SIST

SLOVENSKI STANDARD
oSIST prEN ISO/CIE 11664-1:2019

01-marec-2019

Kolorimetrija - 1. del: Standardizirani barvnometrični opazovalec CIE (ISO/CIE/FDIS 11664-1:2019)

Colorimetry - Part 1: CIE standard colorimetric observers (ISO/CIE/FDIS 11664-1:2019)

Farbmetrik - Teil 1: CIE farbmetrische Normalbeobachter (ISO/CIE/FDIS 11664-1:2019)

Colorimétrie - Partie 1: Observateurs CIE de référence pour la colorimétrie (ISO/CIE/FDIS 11664-1:2019)

Ta slovenski standard je istoveten z: **prEN ISO/CIE 11664-1**

ICS:

17.180.20	Barve in merjenje svetlobe	Colours and measurement of light

oSIST prEN ISO/CIE 11664-1:2019 **en,fr,de**

FINAL DRAFT

INTERNATIONAL STANDARD

ISO/CIE FDIS 11664-1

CIE

Secretariat: ISO secretariat

Voting begins on:
2019-01-29

Voting terminates on:
2019-04-23

Colorimetry —

Part 1: CIE standard colorimetric observers

Colorimétrie —

Partie 1: Observateurs CIE de référence pour la colorimétrie

Member bodies are requested to consult relevant national interests in ISO/TC 274 before casting their ballot to the e-Balloting application.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/CIE FDIS 11664-1:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

CIE Central Bureau
Babenbergerstraße 9/9A
A-1010 Vienna, Austria
Phone: +43 1 714 3187
Fax: +41 22 749 09 47
Email: ciecb@cie.co.at
Website: www.cie.co.at

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by the International Commission on Illumination (CIE) in cooperation with ISO/TC 274.

This first edition of ISO/CIE 11664-1 cancels and replaces ISO 11664-1:2007/CIE S 014-1:2006, of which it constitutes a minor revision, incorporating minor editorial updates.

A list of all parts in the ISO/CIE 11664 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the CIE Central Bureau or to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Colours with different spectral compositions can look alike. An important function of colorimetry is to determine whether a pair of such metameric colours will look alike. The use of visual colorimeters for this purpose is handicapped by variations in the colour matches made among observers classified as having normal colour vision. Visual colorimetry also tends to be time-consuming. For these reasons, it has long been the practice in colorimetry to make use of sets of colour-matching functions to calculate tristimulus values for colours: equality of tristimulus values for a pair of colours indicates that the colour appearances of the two colours match, when they are viewed in the same conditions by an observer for whom the colour-matching functions apply. The use of standard sets of colour-matching functions makes the comparison of tristimulus values obtained at different times and locations possible.

Colorimetry —

Part 1:
CIE standard colorimetric observers

1 Scope

This document specifies colour-matching functions for use in colorimetry. Two sets of colour-matching functions are specified.

a) Colour-matching functions for the CIE 1931 standard colorimetric observer.

This set of colour-matching functions is representative of the colour-matching properties of observers with normal colour vision for visual field sizes of angular subtense from about 1° to about 4°, for vision at photopic levels of adaptation.

b) Colour-matching functions for the CIE 1964 standard colorimetric observer.

This set of colour-matching functions is representative of the colour-matching properties of observers with normal colour vision for visual field sizes of angular subtense greater than about 4°, for vision at sufficiently high photopic levels and with spectral power distributions such that no participation of the rod receptors of the retina is to be expected.

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.

CIE S 017, ILV: *International Lighting Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CIE S 017 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
colour stimulus function
$\varphi_\lambda(\lambda)$
description of a colour stimulus by the spectral distribution of a radiometric quantity, such as radiance or radiant power, as a function of wavelength

[SOURCE: CIE DIS 017:2016, Term 17-23-003]

3.2
metameric colour stimuli, pl
metamers, pl
spectrally different colour stimuli that have the same tristimulus values in a specified colorimetric system

Note 1 to entry: The corresponding property is called “metamerism”.

[SOURCE: CIE DIS 017:2016, Term 17-23-008]

3.3
monochromatic stimulus
spectral stimulus
stimulus consisting of monochromatic radiation

[SOURCE: CIE DIS 017:2016, Term 17-23-011]

3.4
equi-energy spectrum
spectrum of radiation whose spectral distribution of a radiometric quantity as a function of wavelength is constant throughout the visible region

Note 1 to entry: The radiation of the equi-energy spectrum is sometimes regarded as an illuminant, in which case it is denoted by the symbol *E*.

[SOURCE: CIE DIS 017:2016, Term 17-23-023, modified — “($\varphi_\lambda(\lambda)$ = constant)” at the end of the definition omitted.]

3.5
additive mixture
<colour stimuli> stimulation that combines on the retina the actions of various colour stimuli in such a manner that they cannot be perceived individually

[SOURCE: CIE DIS 017:2016, Term 17-23-030]

3.6
colour matching
action of making a colour stimulus appear the same in colour as a given colour stimulus

[SOURCE: CIE DIS 017:2016, Term 17-23-031]

3.7
trichromatic system
system for specifying colour stimuli in terms of tristimulus values, based on matching colours by additive mixture of three suitably chosen reference colour stimuli

[SOURCE: CIE DIS 017:2016, Term 17-23-036]

3.8
reference colour stimuli, pl
set of three colour stimuli on which a trichromatic system is based

Note 1 to entry: These stimuli are either real colour stimuli or theoretical stimuli which are defined by linear combinations of real colour stimuli.

Note 2 to entry: In the CIE standard colorimetric systems, the reference colour stimuli are represented by the symbols [R], [G], [B], [X], [Y], [Z], $[\mathrm{R}_{10}]$, $[\mathrm{G}_{10}]$, $[\mathrm{B}_{10}]$ and $[\mathrm{X}_{10}]$, $[\mathrm{Y}_{10}]$, $[Z_{10}]$.

[SOURCE: CIE DIS 017:2016, Term 17-23-037]

3.9

tristimulus values, pl

<of a colour stimulus> amount of the three reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

Note 1 to entry: In the CIE standard colorimetric systems, the tristimulus values are represented, for example, by the symbols R, G, B; X, Y, Z; R_{10}, G_{10}, B_{10} or X_{10}, Y_{10}, Z_{10}.

[SOURCE: CIE DIS 017:2016, Term 17-23-038]

3.10

colour-matching functions, pl

<of a trichromatic system> tristimulus values of monochromatic stimuli of equal radiant flux

[SOURCE: CIE DIS 017:2016, Term 17-23-039, modified — Notes to entry omitted.]

3.11

CIE 1931 standard colorimetric system

X, Y, Z

system for determining the tristimulus values of any spectral power distribution using the set of reference colour stimuli [X], [Y], [Z], and the three CIE colour-matching functions $\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ adopted by the CIE in 1931

Note 1 to entry: $\bar{y}(\lambda)$is identical to $V(\lambda)$ and hence the tristimulus values Y are proportional to values of luminance.

Note 2 to entry: The CIE 1931 standard colorimetric system is applicable to centrally viewed fields of angular subtense between about 1° and about 4° (0,017 rad and 0,07 rad).

Note 3 to entry: The CIE 1931 standard colorimetric system can be derived from the CIE 1931 RGB colorimetric system using a transformation based on a set of three linear equations. The CIE 1931 RGB system is based on three real monochromatic reference stimuli.

Note 4 to entry: See also CIE 15 *Colorimetry*.

[SOURCE: CIE DIS 017:2016, Term 17-23-045]

3.12

CIE 1964 standard colorimetric system

X_{10}, Y_{10}, Z_{10}

system for determining the tristimulus values of any spectral power distribution using the set of reference colour stimuli [X_{10}], [Y_{10}], [Z_{10}], and the three CIE colour-matching functions $\bar{x}_{10}(\lambda), \bar{y}_{10}(\lambda), \bar{z}_{10}(\lambda)$ adopted by the CIE in 1964

Note 1 to entry: The CIE 1964 standard colorimetric system is applicable to centrally viewed fields of angular subtense greater than about 4° (0,07 rad).

Note 2 to entry: When the CIE 1964 standard colorimetric system is used, all symbols that represent colorimetric measures are distinguished by use of the subscript 10.

Note 3 to entry: See also CIE 15 Colorimetry.

[SOURCE: CIE DIS 017:2016, Term 17-23-046]

3.13

CIE colour-matching functions, pl

functions $\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ in the CIE 1931 standard colorimetric system or $\bar{x}_{10}(\lambda), \bar{y}_{10}(\lambda), \bar{z}_{10}(\lambda)$ in the CIE 1964 standard colorimetric system

[SOURCE: CIE DIS 017:2016, Term 17-23-047]

3.14
CIE 1931 standard colorimetric observer
ideal observer whose colour-matching properties correspond to the CIE colour-matching functions $\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ adopted by the CIE in 1931

[SOURCE: CIE DIS 017:2016, Term 17-23-049]

3.15
CIE 1964 standard colorimetric observer
ideal observer whose colour-matching properties correspond to the CIE colour-matching functions $\bar{x}_{10}(\lambda), \bar{y}_{10}(\lambda), \bar{z}_{10}(\lambda)$ adopted by the CIE in 1964

[SOURCE: CIE DIS 017:2016, Term 17-23-050, modified — Note 1 to entry omitted.]

3.16
chromaticity coordinates, pl
coordinates expressing the ratios of each of a set of three tristimulus values to their sum

Note 1 to entry: As the sum of the three chromaticity coordinates is equal to 1, two of them are sufficient to define a chromaticity.

Note 2 to entry: In the CIE standard colorimetric systems, the chromaticity coordinates are represented by the symbols x, y, z or x_{10}, y_{10}, z_{10}.

Note 3 to entry: The chromaticity coordinates are a quantity of unit one.

[SOURCE: CIE DIS 017:2016, Term 17-23-053]

3.17
spectral chromaticity coordinates, pl
$r(\lambda)$, $g(\lambda)$, $b(\lambda)$; $x(\lambda)$, $y(\lambda)$, $z(\lambda)$; $r_{10}(\lambda)$, $g_{10}(\lambda)$, $b_{10}(\lambda)$; $x_{10}(\lambda)$, $y_{10}(\lambda)$, $z_{10}(\lambda)$
chromaticity coordinates of monochromatic stimuli

[SOURCE: CIE DIS 017:2016, Term 17-23-055]

3.18
spectral luminous efficiency
$V(\lambda)$, <for photopic vision>; $V'(\lambda)$, <for scotopic vision>; $V_{\text{mes};m}(\lambda)$, <for mesopic vision>; $V_{10}(\lambda)$, <for the CIE 10° photopic photometric observer>; $V_{\text{M}}(\lambda)$, <for the CIE 1988 modified 2° spectral luminous efficiency function for photopic vision>
<for a specified photometric condition> quotient of the radiant flux at wavelength λ_{m} and that at wavelength λ, such that both produce equally intense luminous sensations for a specified photometric condition and λ_{m} is chosen so that the maximum value of this quotient is equal to 1

[SOURCE: CIE DIS 017:2016, Term 17-21-035, modified — Notes to entry omitted.]

3.19
perfect reflecting diffuser
ideal isotropic diffuser with a reflectance equal to unity

4 Specifications

4.1 Colour-matching functions

The colour-matching functions $\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$ of the CIE 1931 standard colorimetric observer are defined by the values given in Table 1, and those $\bar{x}_{10}(\lambda), \bar{y}_{10}(\lambda), \bar{z}_{10}(\lambda)$ of the CIE 1964 standard colorimetric observer are defined by the values given in Table 2. The values are given at 1 nm wavelength intervals from 360 nm to 830 nm. If values are required at closer wavelength intervals than 1 nm, they should be derived by linear interpolation.

4.2 Spectral chromaticity coordinates

Tables 1 and 2 also give values for the spectral chromaticity coordinates, $x(\lambda)$, $y(\lambda)$, $z(\lambda)$; $x_{10}(\lambda)$, $y_{10}(\lambda)$, $z_{10}(\lambda)$; these have been derived from the appropriate colour-matching functions by forming the ratios according to Formulae (1) to (6):

$$\mathrm{x}(\lambda)=\frac{\bar{x}(\lambda)}{\bar{x}(\lambda)+\bar{y}(\lambda)+\bar{z}(\lambda)} \tag{1}$$

$$\mathrm{y}(\lambda)=\frac{\bar{y}(\lambda)}{\bar{x}(\lambda)+\bar{y}(\lambda)+\bar{z}(\lambda)} \tag{2}$$

$$\mathrm{z}(\lambda)=\frac{\bar{z}(\lambda)}{\bar{x}(\lambda)+\bar{y}(\lambda)+\bar{z}(\lambda)} \tag{3}$$

and

$$\mathrm{x}_{10}(\lambda)=\frac{\bar{x}_{10}(\lambda)}{\bar{x}_{10}(\lambda)+\bar{y}_{10}(\lambda)+\bar{z}_{10}(\lambda)} \tag{4}$$

$$\mathrm{y}_{10}(\lambda)=\frac{\bar{y}_{10}(\lambda)}{\bar{x}_{10}(\lambda)+\bar{y}_{10}(\lambda)+\bar{z}_{10}(\lambda)} \tag{5}$$

$$\mathrm{z}_{10}(\lambda)=\frac{\bar{z}_{10}(\lambda)}{\bar{x}_{10}(\lambda)+\bar{y}_{10}(\lambda)+\bar{z}_{10}(\lambda)} \tag{6}$$

NOTE All wavelengths are for standard air.

5 Derivation of the colour-matching functions for the CIE 1931 standard colorimetric observer

5.1 Experimental basis

The CIE 1931 colour-matching functions, $\bar{x}(\lambda),\bar{y}(\lambda),\bar{z}(\lambda)$, were derived from experimental work carried out by Wright[1] and Guild[2] in which a total of 17 observers matched the monochromatic stimuli of the spectrum, over the range of about 400 nm to 700 nm, with additive mixtures of red, green and blue lights, using observing fields of 2° angular subtense.

5.2 Transformation procedures

The experimental results were converted into those that would have been obtained if the matching had been carried out using, as reference colour stimuli, monochromatic radiations of wavelengths 700 nm for the red [R], 546,1 nm for the green [G] and 435,8 nm for the blue [B], measured in units such that equal quantities of [R], [G] and [B] were required to match the equi-energy spectrum.

The results for the 17 observers were averaged and then slightly adjusted so that by adding together suitable proportions of the [R], [G], [B] colour-matching functions $\bar{r}(\lambda),\bar{g}(\lambda),\bar{b}(\lambda)$ it was possible to obtain a function identical to that of the CIE spectral luminous efficiency, $V(\lambda)$; the proportions used were in the ratios of 1,000 0 to 4,590 7 to 0,060 1, and these were then the relative luminances of unit quantities of [R], [G] and [B]. The CIE 1931 colour-matching functions were then determined by Formulae (7) to (9):

$$\bar{x}(\lambda)=\left[0{,}49\,\bar{r}(\lambda)+0{,}31\,\bar{g}(\lambda)+0{,}20\,\bar{b}(\lambda)\right]n \tag{7}$$