SLOVENSKI STANDARD
oSIST prEN 4828:2021

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Aeronavtika - Toplotni premik LED-svetilk - Razvrstitev in merilne metode

Aerospace series - Thermal drift of LED luminaires - Classification and measuring methods

Luft- und Raumfahrt - Thermische Drift von LED Leuchten - Klassifizierung und Messmethoden

Série aérospatiale - Dérive thermique des luminaires à LED - Classification et méthodes de mesure

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ICS:

29.140.99	Drugi standardi v zvezi z žarnicami	Other standards related to lamps
49.095	Oprema za potnike in oprema kabin	Passenger and cabin equipment

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Aerospace series - Thermal drift of LED luminaires - Classification and measuring methods

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

European foreword

This document (prEN 4828:2021) has been prepared by the Aerospace and Defence Industries Association of Europe – Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD-STAN, prior to its presentation to CEN.

This document is currently submitted to the CEN Enquiry.

Introduction

Colour and light output of a LED lighting device are influenced by its own and environmental temperature. Variations in temperature can result in variations of light output and chromaticity which in turn can negatively influence the quality of illumination. Especially when using LED operated light units, there can be clearly visible differences in chromaticity and luminance of adjacent fixtures as LEDs are very susceptible to thermal changes.

These differences depend on the utilized LED types and can be compensated to a certain extent by electronic means within the device.

By introducing a measurement method, the functional link between temperature variation and thermal drift of chromaticity and luminance in aircraft applications can be quantified. The aim of this method is to ensure a homogenous appearance of LED light units by considering thermal effects.

1 Scope

This document defines terms, measuring methods and setting(s) for the classification of the thermal behaviour of LED and OLED luminaires in the aircraft cabin regarding chromaticity and luminance. This document is intended for luminaires that are designed to provide photopic vison.

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.

EN 13032-4, *Light and lighting — Measurement and presentation of photometric data of lamps and luminaires — Part 4: LED lamps, modules and luminaires*

3 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 https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
chromaticity
colour valences that only differ in luminance

3.2
chromaticity coordinate
two-dimensional data representation of the colour in the corresponding colour space, e. g. x and y for the CIE 1931

[SOURCE: EN 4706:2019, definition 3.6]

3.3
CIE 1931 colour space
description of a two-dimensional colour space for light colours

Note 1 to entry: In the CIE 1931 diagram the colour coordinates x and y describe the chromaticity locus in the diagram. For this document the CIE 1931 2° observer is applicable.

Note 2 to entry: CIE 015 provides more information about the CIE 1931 colour space.

[SOURCE: EN 4706:2019, definition 3.5]

3.4
colour space
description model to define colours in a two-dimensional (colour without intensity, e. g. xy space CIE 1931) or three-dimensional space, (colour and intensity, e. g. Yxy CIE 1931)

[SOURCE: EN 4706:2019, definition 3.3]

3.5
illuminance
measure of the total luminous flux incident on a surface, per unit area

Note 1 to entry: The unit is lx.

3.6
LED luminaire
device based on LEDs as light source including optics, electronics and cooling equipment enclosed in a housing

[SOURCE: EN 4706:2019, definition 3.4]

3.7
light emitting diode
LED
solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current

Note 1 to entry: The term LED in the following context includes organic LED (OLED).

[SOURCE: EN 4706:2019, definition 3.1 modified]

3.8
MacAdam ellipse
area in the corresponding colour space (e.g. CIE 1931) in which all colours have the same visual impression to an observer as the colour in the centre of this area

Note 1 to entry: The borderline of the ellipse represents the just noticeable colour difference. Based on experimental data, originally 25 MacAdam ellipses were defined in the CIE 1931 colour space. In the experiment an observer had a given colour and was able to modify the chromaticity locus of a second colour. The chromaticity loci, where the observer determined a difference between the two colours were recorded. When all these points were plotted in the CIE 1931 diagram, they created an ellipse around the chromaticity locus of the given colour. The size and the orientation of the ellipses are different for different colours.

[SOURCE: MacAdam, D.L.]

3.9
organic light emitting diode
OLED
organic solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current

[SOURCE: EN 4706:2019, definition 3.2]

3.10
standard deviation of colour matching
SDCM
metric of the difference between chromaticities at photopic light level, that describes approximately the perceptual distance between two chromaticity loci as a multiple of the MacAdam ellipses for these chromaticity loci

Note 1 to entry: *n* SDCM means that the distance between the two chromaticity loci is *n*-times the radius of the appropriate MacAdam ellipse in that direction. The centre of the ellipse is given by the chromaticity locus of the reference colour. Two chromaticity loci on opposite points of the MacAdam ellipse have a distance of (2 *n*) SDCM. The SDCM calculation between two chromaticity loci may be non-linear, dependent on the selected colour space. Therefore distances are limited to less than 10 SDCM.

Note 2 to entry: For this document the calculated data from the MacAdam ellipses has been used.

[SOURCE: EN 4706:2019, definition 3.8 modified]

3.11
thermal drift
variation in chromaticity and luminous flux due to altering temperature

4 Classification references

4.1 General

The luminance and colour performance of the LED lighting device shall be classified depending on the ambient temperature from −15 °C to 55 °C. The ambient temperature is the temperature in thermal equilibrium in the installation space of the device.

It shall be specified whether the LED lighting device is a single or multi primary solution.

4.2 Reference temperature

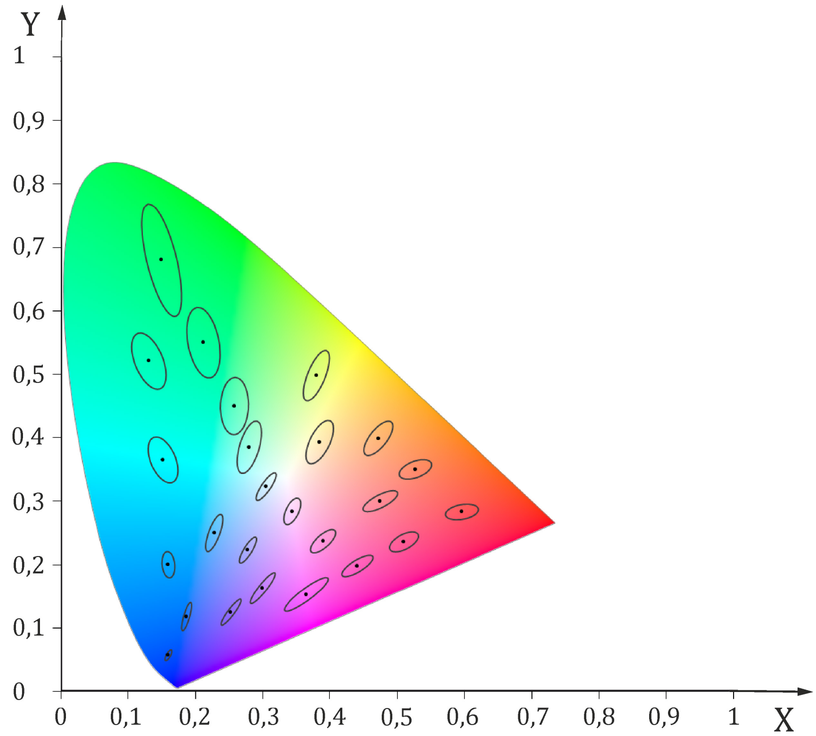
For the classification of the device properties three ambient temperature ranges are specified: Low temperature from −15 °C to < 10 °C, normal operation from 10 °C to 40 °C and high temperature from > 40 °C to 55 °C. According to those ranges, 5 reference temperatures are defined as measuring conditions, see Table 1.

Table 1 —Thermal measurement conditions

	Low temperature °C	**Normal operation** °C	**High temperature** °C
Measurement conditions	−15	10, 25, 40	55

4.3 Reference colour coordinates

For chromaticity classification of the luminaires, see 5.2, the closest MacAdam ellipse(s) shall be used, see Figure 1. The quantification of colour deviations using SDCM refers to the 25 reference colours given by MacAdam. For other comparative colours the interpolation method described in Annex A shall be used. For white tones, described by (correlated) colour temperatures, white colour ellipses, e.g. S 4000, can be used alternatively.



Key

X chromaticity coordinate *x*

Y chromaticity coordinate *y*

Figure 1 — 25 MacAdam ellipses

5 Classification categories

5.1 Flux classification

The flux performance of the LED lighting devices shall be classified for three temperature ranges, see Table 1. All values shall be denoted in relation to the flux at a temperature of 25 °C:

flux indicator (T) = flux (T)/flux (25 °C)

The flux indicator can be calculated by the ratio of any photometric parameter that is proportional to flux such as illuminance, luminance and luminous intensity.

The flux performance is determined by different flux classifications FXY. F indicates the flux indicator whereas X corresponds to the temperature range and Y to the flux variation in percent. The flux variation shall be quantified in a 1 % step grid.

Table 2 shows an example of flux classification.