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INTERNATIONAL STANDARD

colour inside

Laser display devices –
Part 5-2: Optical measuring methods of speckle contrast

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International Standard IEC 62906-5-2 has been prepared by IEC technical committee 110: Electronic display devices.

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

FDIS	Report on voting
110/760/FDIS	110/768/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.

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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LASER DISPLAY DEVICES –

Part 5-2: Optical measuring methods of speckle contrast

1 Scope

This part of IEC 62906 specifies the standard measurement conditions and measurement methods for determining the monochromatic speckle contrast of laser display devices (LDDs). The LDDs may include hybrid types using both a laser or lasers, and spontaneous emission-based light sources, such as LEDs.

NOTE The monochromatic speckle contrast measurements do not include image quality issues.

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.

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

IEC 62906-1-2:2015, *Laser display devices – Part 1-2: Vocabulary and letter symbols*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in IEC 62906-1-2, as well as the following apply.

3.1 Terms and definitions

3.1.1
fully developed speckle
FDS
speckle when the speckle contrast ratio is equal to one (C_s = 1)

[SOURCE: Goodman:2006] [1][1]

3.2 Abbreviations

DN digital number
DUT device under test
LD laser diode
LMD light measuring device
MTF modulation transfer function
NA numerical aperture
PPUT projection plane under test
PSF point spread function

[1] Numbers square brackets refer to the bibliography.

SNR signal to noise ratio

4 Standard measuring conditions

4.1 General

An LDD is featured by using coherent or partially-coherent light sources. Speckle is created particularly by coherence of the light sources. Therefore, measuring methods and equipment particularly designed for speckle are necessary.

When carrying out optical measurements of LDD, the measuring environment, equipment and methods shall be compliant with IEC 60825-1 for human safety.

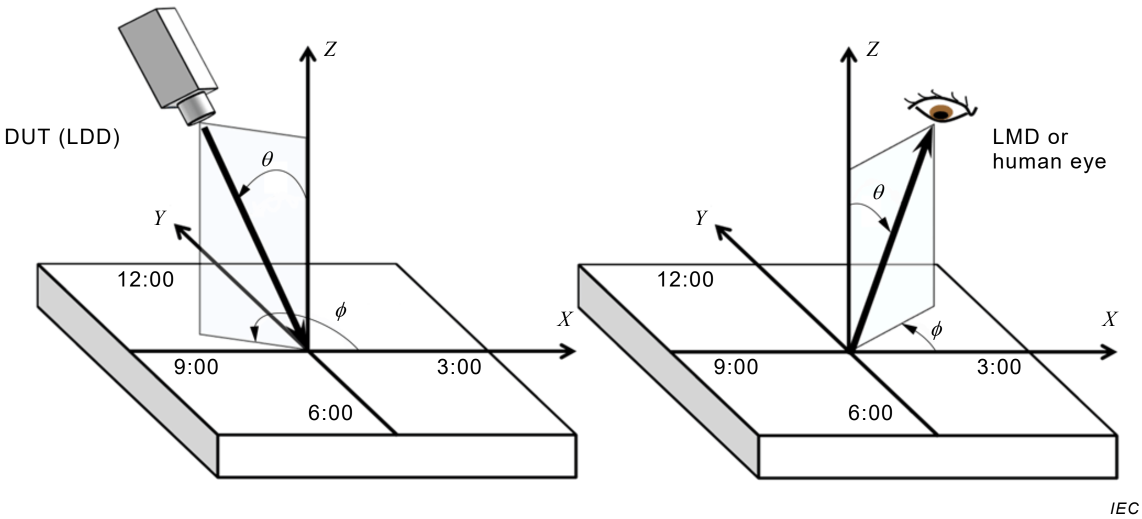
4.2 Standard measuring environmental conditions

Optical measurements related to speckle shall be carried out under the standard environmental conditions, at a temperature of 25 °C ± 3 °C, a relative humidity of 25 % to 85 %, and pressure of 86 kPa to 106 kPa. When different environmental conditions are used, they shall be noted in the report.

4.3 Measurement coordinate system

The projection direction is the direction of a beam coming from the LDD to the projection plane under test (PPUT). The projection direction is defined by two angles: the angle of inclination θ (relative to the surface normal of the PPUT) and the angle of rotation ϕ (also called azimuth angle) as illustrated in Figure 1 a). Although the azimuth angle is measured in the counter-clockwise direction, it is related to the directions on a clock face as follows: $\phi = 0°$ is the 3 o'clock direction ("right"), $\phi = 90°$ the 12 o'clock direction ("top"), $\phi = 180°$ the 9 o'clock direction ("left") and $\phi = 270°$ the 6 o'clock direction ("bottom").

The viewing direction is the direction under which the observer looks at the point of interest on the device under test (DUT), including the projection plane under test (PPUT). During the measurement, the light-measuring device (LMD) simulates the observer, by aiming the LMD at the point of interest on the DUT from the viewing direction. The viewing direction is defined by two angles: the angle of inclination θ (relative to the surface normal of the DUT) and the angle of rotation ϕ (also called azimuth angle) as illustrated in Figure 1. Although the azimuth angle is measured in the counter-clockwise direction, it is related to the directions on a clock face as follows: $\phi = 0°$ is the 3 o'clock direction ("right"), $\phi = 90°$ the 12 o'clock direction ("top"), $\phi = 180°$ the 9 o'clock direction ("left") and $\phi = 270°$ the 6 o'clock direction ("bottom").



a) PPUT (screen) for front projection

b) PPUT (screen) for front projection, or DUT (LDD) for rear projection

Figure 1 – Coordinate system for projection direction and viewing direction

4.4 Darkroom conditions

The LDD should be measured under controlled lighting conditions. Unwanted background illumination except the light generated by the LDD itself shall be minimized, typically by illuminating the display in a darkroom. The darkroom luminance contribution from the background illumination, which is the measurement illumination reflected off the DUT, shall be ≤ 1/20 of the lowest black level of the display. If this condition is not satisfied, then background subtraction is required and it shall be noted in the report. It is recommended that the background for each pixel of the imaging device be subtracted. In addition, if the sensitivity of the LMD is inadequate to measure at these low levels, then the lower limit of the LMD shall be noted in the report.

Unless stated otherwise, the standard background lighting conditions shall be the darkroom conditions.

4.5 Standard conditions of measuring equipment

4.5.1 General

It is assumed that all measurements are performed by personnel skilled in the general art of radiometric and electrical measurements as the purpose of this standard is not to give a detailed account of good practice in electrical and optical experimental physics. Furthermore, it is necessary to ensure that all equipment is suitably calibrated as is known to skilled personnel and that records of the calibration data and traceability are kept.

It is assumed that all measurements are performed under normal operation conditions as used in the finished product by the end user unless requested otherwise.

Standard equipment conditions are given below. Any deviations from these conditions shall be noted in the report.

Measurements shall be started after the LDD, the light source, and measuring instruments achieve stability.

If the measurement is not carried out under the darkroom conditions, depending on the application, the illumination/detection geometry and the light source spectral behaviour shall be reported.

4.5.2 Adjustment of LDD

The LDD shall be measured at the factory default mode. The LDD may be also measured at additional modes (e.g. bright or movie mode).

4.5.3 Conditions of measuring equipment

The speckle contrast created by the LDD shall be measured using the standard measurement conditions given in 4.2.

The following conditions of the speckle contrast measuring equipment shall be noted in the record:

a) LDD operation mode,
b) distance from projection plane to LDD (except rear projection),
c) distance from projection plane to LMD,
d) projection direction as given in 4.3,
e) viewing direction as given in 4.3,
f) polarization conditions if not operating in the factory default mode,
g) centre wavelength of the LDD,
h) spectrum of the LDD if not operating in the default monochromatic mode,
i) optical system parameters of LMD,
   1) imaging lens F-number
   2) iris diameter
   3) spectral characteristics of the optical filter of the LMD (when they were applied)
j) specifications of two-dimensional imaging device,
   1) pixel size
   2) bit depth
   3) spectral sensitivity
   4) dynamic range
   5) linearity of input signal to DN
   6) exposure time

The speckle of each primary colour generally shall be measured in terms of the spectrum of the LDs which line-width is much narrower than LEDs either in the case of single longitudinal or in the case of multi-longitudinal mode operation (see Annex A). Spectral measurement of such a narrow line-width requires much higher resolution: a spectrometer, or a spectrum analyser may be used.

The measurement shall be performed considering the following aspects.

- A spectrometer or a spectrum analyser shall be capable of covering a wavelength range of at least 380 nm to 780 nm and shall have polarization sensitivity less than 2 %.
- Care shall be taken to ensure that the LMD has enough sensitivity and dynamic range to perform the required task.
- The relative uncertainty and repeatability of all the measuring devices shall be maintained by following the recommended calibration schedule instructed by the instrument supplier.
- The DUT shall be operated at its intended image refresh rate.