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TECHNICAL SPECIFICATION

colour inside

Flexible display devices – Part 5-2: Measuring methods of optical characteristics from the vantage point for curved displays

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 62715-5-2, which is a technical specification, has been prepared by IEC technical committee 110: Electronic display devices.

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

Enquiry draft	Report on voting
110/715/DTS	110/739/RVC

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 publication 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 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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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FLEXIBLE DISPLAY DEVICES –

Part 5-2: Measuring methods of optical characteristics from the vantage point for curved displays

1 Scope

This part of IEC 62715, which is a technical specification, specifies the general rules and the details of optical measuring methods from a fixed point (the so-called vantage point) for curved emissive and transmissive type displays such as OLED and LCD in dark room conditions. This document focuses on concave shape large screen displays (non-portable) around a horizontal and/or vertical axis with fixed or variable curvature radius.

The measuring method stipulated in this technical specification is applied to the curved display modules under the following states:

- vantage-point luminance variation by viewing angles
- vantage-point contrast ratio variation by viewing angles
- vantage-point chromaticity variation of white colour by viewing angles
- vantage-point colour gamut area variation by viewing angles
- vantage-point chromaticity variation of primary colours by viewing angles
- luminance uniformity and its uniformity variation by viewing angles
- chromaticity uniformity and its uniformity variation by viewing angles
- viewing angle of half-luminance
- viewing angle of half-contrast

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

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62715-1-1 as well as the following apply.

3.1.1
curved display
display that has a single curvature radius along the screen horizontally and/or vertically

Note 1 to entry: The curvature radius of each screen position is fixed by the manufacturer or user controllable curvature radius.

Note 2 to entry: The direction of curvature might be concave or convex from the viewer's position.

Note 3 to entry: The curved screen display is also called curved display, as in curved TV and curved monitor.

3.1.2
vantage-point measurement
test configuration in which measurements are taken at various measuring points on the display screen through a common observation point in space in front of the screen

Note 1 to entry: The observer (at the viewing distance D) is at a fixed point, the so-called vantage point or viewing point, and then from that fixed vantage point, the angle of view from the screen centre to the corners is changed according to human viewing directions toward the screen.

Note 2 to entry: In this document, the vantage point for the measurement is located on the same horizontal plane as the display centre, and on a line between the display centre and the display's axis of rotation.

3.1.3
screen visual angle
maximum range of vantage-point viewing directions Θ_{VA} measured from the vantage point towards the edges of the display

Note 1 to entry: The horizontal screen visual angle is the range of vantage-point viewing directions between the left and right edges of the screen.

Note 2 to entry: The vertical screen visual angle is the range of vantage-point viewing directions between the top and bottom edges of the screen.

3.1.4
viewing angle
angle between the normal direction of the screen surface and the measurement or viewing direction

Note 1 to entry: If there is no indication about the screen position, the viewing angle is based on the screen centre.

Note 2 to entry: The horizontal viewing angle is the angle between the screen normal direction and the vantage point, both lying on the same horizontal plane.

Note 3 to entry: The vertical viewing angle is the angle between the screen normal direction and the vantage point, both lying on the same vertical plane.

3.1.5
luminance variation by viewing angle
percent difference of display white luminance, between normal incidence (at 0° viewing angle) and a specific viewing angle at each screen measuring point or averaged over the screen measuring points

3.1.6
contrast ratio variation by viewing angle
percent difference of contrast ratio between normal incidence (at 0° viewing angle) and a specific viewing angle at each screen measuring point or averaged over the screen measuring points

3.1.7
chromaticity variation by viewing angle
chromaticity difference between normal incidence (at 0° viewing angle) and a specific viewing angle at each screen measuring point or averaged over the screen measuring points

3.1.8
luminance uniformity variation by viewing angle
percent difference of display white luminance uniformity between normal incidence (at 0° viewing angle) and a specific viewing angle

3.1.9
chromaticity uniformity variation by viewing angle
difference of chromaticity uniformity at normal incidence (at 0° viewing angle) to the other viewing angle

3.1.10
half-luminance viewing angle
horizontal viewing angle that has the half value of the luminance at the normal direction

3.1.11
half-contrast viewing angle
horizontal viewing angle that has the half value of the contrast at the normal direction

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

APL	average picture level
CCT	correlated colour temperature
CIE	Commission Internationale de l'Eclairage (International Commission on Illumination)
CIELAB	CIE 1976 (L*a*b*) colour space
DUT	device under test
LMD	light measurement device

4 Standard measuring equipment

4.1 Video signal generator

An analogue video signal generator or a digital video signal generator is used. The signal characteristics shall match with the measured curved display module. Input signal, in this document, means pre-gamma signal and APL means post-gamma APL.

4.2 Non-contact LMD

For the purpose of vantage-point measurement, the non-contact LMD shall be used. When using a non-contact LMD, a spectroradiometer or a non-contact colorimeter is installed, as shown in Figure 1. The optical axis of the non-contact LMD should be normal in the case of measuring the centre of the display surface. In this document, for the purpose of vantage-point measurement, the measuring distance l_M from the LMD to the centre of the display screen shall be either the design viewing distance or $3V$ where V is the effective screen height of the display and H is the horizontally effective screen width of the display. The design viewing distance might be recommended based on the display resolution and curvature radius. The LMD colour measurements shall comply with the colour matching functions for the CIE 1976 standard colorimetric observer.

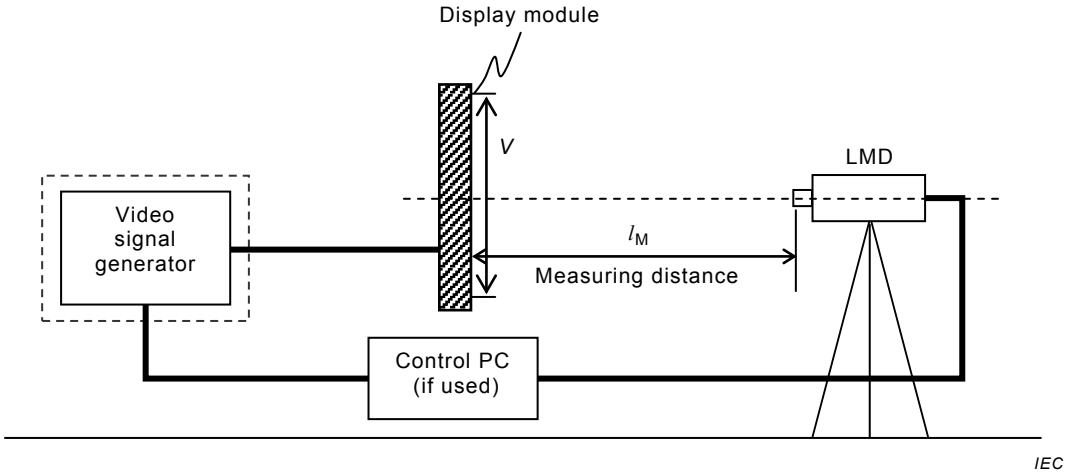

Figure 1 – Measuring layout for non-contact measurement

5 Standard measuring conditions

5.1 Standard measuring environmental conditions

Measurements shall be carried out under the standard environmental conditions. When different environmental conditions are used, they shall be noted in the report.

Temperature: 25 °C ± 3 °C

Relative humidity: 25 % RH to 85 % RH

Atmospheric pressure: 86 kPa to 106 kPa

5.2 Power supply

The power supply for driving the DUT shall be adjusted to the rated voltage ±5 %. In addition, the frequency of the power supply shall provide the rated frequency ±2 %.

5.3 Warm-up time

Measurements shall be started after the display modules and measuring instruments achieve stability. Sufficient warm-up time is defined as the time elapsed from when the supply source is switched on, and a 100 % gray level of input signal is applied to the DUT, until repeated measurements of the display show a variation in luminance of no more than 2 % per minute and 5 % per hour.

5.4 Standard measuring dark room conditions

The luminance contribution from the background illumination reflected off the test display shall be ≤ 0,01 cd/m^2. If this condition is not satisfied, then background subtraction is required and it shall be noted in the ambient performance 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 ambient performance report. The clothes of the observer(s) and the wall of the room shall be dark in order to avoid the reflection of the light emitted from the display back onto the display. The measurement for all measuring points of the display screen and all measuring positions shall proceed in the same dark room.

5.5 Adjustment of display modules

Luminance, contrast and chromaticity of the white field and other relevant parameters of the displays have to be adjusted to nominal status in the detail specification and they shall be noted in the measurement report. When there is no level specified, the maximum contrast

and/or luminance level shall be used. These adjustments shall be held constant for all measurements, unless noted otherwise in the measurement report. Additional conditions are specified separately for each measuring method.

5.6 Measuring geometry for vantage point

5.6.1 General

To measure in vantage-point directions, the display module should be installed on a rotatable and tiltable fixture to enable the changes in horizontal, vertical, and/or oblique measuring directions. In 5.6, it is assumed that the display module shall be generally installed in the vertical position to the ground. The curvature type of the examples is concave, but the convex type is also available for these applications. The measuring direction that is the same as the viewing direction is varied according to each vantage point and each viewing angle of the measuring position.

5.6.2 Measuring geometry in horizontal vantage point

Figure 2 shows the measuring geometry of the top view in the horizontal vantage point. The measuring distance l_M at the left or right measuring point of the screen may be unequal to that of the screen centre, which will require the LMD to be refocused at these points. The measuring distance is based on the standard viewing distance of the normal direction. It can be measured between the screen centre of the display module and the optical lens of the LMD.

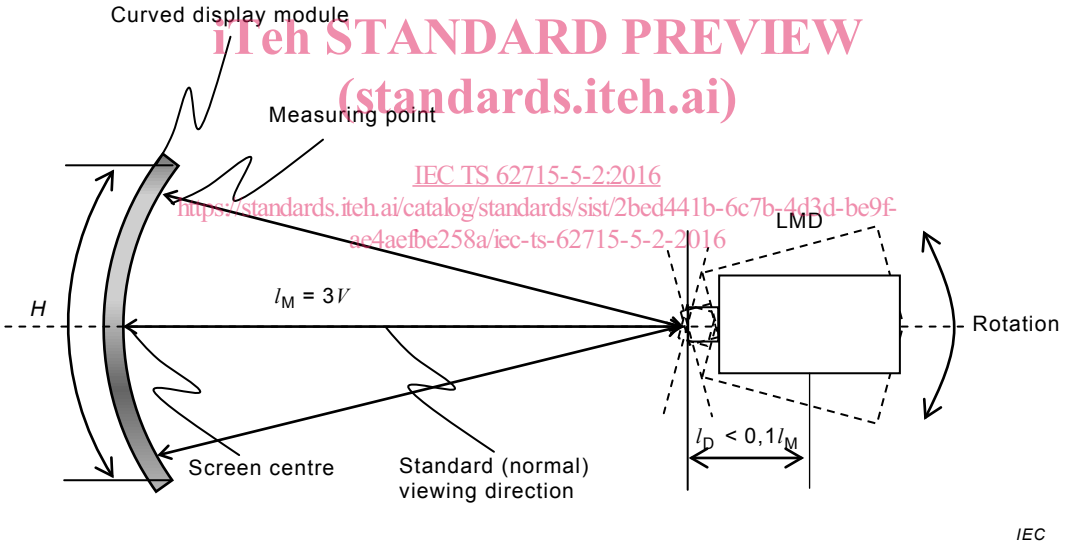

Figure 2 – Measuring geometry in horizontal vantage point (top view)

5.6.3 Measuring geometry in vertical vantage point

Figure 3 shows the measuring geometry of the top view in the vertical vantage point. The measuring distance l_M at the upper or lower measuring point of the screen may be unequal to that of the screen centre, which will require the LMD to be refocused at these points. When using a tripod mount for the LMD, the LMD might be rotated by the mount point. Because of the gap l_D between the LMD lens and the mount point, the viewing angle of the upper/lower and left/right measuring point of the screen becomes slightly small, but if $l_D < 0,1\ l_M$, it can be neglected.