SLOVENSKI STANDARD
SIST ISO 12641:2002

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Grafična tehnologija - Izmenjava digitalnih podatkov v grafični pripravi - Barvne tablice za umerjanje skenerjev

Graphic technology -- Prepress digital data exchange -- 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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ICS:

35.240.30	Uporabniške rešitve IT v informatiki, dokumentiranju in založništvu	IT applications in information, documentation and publishing
37.080	Uporabniške rešitve za predstavitev dokumentov	Document imaging applications
37.100.99	Drugi standardi v zvezi z grafično tehnologijo	Other standards related to graphic technology

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INTERNATIONAL STANDARD

ISO 12641

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

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

Reference number
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Contents

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 12641 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

Annexes A, B, and C of this International Standard are for information only.

Introduction

The technical requirements of this International Standard are identical to the American National Standards IT8.7/1-1993 and IT8.7/2-1993. These documents 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 DDES (Digital Data Exchange Standards) 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 International Standard

Colour input scanners do not all analyze 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 a variability in the input scanner response to metameric colours produced by the various materials. The intent of this International Standard 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 International Standard 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. It was

determined that the remainder of the target should define the unique colour characteristics of the particular dye set used to create a specific target; the values for each target patch should 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 modeling (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[1], 9-12(1986).
2. M. Inui, "Fast Algorithm for Computing Color Gamuts," Color Research and Application, 18[5], 341-348 (1993).

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

1 Scope

This International Standard 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 standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology - ISO 7-bit coded character set for information interchange.*

ISO 1008:1992, *Photography — Paper dimensions — Pictorial sheets.*

ISO 1012:1991, *Photography — Film dimensions — Pictorial sheets .*

ISO 13655:1996, *Graphic technology - Spectral measurement and colorimetric computation for graphic arts images.*

CIE 15.2:1986, *Colorimetry* (second edition).

CIE 17.4:1987, *International Lighting Vocabulary* (fourth edition).

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 CIE tristimulus values: Amounts of the three reference colour stimuli, in the CIE-specified trichromatic system, required to match the colour of the stimulus considered.

NOTE 1 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. [International Lighting Vocabulary 845-03-55].

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

where

ΔL^*, Δa^* and Δb^* refer to the difference between corresponding values for the two stimuli.

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 equations:

$$L^* = 116[f(Y/Y_n)] - 16$$
$$a^* = 500[f(X/X_n) - f(Y/Y_n)]$$
$$b^* = 200[f(Y/Y_n) - f(Z/Zn)]$$

where for:

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

and for:

$$X/X_n \le 0{,}008\,856, \quad f(X/X_n) = 7{,}786\,7(X/X_n)+16/116$$
$$Y/Y_n \le 0{,}008\,856, \quad f(Y/Y_n) = 7{,}786\,7(Y/Y_n)+16/116$$
$$Z/Z_n \le 0{,}008\,856, \quad f(Z/Z_n) = 7{,}786\,7(Z/Z_n)+16/116$$

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

Further:

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

and

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

where:

0°	≤ h_{ab}	< 90°	if	$a^* > 0$, $b^* \geq 0$
90°	≤ h_{ab}	< 180°	if	$a^* \leq 0$, $b^* > 0$
180°	≤ h_{ab}	< 270°	if	$a^* < 0$, $b^* \leq 0$
270°	≤ h_{ab}	< 360°	if	$a^* \geq 0$, $b^* < 0$

[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 ten 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 ten 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 (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. [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 2 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 3 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 4 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 5 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 International Standard 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 5 distinct sections. These are:

1) sampled colour area
2) colour dye scales
3) neutral dye scale
4) Dmin/Dmax area
5) vendor-optional area

4.2 Transmission targets

4.2.1 Target layout and physical characteristics

4.2.1.1 Type 1, 4 in x 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 x 5 in (10,2 cm x 12,7 cm) in accordance with ISO 1012. All non-image areas of the target shall be approximately neutral and shall have a lightness (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 and at least 10 mm on the bottom to provide for identification information.

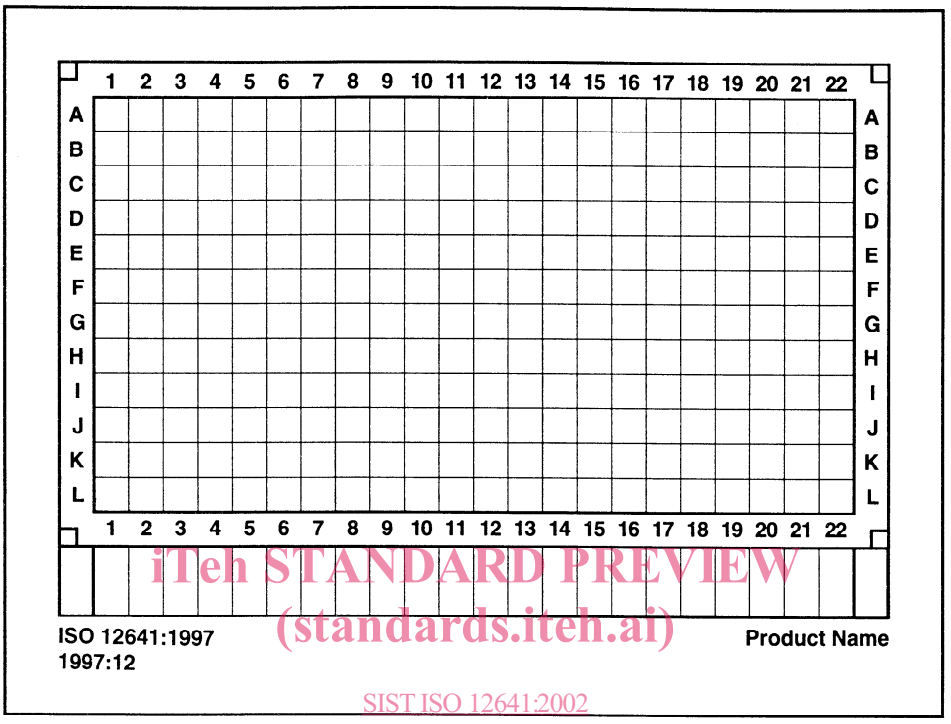

Figure 1 — Layout, Type 1 colour transmission target

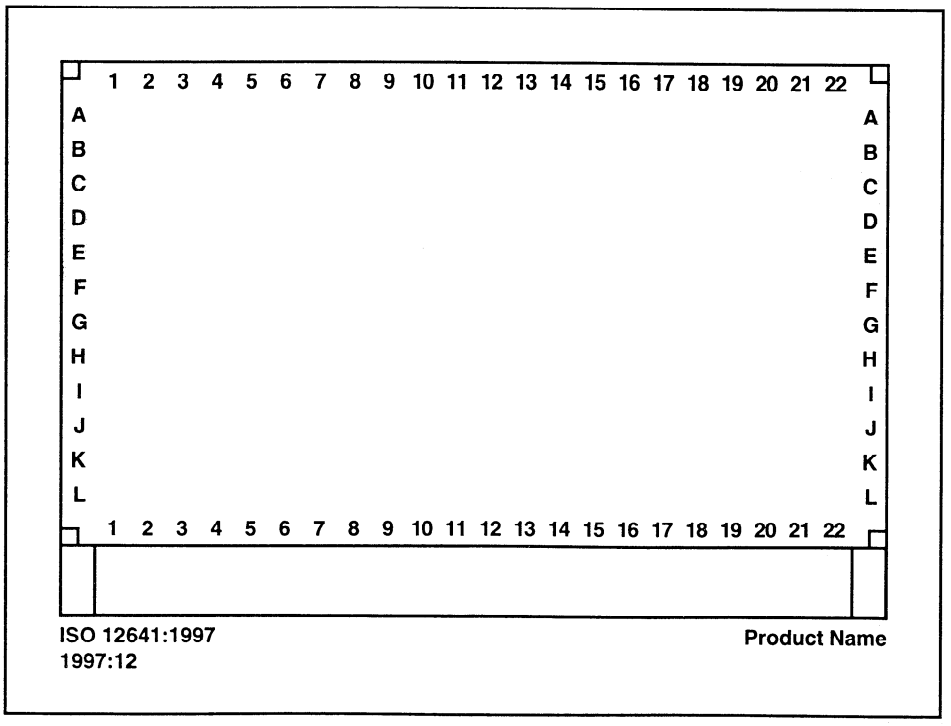

Figure 2 — Type 1 target, row and column numbering