



BSI Standards Publication

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

Part 4: Programmable light emission system

**National foreword**

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**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 numériques —*

*Partie 4: Système d'émission de lumière programmable*



Reference number  
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## 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](http://www.iso.org/directives)).

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For an explanation on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 42, *Photography*.

ISO 17321 consists of the following parts, under the general title *Graphic technology and photography — Colour characterization of digital still cameras (DSCs)*:

- *Part 1: Stimuli, metrology and test procedures*
- *Part 2: Considerations for determining scene analysis transforms* [Technical Report]
- *Part 4: Programmable light emission system* [Technical Specification]

The following parts are under preparation:

- *Part 3: User controls and requirements for scene-referred imaging applications* [Technical Report]

## Introduction

There are many application areas such as medical imaging, cosmetics, e-commerce, sales catalogue, fine art reproduction and artistic archive where colorimetric image capture and colorimetric image reproduction are desired.

A high colour-fidelity imaging system using a black-and-white digital camera with rotary colour filters<sup>[12]</sup>, and digital video cameras specified for colorimetric image capture<sup>[13]</sup>, both of which have the same colour sensitivity as the colour matching functions defined by CIE 1931, are available today and fulfil these requirements. However, Reference [12] is a large-scale device which cannot be used to capture moving objects, and Reference [13] is dedicated to motion picture use.

Digital still cameras (DSCs) are often used as convenient devices for colorimetric image capture. Typically, DSCs do not have sensor sensitivities that are linear transforms of the colour matching functions defined by CIE 1931. It is, therefore, necessary that a matrix conversion from DSC-image-capture data to scene-colorimetric data be done to transform camera image data to estimates of scene colorimetric data. Although there are several methods to derive such a matrix, a method using colour targets is the most common when there is no data describing the DSC sensor spectral sensitivities.

Colour targets used to derive this conversion matrix are X-Rite ColorChecker Classic<sup>®1)</sup>, X-Rite ColorChecker Digital SG<sup>®2)</sup> and others. These targets are reflective and have a limited colour gamut compared to scenes where the subject includes highly saturated colours. In such a case, colour targets with highly saturated colours that can be used to derive the colour conversion matrix are very useful.

This part of ISO 17321 is applicable to light emitting devices such as inorganic or organic LEDs, quantum dots and laser diodes.

Note that although an integrating sphere is typically used, other mechanisms would also be applicable.

A procedure using a nonlinear Generalized Reduced Gradient (GRG) algorithm is specified in this part of ISO 17321 to minimize the square of the difference between a desired colour spectrum and the colour spectrum of the programmable light emission system.

This part of ISO 17321 will make use of a metric ( $S_{R2}$ ), which provides a simple and direct means to calculate the colour difference between two spectra. This criterion ( $S_{R2}$ ) will be used as a method to evaluate the performance of a programmable light emission system in terms of its ability to match a reference spectral power distribution.  $S_{R2}$  and CIEDE2000 metrics are both used for colour target evaluation.

This programmable light emission system can generate arbitrary illuminants such as D55, D65 and Illuminant A. Annex D describes evaluation metrics for light sources.

This system has several advantages as follows.

- An arbitrary smooth spectral power distribution similar to colour targets under a light source can be produced.
- Many colour metamers can be generated easily.
- Colours with different luminance, same hue and same saturation can be generated easily.
- Colours with different saturation, same luminance and same hue can be generated easily.
- Colours with high luminance can be produced.
- Reference colour target can be provided for display systems.

1) ColorChecker Classic<sup>®</sup> is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

2) ColorChecker Digital SG<sup>®</sup> is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

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

## Part 4: Programmable light emission system

### 1 Scope

This part of ISO 17321 specifies requirements for a programmable light emission system to produce various spectral radiance distributions intended for DSC colour characterization applications.

NOTE 1 Evaluation metrics are described in this part of ISO 17321. These evaluation metrics are intended to provide “Figure of Merit (goodness)” relating to the ability of the device to produce arbitrary spectral power distributions.

NOTE 2 This part of ISO 17321 applies to a programmable light emission system composed of LEDs. However, it can be applied to light emitting devices such as quantum dots, organic LEDs, laser diodes and so forth.

NOTE 3 If spiky spectral reproduction is required, devices which have more spiky spectral light emission are intended to be used.

### 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.

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

### 3 Terms and definitions

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

#### 3.1

##### colour matching functions

*tristimulus values* (3.6) of monochromatic stimuli of equal radiant power

[SOURCE: CIE Publication 17.4, 845-03-23]

#### 3.2

##### colour rendering index [R]

Measure of the degree to which the psychophysical colour of an object illuminated by a test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation

[SOURCE: CIE Publication No. 17.4:1987, 845-02-61]