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Graphic technology — Prepress digital data exchange — Part 1: Colour targets for input scanner calibration

Technologie graphique — Échange de données numériques de préimpression — Partie 1: Cibles de couleur pour l'étalonnage des scanners en entrée

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International Standard

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Second edition
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Graphic technology — Prepress digital data exchange —

Part 1: Colour targets for input scanner calibration

Technologie graphique — Échange de données numériques de préimpression —

Partie 1: Cibles de couleur pour l'étalonnage des scanners en entrée

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Contents

Page

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 document 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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This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This second edition cancels and replaces the first edition (ISO 12641-1:2016), which has been technically revised.

The main changes are as follows:

— the title has been changed to align with the ISO/IEC Directives Part 2;

— some subclauses have been corrected;

— the normative references (see Clause 2) have been updated;

— the terms and definitions (see Clause 3) have been updated.

A list of all parts in the ISO 12641 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.

Introduction

0.1 General

The technical requirements of this document are identical to the American National Standards IT8.7/1-1993 and IT8.7/2-1993. These standards resulted from the joint efforts of an international industry group that included participants representing a broad range of prepress vendors, film manufacturers and users. This group, initially identified as the digital data exchange standards (DDES) committee, later became the founders of the ANSI IT8 (Image Technology) accredited standards committee which is responsible for electronic data exchange standards in graphic arts prepress.

0.2 Purpose of this document

Colour input scanners do not all analyse colour the same way the human eye does. These devices are designed to optimize the signal generated when typical materials are scanned. Colour reflection and transparency products use various combinations of proprietary dye sets to achieve visual responses that simulate the colour appearance of natural scene elements. The ability to achieve the same colour appearance from different combinations of dyes is referred to as metamerism. Because both photographic dyes and input scanner sensitivities vary from product to product, there is variability in the input scanner response to metameric colours produced by the various materials. The intent of this document is to define an input test target that will allow any colour input scanner to be calibrated with any film or paper dye set used to create the target. This document is intended to address the colour reflection and transparency products which are generally used for input to the preparatory process for printing and publishing.

The target was designed to be useable for calibration by visual comparison and as a numerical data target for electronic systems and future development. The target design made use of a uniform colour space to optimize the spacing of target patches. The tolerances developed for individual coloured patches meet the values needed for both numerical and visual analysis.

0.3 Design of the target

The CIE 1976 ($L^*a^*b^*$) or CIELAB colour space was chosen as the space to be used for the design of the colour calibration target. Uniform spacing in hue angle, lightness and chroma, and tolerancing in terms of differences in these parameters (ΔE^*_{ab}) is believed to provide a reasonable distribution of coloured patches in the most effective manner. Although CIELAB was defined with reference to reflection viewing conditions, tolerancing in terms of vector differences (ΔE^*_{ab}) does provide a reasonable error estimate for transmission materials as well, although the uniformity of the space is dependent upon the conditions of viewing.

The design goal was to define a target that would have, as its main part, as many common coloured patches as was practical, regardless of the dye set used. The remainder of the target is intended to define the unique colour characteristics of the particular dye set used to create a specific target; the values for each target patch is to be established using a common procedure.

To provide a reasonable measure of the colour gamut that is within the capability of modern colour papers and films, all manufacturers of these products were invited to provide colour dye data along with the necessary minimum and maximum density data for each of their image forming colour dye sets. Data were provided by Agfa Company, Eastman Kodak Company, Fuji Photo Film Company and Konica Corporation. These data were then used to estimate the CIELAB colour gamut that each paper and film dye set could produce. This estimate was achieved by mathematical modelling (by several of the participating companies) using methods which were different but gave very similar results. Annex A provides additional reference material concerning the method used in selecting aim values.

References [15] and [16] provide reference information on the computational methods used in gamut determination.

All computations were based upon the use of the CIE 2 degree observer and D_{50} illuminant. All transmission measurements were made using diffuse/normal or normal/diffuse geometry as defined for total transmittance. All reflection measurements were made using 0°/45° or 45°/0° geometry as defined in ISO 13655. The reference white was assumed to be a perfect diffuser. The use of an absolute reference allows all colours on similar media (reflection or transmission) that have the same colorimetric definition to also look the same when viewed at the same time.

The gamut plots developed were then used to determine the colour gamut for film and for paper that were common to all of the provided dye families. The limiting values of chroma were then reduced to 80 % of their computed values to create a "common gamut" for purposes of target design.

The goal was to have all coloured patches defined in the same way (regardless of the product used) and to have as many patches as practical. The defined colour gamut therefore required a pattern with a consistent reference. An existing colour input target provided by Eastman Kodak Company under the designation of "Kodak Colour Reproduction Guides, Q-60™" was used as a guide in the development of the target. The Q-60™ target used 12 approximately uniformly spaced hue angles in CIELAB. These were sampled at three chroma values at each of three lightness levels. Although this pattern does not provide equal spacing in terms of ΔE^*_{ab}, it does provide an easily understandable and defined patch arrangement. It was adopted for these targets with the addition of a fourth product-specific chroma value at each hue angle/lightness combination.

Lightness levels were chosen for each hue angle to best characterize the gamut at that hue angle. The three common chroma values were then chosen such that one fell on the computed 80 % chroma limit common to all the products and the others were equally spaced in chroma between this value and the neutral. The fourth chroma, which is product-specific, was defined to be the maximum available from each product at the specific hue angle and lightness level. This provided a consistent mapping for all products.

It was also felt to be important to include scales in each of the individual dyes, dye pairs, and a dye neutral along with areas to define product minimum and maximum densities.

A "vendor-optional" area was provided so that different target manufacturers could add unique patches of their own determination beyond those which are required by this document.

0.4 Manufacturing tolerances

In order to permit practical production of these targets, tolerances had to be set which were capable of being achieved over a significant number of targets. However, this conflicted with the relatively narrow tolerances required for numerical colour calibration. Different tolerances were therefore defined for differing applications, with the objective of minimizing variations as far as was reasonable.

Graphic technology — Prepress digital data exchange —

Part 1:
Colour targets for input scanner calibration

1 Scope

This document defines the layout and colorimetric values of targets for use in the calibration of a photographic product/input scanner combination (as used in the preparatory process for printing and publishing). One target is defined for positive colour transparency film and another is defined for colour photographic paper.

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 1008, *Photography — Paper dimensions — Pictorial sheets*

ISO 1012, *Photography — Films in sheets and rolls for general use — Dimensions*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

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
CIE tristimulus value
tristimulus value
amount of the three reference colour stimuli, in the CIE-specified trichromatic system, required to match the colour of the stimulus considered

Note 1 to entry: In the 1931 CIE standard colorimetric system, the tristimulus values are represented by the symbols X, Y, Z.

3.2
CIELAB colour difference
CIE 1976 *L, *a**, *b** colour difference**
ΔE^*_{ab}
difference between two colour stimuli defined as the Euclidean distance between the points representing them in *L**, *a**, *b** space

$$\Delta E^*_{ab} = \sqrt{\left(\Delta L^*\right)^2 + \left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2}$$

where ΔL^*, Δa^*, and Δb^* are the difference between corresponding values for the two stimuli

[SOURCE: International Lighting Vocabulary 845-03-55]

3.3
CIELAB colour space
CIE 1976 *L, *a**, *b** colour space**
three-dimensional, approximately uniform, colour space produced by plotting in rectangular coordinates the quantities L^*, a^*, and b^* defined by the formulae:

$$L^* = 116[f(Y/Y_n)] - 16$$

$$a^* = 500[f(X/X_n) - f(Y/Y_n)]$$

$$b^* = 200[f(Y/Y_n) - f(Z/Z_n)]$$

where

$$f(X/X_n) = (X/X_n)^{1/3} \text{ if } X/X_n > (6/29)^3$$

$$f(X/X_n) = (841/108)\,(X/X_n) + 4/29 \text{ if } X/X_n \le (6/29)^3$$

and

$$f(Y/Y_n) = (Y/Y_n)^{1/3} \text{ if } Y/Y_n > (6/29)^3$$

$$f(Y/Y_n) = (841/108)\,(Y/Y_n) + 4/29 \text{ if } Y/Y_n \le (6/29)^3$$

and

$$f(Z/Z_n) = (Z/Z_n)^{1/3} \text{ if } Z/Z_n > (6/29)^3$$

$$f(Z/Z_n) = (841/108)\,(Z/Z_n) + 4/29 \text{ if } Z/Z_n \le (6/29)^3$$

and

$$X_\mathrm{n} = 96{,}422,$$
$$Y_\mathrm{n} = 100{,}000 \; and$$
$$Z_\mathrm{n} = 82{,}521, \; for\ the\ conditions\ of\ ISO\ 13655.$$

Further

$$C^*_{ab} = \sqrt{a^{*2} + b^{*2}}$$

and

$$h_{ab} = arctan\left(\frac{b^*}{a^*}\right)$$

where

0°	<	h_{ab}	<	90°	if $a^* > 0$ and $b^* > 0$
90°	<	h_{ab}	<	180°	if $a^* < 0$ and $b^* > 0$
180°	<	h_{ab}	<	270°	if $a^* < 0$ and $b^* < 0$
270°	<	h_{ab}	<	360°	if $a^* > 0$ and $b^* < 0$

[SOURCE: ISO 13655 and CIE Publication 15:2018]

3.4
transmittance factor
ratio of the measured flux transmitted by the sample material to the measured flux when the sample material is removed from the sampling aperture of the measuring device

3.5
reflectance factor
ratio of the measured flux reflected from the sample material to the flux reflected from a perfect reflecting diffuser

3.6
colour gamut
subset of perceivable colours reproducible by a device or medium

3.7
dye set
combination of light absorbing dyes

Note 1 to entry: Usually referred to as cyan, magenta and yellow. Used in a particular photographic product which produce object colours by the selective subtraction of the incident light.

3.8
dye scale
array of physical areas having varying amounts of one or more (cyan, magenta, or yellow) dyes

3.9
neutral scale
array of physical areas having combination of dye amounts such that their chroma is equal to, or near, zero

3.10
minimum density
D_{min}
density corresponding to the maximum *transmittance factor* (3.4) (film) or *reflectance factor* (3.5) (paper) that a photographic product can achieve

Note 1 to entry: It is not necessarily neutral in colour and should not be confused with minimum neutral density.

3.11
minimum neutral density
minimum density that a photographic product can achieve (maximum transmittance or *reflectance factors* (3.5)) and maintain a $C^*_{ab} = 0$

Note 1 to entry: It should not be confused with minimum density (Dmin).

3.12
maximum density
D_{max}
density corresponding to the minimum transmittance or *reflectance factor* (3.6) that a photographic product can achieve

Note 1 to entry: It is not necessarily neutral in colour and should not be confused with maximum neutral density.