INTERNATIONAL STANDARD

ISO 12641-1

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

Part 1:
Colour targets for input scanner calibration

Technologie graphique — Échange de données numériques de préimpression — Cibles de couleur pour étalonnage à l'entrée du scanner

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 130, *Graphic technology*.

This first edition of ISO 12641-1 cancels and replaces ISO 12641:1997, which has been technically revised to take account of the technical advancements in the related fields and the associated equipment.

ISO 12641 consists of the following parts, under the general title *Graphic technology — Prepress digital data exchange*:

— *Part 1: Colour targets for input scanner calibration*

An additional part dealing with advanced colour targets for input scanner calibration is planned.

Annexes A and B are for information only.

Introduction

The technical requirements of this part of ISO 12641 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.

Purpose of this part of ISO 12641

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 part of ISO 12641 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 part of ISO 12641 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.

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.

The following documents provide reference information on the computational methods used in gamut determination.

1. N. Ohta, "The Color Gamut Obtainable by the Combination of Subtractive Color Dyes. V. Optimum Absorption Bands as Defined by Nonlinear Optimization Technique." *Journal of Imaging Science*, **30**, 9-12 (1986)[1].

2. M. Inui, "Fast Algorithm for Computing Color Gamuts," *Colour Research and Application*, **18**, 341-348 (1993)[4].

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 gamuts for film and 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 International Standard.

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 — Colour targets for input scanner calibration —

Part 1:
Colour targets for input scanner calibration

1 Scope

This part of ISO 12641 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, 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 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.

3.1
CIE 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

$$\Delta E^*_{ab} = \left[\left(\Delta L^*\right)^2 + \left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2 \right]^{1/2}$$

where

ΔL^*, Δa^*, and Δb^* is 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:

$$L* = 116\left[f\left(Y/Y_n\right)\right] - 16$$
$$a* = 500\left[f\left(X/X_n\right) - f\left(Y/Y_n\right)\right]$$
$$b* = 200\left[f\left(Y/Y_n\right) - f\left(Z/Z_n\right)\right]$$

where for

$$X/X_n > 0,008\,856, \text{f}\left(X/X_n\right) = \left(X/X_n\right)^{1/3}$$
$$Y/Y_n > 0,008\,856, \text{f}\left(Y/Y_n\right) = \left(Y/Y_n\right)^{1/3}$$
$$Z/Z_n > 0,008\,856, f\left(Z/Z_n\right) = \left(Z/Z_n\right)^{1/3}$$

and for

$$X/X_n > 0,008\,856, f\left(X/X_n\right) = 7,786\,7\left(X/X_n\right) + 16/116$$
$$Y/Y_n > 0,008\,856, f\left(Y/Y_n\right) = 7,786\,7\left(Y/Y_n\right) + 16/116$$
$$Z/Z_n > 0,008\,856, f\left(Z/Z_n\right) = 7,786\,7\left(Z/Z_n\right) + 16/116$$

and

$$X_n = 96,422,$$
$$Y_n = 100,000\ and$$
$$Z_n = 82,521,\ for\ the\ conditions\ of\ ISO\ 13655.$$

Further

$$C*_{ab} = \left(a*^2 + b*^2\right)^{1/2}$$

and

$$h_{ab} = tan^{-1}\left(b*/a*\right)$$

where

$$0 Υ \leq h_{ab} < 90\ Υ \quad if \quad a* > 0$$
$$b* \geq 0$$
$$90 Υ \leq h_{ab} < 180\ Υ \quad if \quad a* \leq 0$$
$$b* > 0$$
$$180 Υ \leq h_{ab} < 270\ Υ \quad if \quad a* < 0$$
$$b* \leq 0$$
$$270 Υ \leq h_{ab} < 360\ Υ \quad if \quad a* \geq 0$$
$$b* < 0$$

[SOURCE: CIE Publication 15.2]

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
transmission density
logarithm to base 10 of the reciprocal of the transmittance factor

3.6
reflectance factor
ratio of the measured flux reflected from the sample material to the flux reflected from a perfect reflecting diffuser

3.7
reflection density
logarithm to base 10 of the reciprocal of the reflectance

3.8
colour gamut
subset of perceivable colours reproducible by a device or medium

3.9
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.

3.10
dye scale
array of physical areas having varying amounts of one or more (cyan, magenta, or yellow) dyes

3.11
neutral scale
array of physical areas having combination of dye amounts such that their chroma is equal to, or near, zero

3.12
metameric colour stimuli
spectrally different colour stimuli having the same tristimulus values

[SOURCE: International Lighting Vocabulary 845-03-05]

3.13
minimum density
Dmin
density corresponding to the maximum transmittance factor (film) or reflectance factor (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.

3.14
minimum neutral density
minimum density that a photographic product can achieve (maximum transmittance or reflectance factors) and maintain a $C^*_{ab} = 0$

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

3.15
maximum density
Dmax
density corresponding to the minimum transmittance or reflectance factor 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.

3.16
maximum neutral density
density corresponding to the maximum density that a photographic product can achieve (minimum transmittance or reflectance factors) and maintain a $C^*_{ab} = 0$

Note 1 to entry: It should not be confused with maximum density (Dmax).

3.17
input scanner
device capable of converting the light reflectance or transmittance of a photographic (or other hardcopy) sample into an electronic signal, where the electronic signal is arranged to have an organized relationship to the spatial areas of the image evaluated

3.18
product-specific target areas
portions of the test target whose requirements are specifically defined, but whose values are a function of the particular product used to make the target

3.19
vendor-optional target areas
portions of the test target whose content is not specified but is available for use by the manufacturer of the target

4   Requirements

All colorimetry referenced within this part of ISO 12641 shall be based on D_{50} illuminant, CIE 1931 Standard Colorimetric Observer (2 degree observer) as defined in CIE 15.2, and computational procedures further defined in 4.5. The reference white is the D_{50} illuminant.

4.1   Target design

The target is designed with five distinct sections. These are the following:

— sampled colour area;

— colour dye scales;

— neutral dye scale;

— Dmin/Dmax area;

— vendor-optional area.

4.2   Transmission targets

4.2.1   Target layout and physical characteristics

4.2.1.1   Type 1, 4 in × 5 in film: The layout of the Type 1 colour transmission input calibration target as viewed from the support side of the film shall be as shown in Figure 1. This layout is intended for use with film material having a size of 4 in × 5 in (10,2 cm × 12,7 cm) in accordance with ISO 1012. All non-image areas of the target shall be approximately neutral and shall have a lightness of (L^*) of

approximately 50. The non-image area shall extend at least 4,5 mm beyond the row and column borders on the top and sides at least 10 mm on the bottom to provide for identification information.

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Product Name
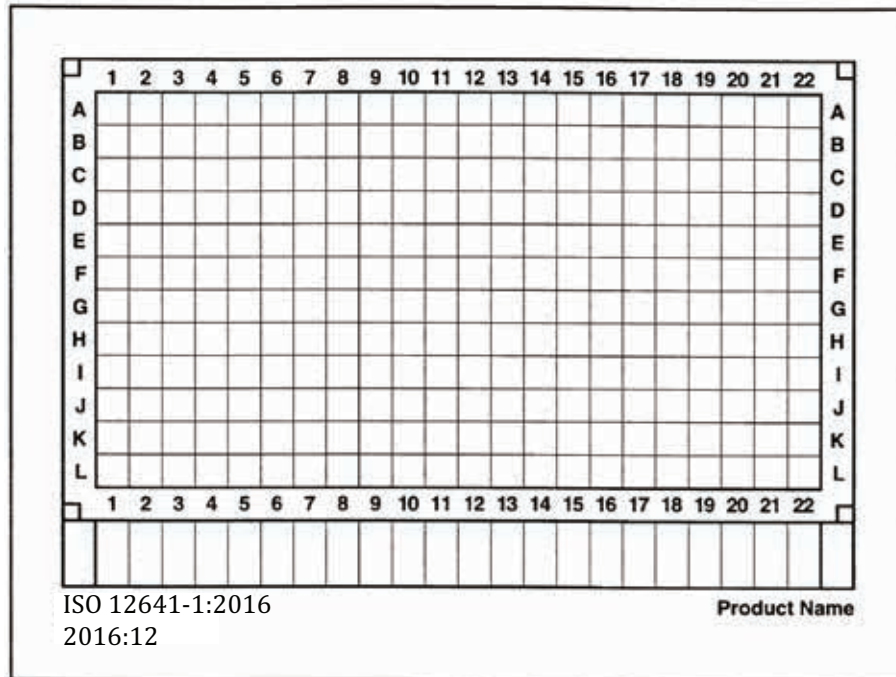
Figure 1 — Layout, Type 1 colour transmission target

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Product Name

Figure 2 — Type 1 target, row, and column numbering

Target row and column numbering shall be of high density and as shown in Figure 2. Vertical lines may be used to separate columns 12 and 13, 15, 16 and 17, and 19 and 20. Indicators may be used at the intersection of target patches. These may be points, crosses, or other symbols, and may be of any

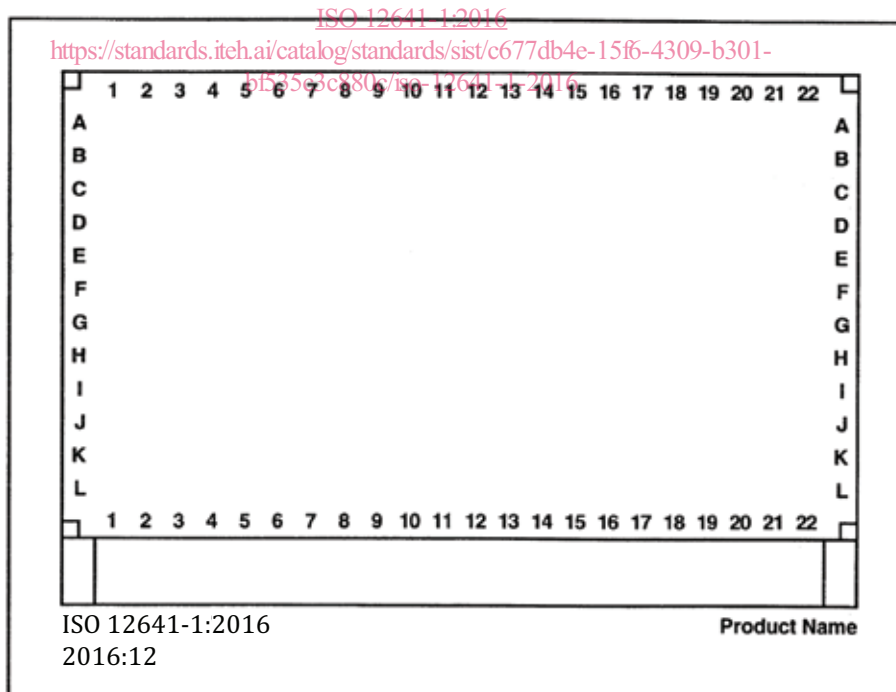density or colour desired. If used, they shall be less than 0,3 mm in width. No other marking lines shall be included within the body of the A1 through L19 portion of the target.

Lines shall be included to separate the Dmin area from the first step and the Dmax area from the last step of the 22-step neutral scale along the bottom of the target.

Unless otherwise noted, all lines shall be neutral and have a lightness (L^*) no greater than that specified for the background.

Fiducial marks shall be included in each corner of the main body of the target as shown in Figure 3. These shall be arranged such that they "point" towards the inside or centre of the target.

Because target patches are 4,5 mm × 4,5 mm in size (see 4.2.2), the intersection of the lines of the fiducial marks shall be offset 4,5 mm in both the horizontal and vertical direction from the centre of the nearest patch to provide a reference for automatic measurement alignment.

Fiducial marks shall be clear lines on the neutral background and shall be approximately 0,1 mm in width.

Figure 3 — Fiducial mark design

The area at the bottom of the target shall contain the following information in English text:

a)   ISO 12641-1:2016;

b)   the name of the film product or product family;

c)   the year and month of production of the target in the form yyyy:mm;

d)   an area of at least 10 mm × 25 mm for addition of a unique identification.

NOTE   Targets bearing the designation IT8.7/1-1993 are prepared in accordance with ANSI IT8.7/1-1993 whose technical requirements are identical to those of this part of ISO 12641.