the measurement coordinate system with eye rotation described in IEC 63145-20-10 shall be used. In that case, the entrance pupil of the LMD is centred at the focal point and the LMD is pivoted about a point 10 mm behind the entrance pupil when scanning the field of view over the virtual image.



NOTE This is an example. Two single-axis MEMS mirrors can be also used.

Figure 1 – Coordinate system and setup for planar measurements

4.3 Standard conditions of RS-RDP laser display (DUT) and light measuring device (LMD)

4.3.1.1 General

Measurements shall be started after the DUT and LMD gained sufficient stability. All the LMDs shall be suitably calibrated, and the calibration data shall be recorded. Residual infrared (IR) radiation shall be filtered out if frequency doubled laser is used.

4.3.2 Adjustment of RS-RDP laser display (DUT)

The RD-RDP laser display shall be measured in the default mode unless otherwise specified. All measurements shall be carried out in the same display mode.

4.3.3 Requirement of light measuring device (LMD)

The requirements for narrow linewidth laser spectra are described in IEC 62906-5-6. The wavelength accuracy required for certain chromaticity accuracy is described in IEC 62595-2-4. The LMD performance particularly used for the RS-RDP laser displays shall be required as follows.

- a) Laser power meter
 - 1) power range: 10 nW - 1 mW
 - 2) accuracy: $\pm 5 \%$
 - 3) spectral wavelength range: covering at least the R, G, B-LD wavelengths
 - 4) spectral responsivity shall be calibrated for given wavelength.
 - 5) integration time: integral multiples of frame period
- b) 2D image sensor

- 1) type of sensor: CMOS or CCD
 - 2) pixel size: $< 10 \mu\text{m}$
 - 3) pixel number: $> 8\text{M}$ ($8 \times 1\,024 \times 1\,024$) pixels
 - 4) $f_2 < 10\%$ at 60 degrees
 - 5) minimum illuminance: 0,01 lx
 - 6) linearity error: $< 2 \%$
over 5 % to 95 % of the LMD measurement range, particularly for the resolution measurement
 - 7) AD converter: ≥ 10 bit
 - 8) exposure time: an integer multiple of frame period
 - 9) polarization error: $\pm 2 \%$
- The 2D image sensor is used for eye box measurement, FOV measurement, and angular resolution measurement. For the measurement of chromaticity non-uniformity, the 2D sensor should be used only for measuring the relative intensity distribution of monochromatic lasers.

c) Illuminance meter

- 1) Illuminance meter class (DIN 5032 Part 7 Class B)
- 2) Minimum illuminance: 0,01 lx
- 3) Polarization error: $\pm 2 \%$
- 4) f_1' : $< 3\%$ (DIN 5032 Part 7 Class B)
- 5) f_2 : $< 5 \%$ at 60 degrees (DIN 5032 Part 7 Class B)
- 6) Integration time: integral multiples of frame period

d) Spectral irradiance meter

- 1) wavelength range: covering the R, G, B-LD wavelengths
- 2) spectral bandwidth: $\leq 5 \text{ nm}$ (Half bandwidth)
- 3) wavelength accuracy: $\pm 0,3 \text{ nm}$
- 4) polarization error: $< \pm 2 \%$ at R, G, B-LD wavelengths
- 5) typically $\leq 4 \text{ mm}$ diameter measurement area
- 6) spectral stray light correction recommended

e) Laser multi-meter (See 3.1.6)

- 1) wavelength range: covering the R, G, B-LD wavelengths
- 2) power range: zero to the absolute maximum rating.
- 3) wavelength accuracy: $\pm 0,3 \text{ nm}$

f) Spectroradiometer (per IEC 63145-20-10 and CIE 233)

- 1) wavelength range: covering the R, G, B-LD wavelengths
- 2) spectral bandwidth: $\leq 5 \text{ nm}$ (FWHM)
- 3) polarization error: $\pm 2 \%$ R, G, B-LD wavelengths
- 4) measurement field angle: ≤ 2 degrees
- 5) entrance pupil diameter: 2-5 mm
- 6) wavelength accuracy: $\pm 0,3 \text{ nm}$
- 7) spatial variation in entrance pupil response [2]: $< 5 \%$
- 8) spectral stray light correction recommended

g) Spectral radiant flux meter (per CIE 233)

- 1) integrating sphere with $\geq 4 \text{ mm}$ diameter measurement port

- 2) wavelength range: covering the R, G, B-LD wavelengths
 - 3) spectral bandwidth: ≤ 5 nm (Half bandwidth)
 - 4) wavelength accuracy: $\pm 0,3$ nm
 - 5) polarization error: ± 2 % R, G, B-LD wavelengths
 - 6) spectral stray light correction recommended
- h) 2D imaging LMD (per IEC 63145-20-20)
- 1) entrance pupil diameter: 2-5 mm
 - 2) at least 4 sensor pixels per virtual image sub-pixel
 - 3) AD converter: ≥ 10 bit
 - 4) exposure time: an integer multiple of frame period
 - 5) polarization error: ± 2 %
 - 6) Include background subtraction, flat field correction, and geometric correction

NOTE LMDs for scanning laser displays are subject to detector saturations errors. (See [3].)

4.4 Laser-safety requirements for measurement

The measurement shall be carried out strictly in accordance with the requirements of IEC 60825-1, depending on the laser output power of DUT.

5 Optical measuring methods

5.1 General

An RS-RDP laser display is a specific type of raster-scanning projector. This document particularly specifies the following optical measurement items.

- Optical power
- Eye-box
- Field of view (FOV)
- Aspect ratio
- Effective angular Image resolution
- Free focus range
- Retinal illuminance
- Chromaticity / illuminance non-uniformity
- Chromaticity gamut area

5.2 Fundamental optical properties

5.2.1 Optical power

5.2.1.1 General

The measurement of the optical output power of DUT and the optical power coupled into an eye through the pupil are most important and fundamental optical properties of eyewear displays. They can be classified by the optical power levels. The two points in Figure 2 are appropriate for measuring the optical power. One is the output exit window (Position 1) which is closest to the beam spot at the MEMS mirror inside the DUT. The other is the focal point of the power incident to the eye (Position 2).

The DUT shall be measured under the dark room condition specified in Subclause 4.1.

5.2.1.2 Measurement at exit window (Position 1)

The exit window is not always be accessible because the optical path can be routed inside the DUT housing. Therefore, this measurement may be skipped if it is inaccessible. Otherwise the measurement shall be carried out.

A full-frame scan area at Position 1 is calculated by the scan angle and the distance from the MEMS position. Depending on the DUT design, the full-frame scan area can be larger than the aperture of the optical power meter. In such a case, a centre pattern much smaller than the full-frame scan area should be used to measure the optical power within the aperture of the laser power meter. Any shapes of the centre pattern may be used if the size at Position 1 is smaller than the aperture size of the power meter.

The individual R, G, B laser powers shall be measured as follows:

- a) Confirm that the laser power meter collects all the optical power.
- b) Display a full-screen monochromatic red colour image or a smaller centre monochromatic red colour pattern with the maximum signal coding.
(The spectral powers other than red (e.g. green and blue) shall be filtered out if they are slightly mixed up.)
- c) Measure the time-averaged optical power P_R power for red at Position 1 using a laser power meter, or spectral radiance flux LMD, with ≥ 4 mm aperture without laser beam clipping (4.3.3, a) or g)).
- d) Measure the wavelength λ_R with spectrometer at Position 1
- e) Repeat b) to d) for green and blue to obtain (P_G, λ_G) and (P_B, λ_B) , respectively.
- f) Assuming that the laser power changes linearly with the scan area, convert the measured power into the full-screen power by multiplying the scaling factor of the centre pattern and the full-screen area when the smaller centre pattern is used.
- g) Report the power and the centroid wavelength for the red, green, and blue images.

When multiple primary wavelengths are present in the spectra, instead of an optical power meter, a laser multi-meter (4.3.3, e)) shall be used, which can measure the centroid wavelengths of the RGB spectra and optical power simultaneously. Or, spectral radiant flux meter with correction of spectral stray lights ((4.3.3, g)) shall be used.

5.2.1.3 Measurement at focal point (Position 2)

- a) Confirm that the laser power meter collects all the optical power.
- b) Display a full-screen monochromatic red colour image with the maximum signal coding.
(The spectral powers other than red (e.g. green and blue) shall be filtered out if they are slightly mixed up.)
- h) Measure the time-averaged optical power P_R at Position 2 using laser power meter, or spectral radiance flux LMD, with ≥ 4 mm aperture without laser beam clipping (4.3.3, a) or g)).
- i) Measure the wavelength λ_R with spectrometer at Position 2.
- j) Repeat b)-d) for green and blue to obtain (P_G, λ_G) and (P_B, λ_B) , respectively.
- k) Report the power and the centroid wavelength for the red, green, and blue images.

When multiple primary wavelengths are present in the spectra, instead of an optical power meter, a laser multi-meter (4.3.3, e)) shall be used, which can measure the centroid wavelengths of the RGB spectra and optical power simultaneously. Or, spectral radiant flux meter ((4.3.3, g)) with correction of spectral stray light shall be used.