TECHNICAL SPECIFICATION

ISO/TS 17321-4

Second edition

Graphic technology and photography — Colour characterization of digital still cameras (DSCs) —

Part 4: Programmable light emission system

Technologie graphique et photographie — Caractérisation de la couleur des appareils photonumériques —

Partie 4: Système d'émission de lumière programmable

PROOF/ÉPREUVE

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Contents

Page

PROOF/ÉPREUVE

Foreword

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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).

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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 Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO/TS 17321-4:2016), which has been technically revised.

The main changes are as follows:

— reorganized introduction and Clause 4;

— Clause 4 is concentrated on the hardware evaluation of programmable light emission system (PLES). New Annexes B and C were added to the second edition;

— a new Clause 5 and a new Annex A using VSA (Vector Space Arithmetic) formulation for simpler-conceptual explanation of spectral match for PLES were added;

— removed unnecessary explanations on spectral generation (Annexes A, B, C, D, E, F and explanation of spectral match in Clause 4), accordingly.

A list of all parts in the ISO 17321 series can be found on the ISO website.

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

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Introduction

This document describes a programmable light emission system. This system may be used to create spectra that are arbitrary combinations of the lights contained within or may be used to create a spectral match to a target reference spectrum. Unless the lights are of high dimensionality (ideal spectral shape at each wavelength) such a match will generally be only approximate. Therefore, evaluation methods for the spectra generated by the system are also described.

An example hardware description of a programmable light emission system is presented in Clause 4. While any programmable light emission system that meets the tolerances specified may be utilized, this document considers systems comprised of light emitting devices such as inorganic or organic LEDs, quantum dots, and laser diodes (if equipped with suitable spatial filtering).

Graphic technology and photography — Colour characterization of digital still cameras (DSCs) —

Part 4: **Programmable light emission system**

1 Scope

This document describes a programmable light emission system to produce various spectral radiance distributions, intended for DSC colour characterization applications.

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.

ISO 7589, *Photography — Illuminants for sensitometry — Specifications for daylight, incandescent tungsten and printer*

ISO/CIE 11664-5, *Colorimetry — Part 5: CIE 1976 L*u*v* colour space and u', v' uniform chromaticity scale diagram*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
colour-matching functions
tristimulus values (3.5) of monochromatic stimuli of equal radiant flux

[SOURCE: CIE S 017:2020, 17-23-039]

3.2
digital still camera
DSC
device which incorporates an image sensor, and which produces a digital signal representing a still picture

Note 1 to entry: A digital still camera is typically a portable, hand-held device. The digital signal is usually recorded on a removable memory, such as a solid-state memory card or magnetic disk.

[SOURCE: ISO 17321-1:2012, 3.2]

3.3
light-emitting diode
LED
semiconductor diode that emits non coherent optical radiation through stimulated emission resulting from the recombination electrons and photons, when excited by an electric current

Note 1 to entry: For an example of LED, CIE S 017:2020, 17-27-050 shall be referred to.

[SOURCE: IEC 60050-521:2002, 521-04-39]

3.4
programmable light emission system
PLES
system that produces various spectral radiance distributions using light emitting devices

3.5
tristimulus values
amounts of the reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

Note 1 to entry: See *colour matching functions* (3.1).

[SOURCE: CIE S 017:2020, 17-23-038]

4 Description

4.1 General

Figure 1 shows a cross-section of an example of a programmable light emission system (PLES). An integrating sphere in the Figure 1 is utilized to ensure good spatial uniformity for the light emission. Light emitting devices are placed at the bottom and an output window is placed on the side to allow the mixed light to be emitted. The ability to measure absolute XYZ values is a requirement. A tele-spectrophotometer is one of such measurement methods to obtain these values and used to verify the accuracy of the generated spectra.

There are many kinds of light emitting devices. For example, if LEDs are used for the light emitting devices, the LEDs are electrically modulated and the emitted flux will be mixed (integrated) by multiple reflections from the inner surface of the sphere, in order to produce a required spectral distribution of light flux.

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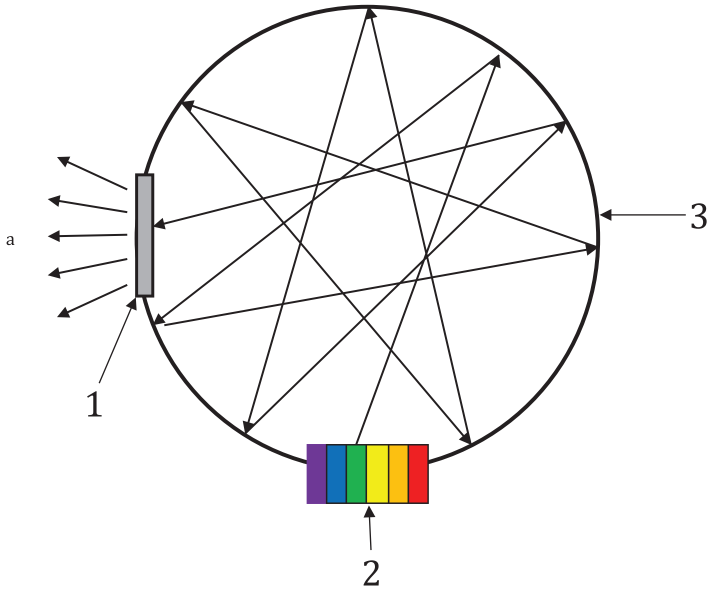

Key

1 output window

2 light emitting device array

3 integrating sphere

a Uniform light emission on the output window.

Figure 1 — Schematic configuration of the programmable light emission system (PLES)

Annex B shows LED driving methods of the PLES.

As a more compact alternative to integrating sphere, flat panel diffusers can also be designed to produce near-uniform output by the light levels of the individual LED modules.

4.2 Operating condition

The light emitting system shall be designed to operate consistently under the ranges described in Table 1.

Table 1 — Operating conditions

Operating condition	Range
Temperature	18 °C to 28 °C
Relative humidity	15 % to 80 %

NOTE The temperature requirements were taken from ISO 12646.

4.3 Description of the system

4.3.1 General

This clause describes the PLES. An example for the PLES conditions is described in Annex C.

Warm-up time shall be chosen to be long enough so that the system has reached stable state and stabilized at the desired operating temperature after power-on of the PLES. It is recommended that a default spectral distribution is outputted during warm-up time in order to reduce warm-up time. This warm-up time is applied to all of spectral distribution measurement.

Every spectral measurement shall be performed after 5 s to 10 s when the PLES outputs different spectral distribution.

4.3.2 Wavelength

The wavelength range over which the combined set of the light emissive devices is evaluated should be at least broad enough to cover the range of spectral sensitivity of the DSC of interest and shall be specified. Generally, this will be 380 nm to 730 nm though longer wavelengths into the near-infrared should be included.

4.3.3 Resolution of digital-analogue conversion for light emitting devices

Sufficient resolution of digital-analogue conversion shall be used assuming that the PLES is setup such that there is a linear relationship between the power applied to each light emitting device and the resulting intensity from each light emitting device.

NOTE See Annex C for more information.

4.3.4 Output window size

The output window (see Figure 1) shall be large enough for the intended use.

NOTE See Annex C for more information.

4.3.5 Luminance

The maximum luminance of the output window shall have sufficient luminance when simulating various light sources including fluorescent and LED light sources.

NOTE See Annex C for more information.

4.3.6 Uniformity

For circular shaped output windows, luminance is measured at the centre and at 8 points evenly spaced next to the circumference of the output window at 45° intervals. The luminance measurements are made normal to the plane of the output window at each measurement point.

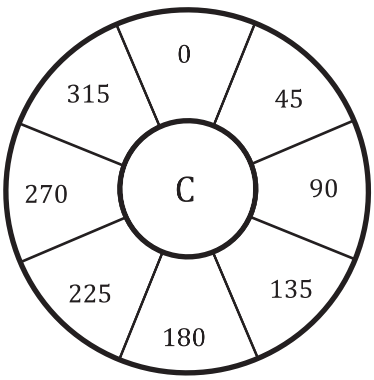

Figure 2 — Measurement points on the output window with every 45°

Figure 2 shows measurement points on the output window to calculate uniformity characteristics.

Uniformity is defined by Formula (1):

$$\Delta Y_u = \max_{i \in c, 0^\circ \sim 315^\circ} \left| \frac{Y_i - Y_{\text{ave}}}{Y_{\text{ave}}} \right| \times 100 \qquad (1)$$

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where

Y_{ave} is the average of the luminance measured on the output window;

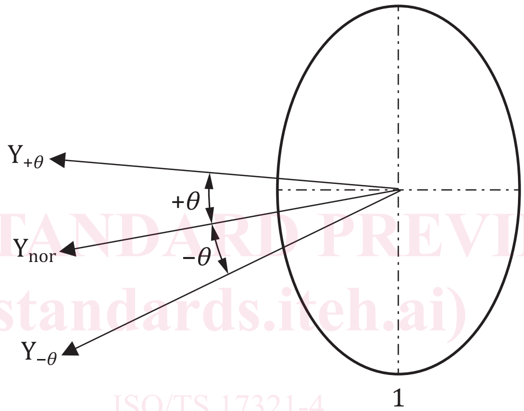
Y_i is the luminance measured either at centre or at each location next to the circumference of the output window.

NOTE See Annex C for more information.

4.3.7 Angular characteristics

The luminance is measured within a 10° cone angle to the normal line of the centre of the output window.

An integrating sphere could be used in order to ensure uniformity across the output window. Figure 3 shows angular characteristic measurement method. It is the typical method for a colour target having an arrangement of an output window and light sources shown in Figure 1.



Key

1 output window

Figure 3 — Angular characteristics measurement method

The luminance measured along the axis which is inclined +θ or -θ to the normal axis is given by Formula (2):

$$\Delta Y_\theta = \max_{i \in +\theta, -\theta} \left| \frac{Y_i - Y_{nor}}{Y_{nor}} \right| \quad (2)$$

where

Y_{nor} is the luminance measured along the axis normal to the output window;

$Y_{+\theta}$ or $Y_{-\theta}$ is the luminance measured along the axis which is inclined +θ or -θ to the normal axis, respectively. Maximum θ is 5° of arc.

NOTE See Annex C for more information.

4.3.8 Repeatability

4.3.8.1 General

There are two use cases for measuring the light intensity repeatability performance. The first one is short-term repeatability for continuous use within a day described in 4.3.8.2 where suffix "$_S$" is used.