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TECHNICAL SPECIFICATION

colour inside

Flexible display devices –
Part 5-4: Measuring method of blur in flexible transparent displays

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62715-5-4, which is a technical specification, has been prepared by IEC technical committee 110: Electronic displays.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
110/1055/DTS	110/1084/RVTDS

Full information on the voting for the approval of this technical specification 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 62715 series, published under the general title *Flexible display devices*, 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- withdrawn,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.

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FLEXIBLE DISPLAY DEVICES –

Part 5-4: Measuring method of blur in flexible transparent displays

1 Scope

This part of IEC 62715 specifies the measuring conditions and measuring methods for determining the blur of objects when viewed through a flexible transparent display. This document mainly applies to flexible transparent display modules that have a constant radius curvature about a single axis. The display is measured in a static mechanical state.

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 62715-1-1, *Flexible display devices – Part 1-1: Terminology and letter symbols*

IEC 62715-5-1, *Flexible display devices – Part 5-1: Measuring methods of optical performance*

3 Terms, definitions and abbreviated terms

For the purposes of this part of IEC 62715, the terms and definitions in IEC 62715-1-1 and the following 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 Terms and definitions

3.1.1
blur
unclear or indistinct outline of objects when they are viewed through a flexible transparent display

3.1.2
through-screen properties
image quality attributes when the intended information is behind the display panel and is viewed through it

3.1.3
pixel
smallest element of a picture that can be distinguished from its neighbouring elements

3.2 Abbreviated terms

DUT device under test

LMD light measuring device

PPI pixels per inch

4 Measuring conditions

4.1 Standard measuring environmental conditions

Measurements shall be carried out under the standard environmental conditions:

- temperature: 25 °C ± 3 °C,
- relative humidity: 25 % to 85 %,
- atmospheric pressure: 86 kPa to 106 kPa.

When different environmental conditions are used, they shall be noted in the test report.

4.2 Standard darkroom conditions

The luminance contribution from unwanted background illumination reflected off and/or transmitted through the DUT shall be less than 1/20 of the DUT's black state luminance. If this condition is not satisfied, then background subtraction is required and it shall be noted in the test report. 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 test report.

4.3 Standard setup conditions

4.3.1 Display mounting

The fixture used to mount a curved display plays a critical role in obtaining accurate and reproducible results.[1][1] The display mount should be designed to accommodate the specific bendable characteristics of the flexible transparent display in its intended use configuration. The mount should be capable of maintaining the intended shape of the display and locate it in the required measurement position and viewing direction. The measuring methods specified in this document only apply for displays that have a constant radius of curvature about a single axis.

The origin of the coordinate system is positioned at the imaging surface of the DUT and centered on the screen. Unless otherwise specified, the optical axis of the LMD shall be aligned to within 1° of the DUT's surface normal at its centre. For spot-type LMDs, the retro-reflection of the LMD can be used to obtain this alignment. Otherwise, an alignment laser can be used to define the optical axis. The methods also assume that the rotation stages and mechanical mounting have sufficient accuracy and stability to maintain a tolerance of less than 1°.

4.3.2 Measuring configuration

Figure 1 illustrates the geometric configuration of the DUT, reference display device and LMD. The DUT is located in its intended use configuration using the display mounting fixture. It is positioned so that the optical axis of the LMD shall be aligned to within 1° of the DUT's surface normal at its centre. The purpose of the reference display device is to display a test pattern. A flat display can be used as a reference display device. It is positioned to be parallel to the DUT's surface normal at the centre. In Figure 1, the distance from the DUT to the reference display device is denoted as background distance. Background distance can be determined for convenience of measurement and based on the intended applications of the DUT. The LMD shall be focused on the test pattern.

[1] Numbers in square brackets refer to the Bibliography.

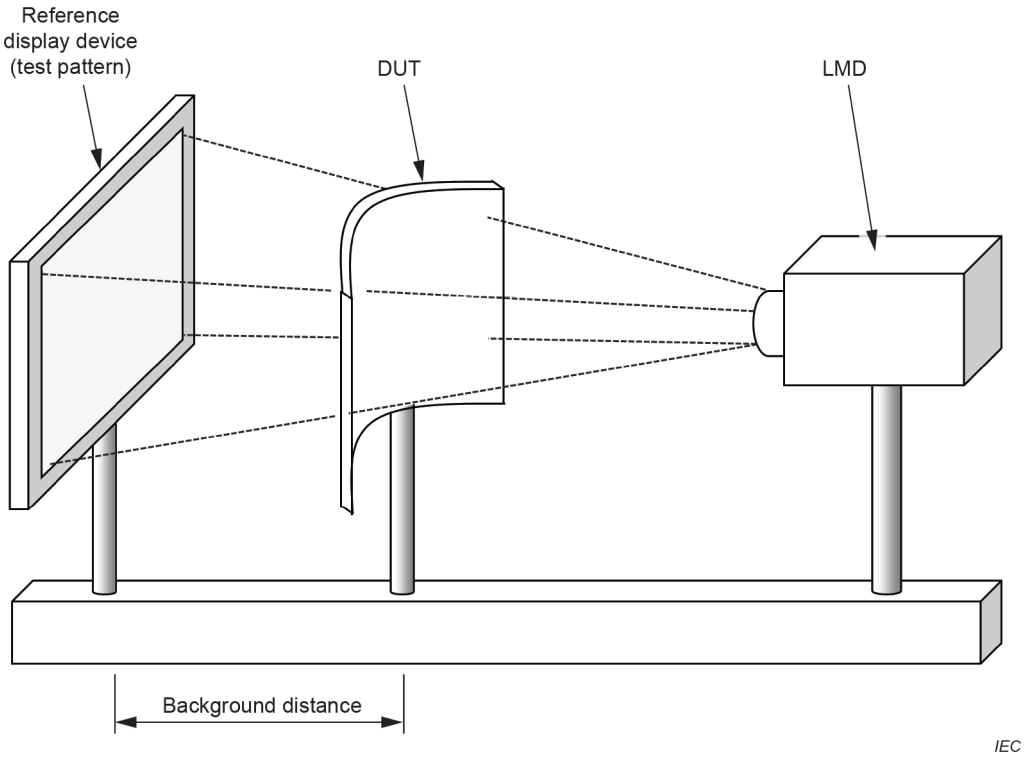

Figure 1 – Geometric configuration of measuring system

4.3.3 Starting conditions of measurements

Measurements shall be started after the DUT, reference display device and the LMD achieve stability. It is recommended that when the display is first turned on, it should be operated for at least 30 min. Sufficient warm-up time has to be allowed for both the DUT and reference display device to reach a luminance stability level of less than ± 3 % over the entire measurement.

4.3.4 Conditions of measuring equipment

The general conditions of the measuring equipment specified in IEC 62715-5-1 are adopted. Light measurements shall generally be measured in terms of photometric or colorimetric units for a CIE 1931 standard colorimetric observer [2]. Illuminance incident on the DUT can be measured by a photometer. The LMD shall be a luminance meter, colorimeter, or a spectroradiometer. An imaging LMD can be used for two-dimensional measurements of transmitted luminance to eliminate the need for translational motions. When a two-dimensional LMD is used for measurement, efforts shall be made so that the measurement results of the two-dimensional LMD are equal to those of the spot-type LMD. A moiré pattern from interference between the pixel patterns of the DUT and LMD can be prevented by focusing the LMD on the test target. If the test target is displayed on a reference display, a moiré pattern from interference between the pixel patterns of the reference display and the LMD can be prevented by using a reference display of high resolution (at least twice the resolution of the imaging LMD focused on the reference display, or by setting the spot LMD to a measurement field that includes more than 500 pixels of the reference display). When a two-dimensional LMD is not available, the measurement can be made by translating the spot-type LMD parallel to the surface of the reference display device and measuring the transmitted luminance along the line of measurement. When using a spot LMD and a translation scan, undesirable aliasing defects should be avoided by complying to the scanning theorem, for example choosing a sampling distance (the linear distance between consecutive spot measurements) not greater than 0,7 of the spot diameter.

The spectroradiometer shall be capable of measuring spectral radiance over at least the 380 nm to 780 nm wavelength range, with a maximum bandwidth of 10 nm for smooth broadband spectra. For light sources that have sharp spectral features, like LEDs and fluorescent lamps, the maximum bandwidth shall be ≤ 5 nm. The spectral bandwidth of the spectroradiometer shall be an integer multiple of the sampling interval. For example, a 5 nm sampling interval can be used for a 5 nm or 10 nm bandwidth.

Care shall be taken to ensure that the LMD has enough sensitivity and dynamic range to perform the required task. The measured LMD signal shall be at least ten times greater than the dark level (noise floor) of the LMD, and no greater than 85 % of the saturation level. If the LMD is not sensitive enough to measure a signal, and truncates the readout to zero, then the measurement is not acceptable and a more sensitive LMD is required.

The following requirements are given for the LMD:

1) The LMD shall be focused on the image plane of the reference display device as illustrated in Figure 1. The centre of the LMD shall be aligned perpendicularly to the centre of the reference display device, unless stated otherwise.
2) The relative uncertainty and repeatability of all the measuring devices shall be maintained by following the instrument supplier's recommended calibration schedule.
3) The LMD integration time shall be an integer number of frame periods, synchronized to the frame rate, or the integration time shall be greater than 200 frame periods.
4) The angular aperture in Figure 2 shall be ≤ 5°, and the measurement field angle shall be ≤ 1°.
5) The display shall be operated at its design field frequency. When using separate driving signal equipment to operate a panel, the drive conditions shall be noted in the test report.

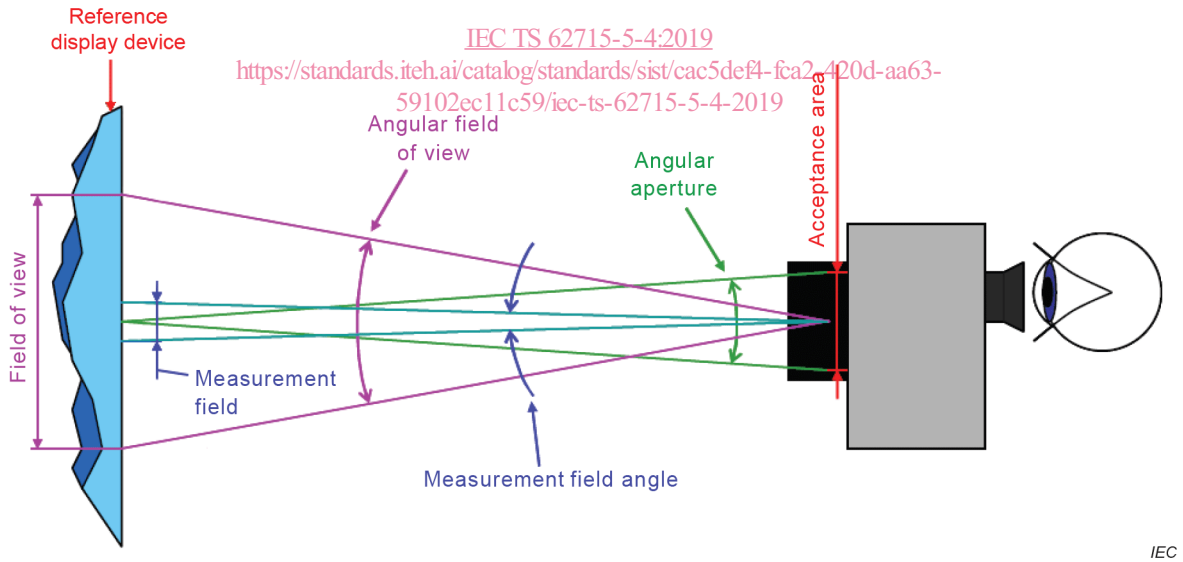

Figure 2 – Layout diagram of measurement setup

5 Blur caused by a flexible transparent display

5.1 Purpose

Figure 3a) illustrates an example of a black-to-white test pattern to be displayed in the reference display device. It mimics an object located behind the flexible transparent display. Figure 3b) illustrates an example of the transmitted image of the black-to-white test pattern in Figure 3a) when it is viewed through the flexible transparent display. The black-to-white test pattern in Figure 3a) is free of blur. However, the blur caused by the flexible transparent

display can be noticed in Figure 3b). The purpose of this measurement method is to calculate the degree of blur caused by the flexible transparent display.

5.2 Measuring conditions

For this measurement, the following conditions shall be applied.

a) Apparatus:
   1) LMD that can measure luminance;
   2) reference display device to display the black-to-white test pattern behind the DUT;
   3) driving power source;
   4) driving signal equipment.

b) Standard measuring environmental conditions:
   1) darkroom conditions;
   2) standard setup conditions.

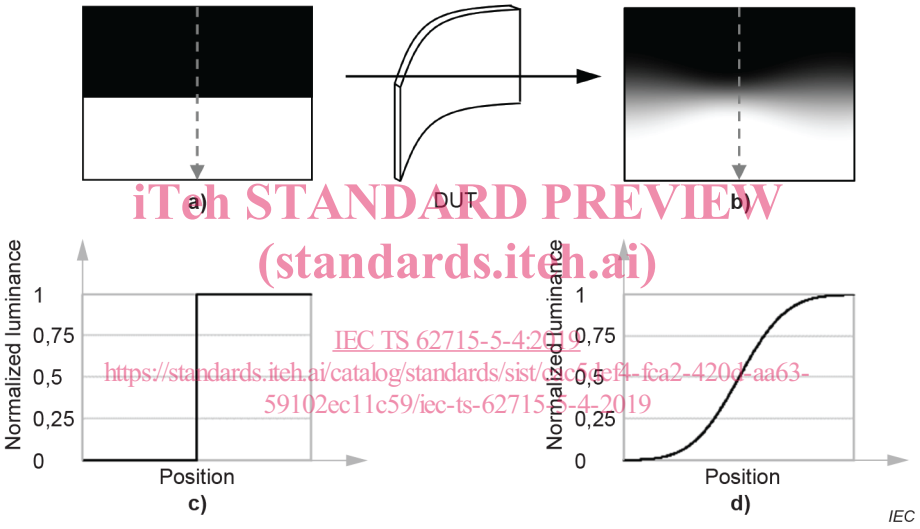

Figure 3 – Examples of test pattern with and without blur and luminance measurements

5.3 Measuring method

For this measurement, the following method shall be applied:

1) Allow sufficient time for the reference display device to reach thermal equilibrium. Then set a reference display device to display the black-to-white test pattern illustrated in Figure 3a). The test pattern in Figure 3a) has a black-to-white transition in the vertical direction. Alternatively, a test pattern with a black-to-white transition in the horizontal direction can also be used. The line of the measurement is illustrated as a dotted line in Figure 3a). The background distance along the line of measurement shall be the same because the blur of the see-through image depends on the background distance. The direction of the black-to-white transition of the test pattern shall be selected to maintain the same background distance along the line of measurement. The direction of the black-to-white transition shall be noted in the test report. In addition, the black and white patches within the test pattern can be placed in opposite positions. In addition to the direction of the black-to-white transition, the positions of the black and white patches within the test pattern shall be noted in the test report.