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TECHNICAL REPORT

colour inside

Display lighting unit –
Part 1-3: Lighting units with arbitrary shapes

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FOREWORD

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IEC TR 62595-1-3, which is a technical report, has been prepared by IEC technical committee 110: Electronic displays.

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

Enquiry draft	Report on voting
110/1018/DTR	110/1064/RVDTR

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 62595 series, published under the general title *Display lighting unit*, 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- withdrawn,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
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A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Recent developments in materials for flexible lighting sources (FLSs) with arbitrary shapes such as organic light emitting devices (OLEDs) have boosted their fabrication process as well as expanding their applications in various fields, for example electronic displays and wearable display devices. Since FLSs can emit light in a curved and deformed shape even under external stress, which is different from that of the devices with rigid substrates, these characteristics and performances require new evaluation and measurement methods. This document focuses on common issues of light emission from FLSs such as spatial uniformity of luminance and colour, and angular distribution of luminance and colour. This document delivers an archetype of a curved FLS's light emission and its measurement. The intent of this document is to provide guidance for the development of future measurement standards.

DISPLAY LIGHTING UNIT –

Part 1-3: Lighting units with arbitrary shapes

1 Scope

This part of IEC 62595 focuses on common issues of light emission such as spatial uniformity of luminance and colour, and angular distribution of luminance and colour, from lighting units with arbitrary shapes like flexible lighting sources (FLSs). This document provides a model of light emission from a curved FLS and of light measurement on a curved FLS. Because the development of flexible liquid crystal panels is in progress (see the notes), the intent of this document is to provide guidance for the development of future measurement standards. This document is applicable to FLSs either as light sources, products or elements with arbitrary shapes of geometrical curvature having different spectral and spatial characteristics of light emission.

NOTE 1 Almost 20 years ago plastic LCDs were developed and used in a few applications.

NOTE 2 Flexible BLUs have been used for bendable LC panels in recent years.

NOTE 3 Recent transmissive and transflective flexible LCs require flexible BLUs.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

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/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
plane FLS
light emission from a flat surface

3.1.2
convex FLS
light emission from a convex curved surface

3.1.3
concave FLS
light emission from a concave curved surface

3.1.4
transparent FLS
FLS with transparent substrate that emits light from both front and back surfaces, or otherwise from the inner or outer surfaces

3.1.5
foldable FLS
FLS bent over upon itself

3.1.6
bendable FLS
long or thin FLS forced from a straight form into a curved or angular one, or from a curved or angular form into some different form

3.1.7
rollable FLS
FLS capable of rolling or being rolled

3.1.8
stretchable FLS
FLS capable of being stretched, or fabricated on a stretchable or elastic substrate

3.1.9
single-curvature surface emission FLS
FLS that possesses a single radius of curvature, whether negative or positive, along its length, width or diagonal

3.1.10
white emission FLS
FLS with phosphor or any phosphor-like material converted white light emission

3.1.11
monochromatic emission FLS
FLS with a narrow band emission of light

3.1.12
chromatic emission FLS
FLS with polychromatic light emission

3.1.13
spatial characteristics
information on measurement point position, area, and size or images captured from spatial view-points at successive time intervals that are shown together on a single picture

3.2 Abbreviated terms

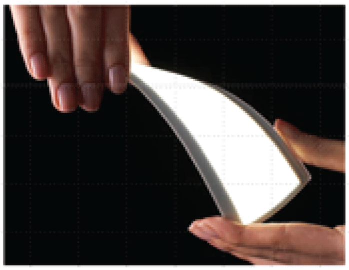
ALD	angular luminance distribution
BLU	backlight unit
DLU	display lighting unit
DUT	device under test
FLS	flexible light source
LCD	liguid crystal display
LED	light emitting diode
LMD	light measuring device
MF	measurement field
OLED	organic light emitting diode
VLU	virtual luminance uniformity

4 Flexible lighting units

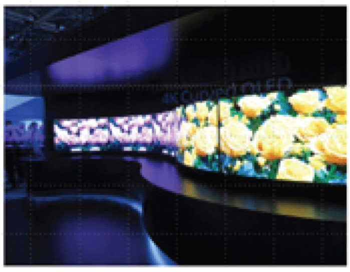
4.1 General

Recent developments in materials for flexible lighting sources (FLSs) such as organic light emitting devices (OLEDs) have expanded their applications in various fields, for example electronic displays and wearable display devices. Their exceptional characteristics, i.e., the flexibility of lighting units, have accelerated the usages of wearable devices.

FLSs are innovative elements with planar light emitting elements. FLSs have excellent surface emission characteristics with mechanical durability as shown in the lighting and display devices in Figure 1 [1][1]. Surface light emitting FLSs are applicable to the fields of display lightings in the wearable, internet of things (IoT), and healthcare industries, and are expected to be a large promising market [1 to 28].



a) White flexible FLS element for display illumination (back or front)



b) Curved display

Figure 1 – Examples of curved FLS and curved display

Nowadays the piecewise and roll-to-roll manufacturing approaches are being explored while addressing problems in FLS durability, efficiency and luminance homogeneity. In addition, the material research, plant construction, component technology and application are being studied for future elements and products [12 to 16].

Since the flexible planar lighting units are thin, light-weight, and have geometrical deformability, i.e., bending, rolling, folding, and stretching, these properties can benefit the automobile and aircraft industries. The robustness of these flexible devices appears in their relatively uniform light distribution, i.e., a weak directivity in bending, in optical invariant, and in light diffusion that results in dimmed shadow in bending.

In addition new industries are exploring the methods to integrate flat and flexible lighting units into automobiles, aircrafts and households. Since the FLSs can emit light in a curved and deformed shape even under external stress, which is different from that of the devices with rigid glass substrates, these characteristics and performances require new evaluation and measurement methods. In addition the measurement items in static and dynamic applications are indispensable for accelerating the new market of the planar FLS elements or products. Therefore, this document intends to focus on and to resolve the issues of curved FLSs such as optical quantities measurements from certain angles and to show the necessity for developing guidance for future standardization work.

The measurements of flat planar light sources as well as flat FLSs have been studied and their optical quantities measurements have been established. The existing measurement devices are mechanically and optically adapted to the flat planar light emitting devices or displays. However, the static FLSs with a single, double or even an arbitrary curvature have not yet been studied or established yet. Therefore, the measurements of the curved FLS

———————

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

elements or products require a new evaluation of the measurement devices, which have adaptive characteristics.

4.2 FLSs possessing arbitrary curvature

The issues of curved TV sets and FLSs with large curvatures have been studied in recent years [17 to 19, 25 to 28]. In addition, the analyses given in [20] to [22] are based on an assumption that the projected cross section of a cone defined as the measurement field (MF) on a single curved surface is elliptical. However, the contour of an MF or the boundary of the field on the DUT is not an ellipse. The projection of a circle on a tilted plane surface is an ellipse. However, the projection of the MF on a curved surface is not an ellipse and should be calculated.

The issues of FLSs with a small curvature, i.e., the degree of flatness and the surface's geometric structure, hitherto have not been studied. In addition, the existing luminous flux or luminance measurement devices have been used for the optical quantities measurements of curved large size illuminating devices. In the conventional measurement the provisions of front luminance evaluation are based on flatness, i.e., an object with a radius of infinity. However, the new measurements require information on surface prior to measurement, and new luminance or luminous flux measuring devices (LMDs). In addition, new definitions are required for curved FLSs (see 3.1.1 to 3.1.12) because the depth of focus or the defocus of the measuring devices changes with respect to FLS curvature. The defocus of an LMD that is used for measuring a flat plane causes erroneous results. The measurement items are the luminance on the surface normal or slanted angles, luminance uniformity (whether with Lambertian or nearly Lambertian distribution) or virtual luminance uniformity, that is, to compare the luminance of different points on a curved surface, angular luminance distribution, angular chromaticity and its uniformity, and luminous flux measurement on an arbitrary point and area on the curving FLSs, as shown in Figure 2.

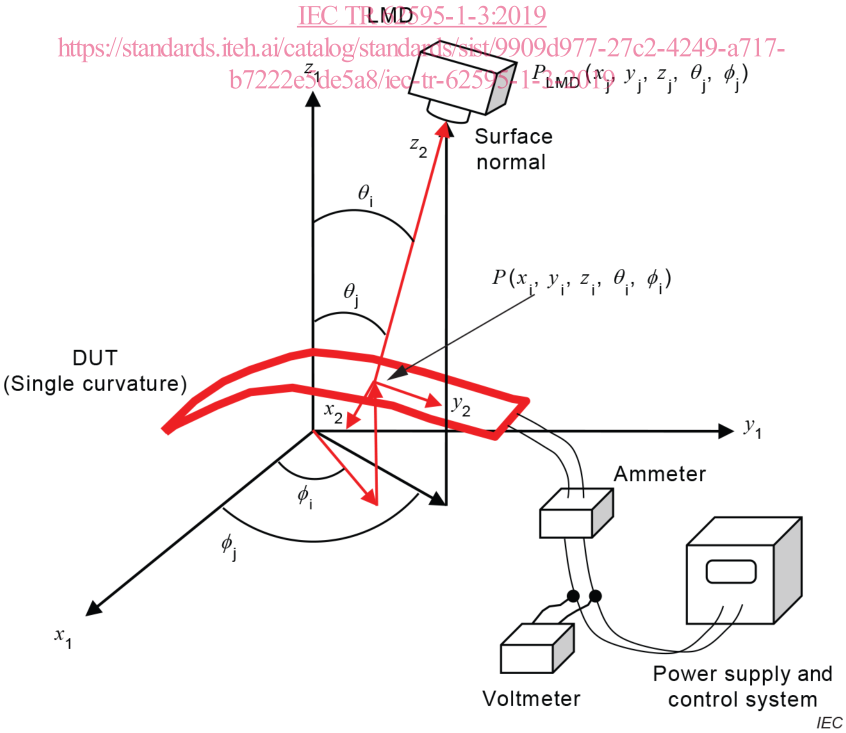


Figure 2 – FLS with an arbitrary curvature and measurement system

Since an FLS can be used in a freeform shape, the optical measurement requires analysis of the complicated curvature and as a result rigorous geometrical mathematics are needed [23, 24]. Hence, this document handles the first degree of curvature, i.e., a concave and convex FLS with a single curvature, as shown in Figure 3.