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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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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

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

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

and

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

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

and

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

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

and

$X_n = 96,422,$
$Y_n = 100,000$ *and*
$Z_n = 82,521$, *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.

3.13
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).

3.14
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

4 Requirements

4.1 General

All colorimetry referenced within this document shall be based on D_{50} illuminant, CIE 1931 Standard Colorimetric Observer (2-degree observer) as defined in ISO 13655, and computational procedures further defined in 4.6. The reference white is the D_{50} illuminant.

4.2 Target design

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

— sampled colour area;

— colour dye scales;

— neutral dye scale;

— D_{min}/D_{max} area;

— vendor-optional area.

4.3 Transmission targets

4.3.1 Target layout and physical characteristics

4.3.1.1 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 shall be used 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.

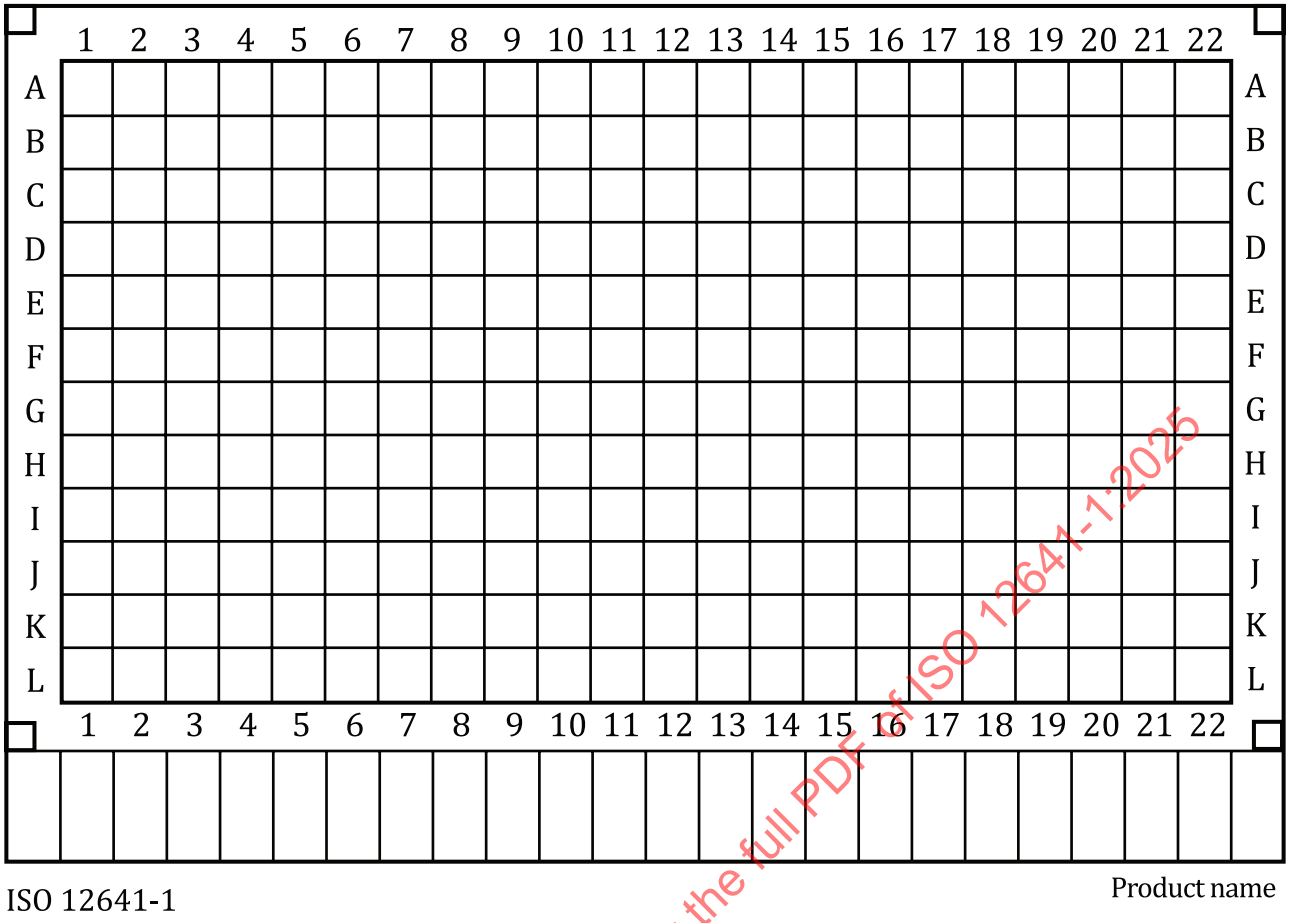


Figure 1 — Layout, Type 1 colour transmission target

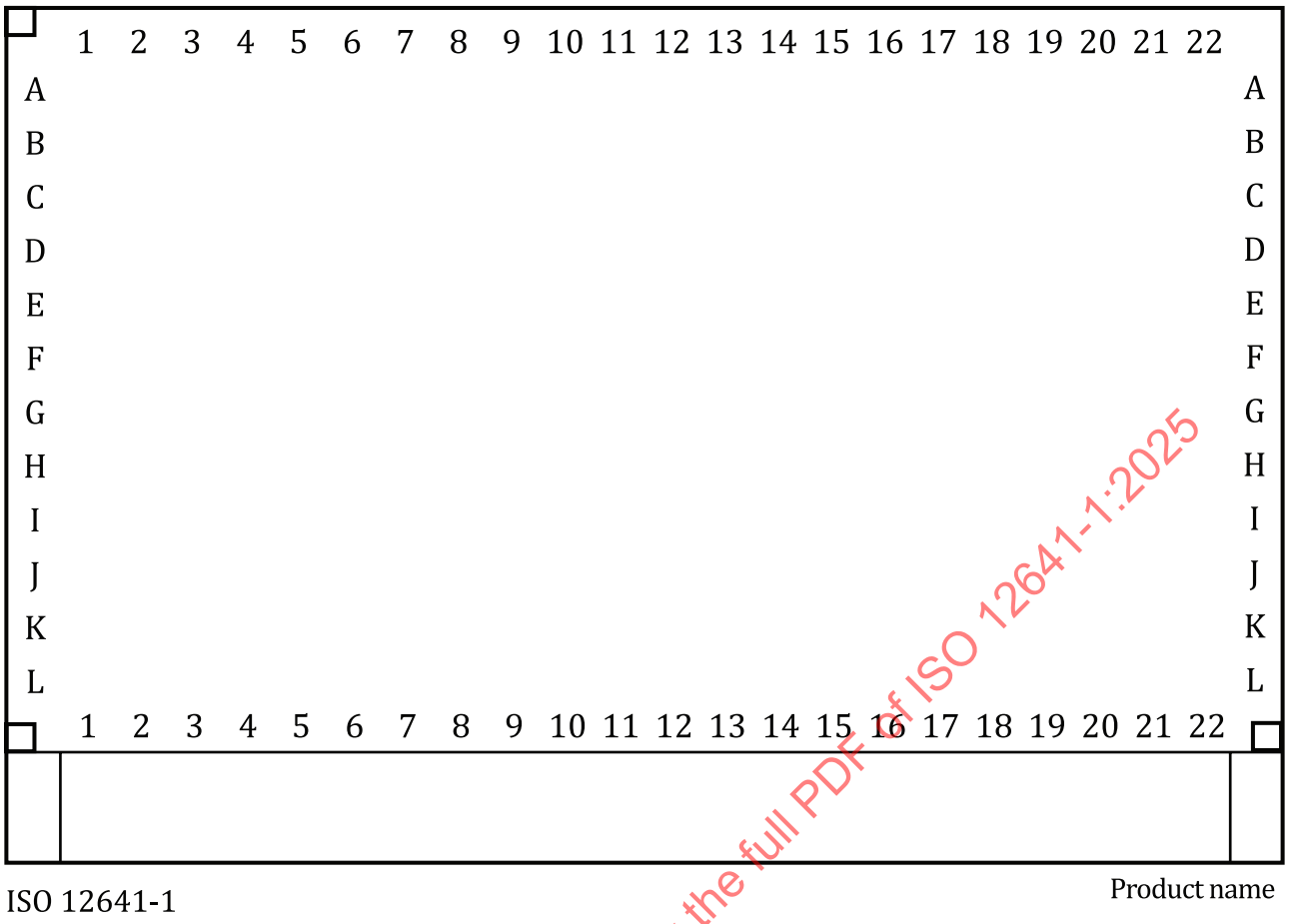


Figure 2 — Type 1 target, row and column numbering

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 D_{min} area from the first step and the D_{max} 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 4.3.2), 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.

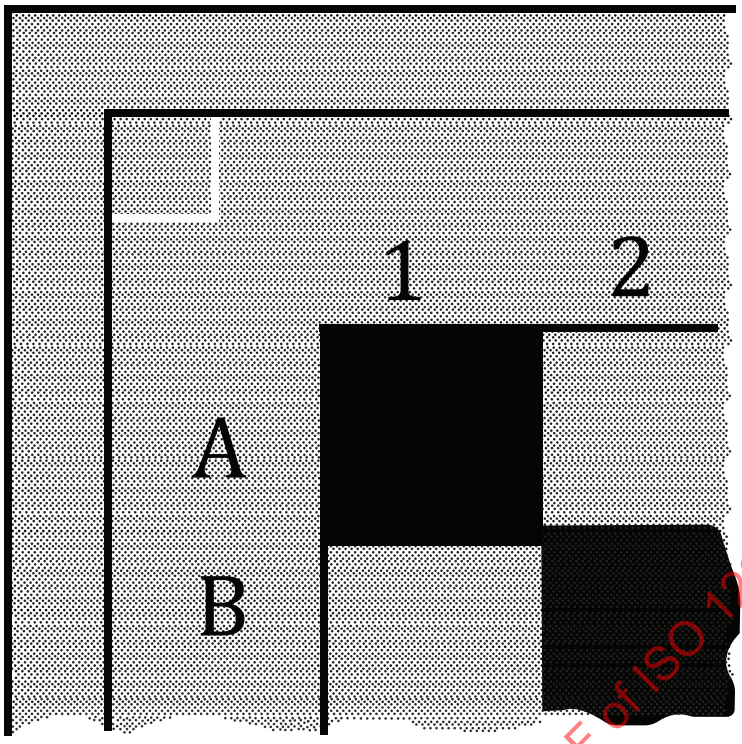


Figure 3 — Fiducial mark design

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

a) a reference to this document, i.e. ISO 12641-1:2025;

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 document. Targets bearing the designation ISO 12641-1:2016 are still valid and prepared in accordance with a previous version of this document whose technical requirements are identical to this document.

4.3.1.2 Type 2, 35 mm film: The Type 2 layout of the colour transmission input calibration target, as viewed from the support side of the product, shall be as shown in Figure 4 (frames 35-1 through 35-7). This layout is intended for use on film material having a basic format of 35 mm. This layout may be provided either as a single strip of film or as seven mounted 35 mm transparencies.

The target shall be divided as follows:

Frame	35-1	The D_{min}, neutral scale, and D_{max} patches from the bottom of Type 1 target format
Frame	35-2	Columns 1 through 4 of the Type 1 target format
Frame	35-3	Columns 5 through 8 of the Type 1 target format
Frame	35-4	Columns 9 through 12 of the Type 1 target format
Frame	35-5	Columns 13 through 16 of the Type 1 target format
Frame	35-6	Columns 17 through 19 of the Type 1 target format

Frame 35-7 Columns 20 through 22 of the Type 1 target format

In addition, each frame shall have a six step neutral scale as column *N* with *L** values as follows:

Step 1 82(top)

Step 2 66

Step 3 50

Step 4 34

Step 5 18

Step 6 2

All non-image areas of the target shall be approximately neutral and shall have a lightness (*L**) of approximately 50.

Each frame of the target shall contain the following information in English text:

a) a reference to this document, i.e. ISO 12641-1:2025;

b) a frame number of the form 35-X;

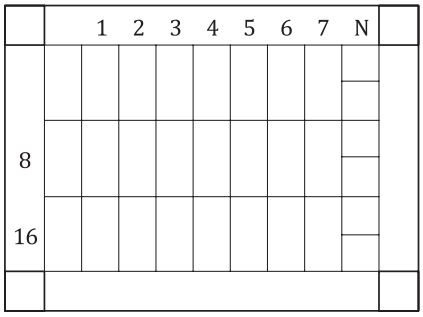
c) the name of the film product or product family;

d) the year and month of production of the target in the form yyyy:mm.

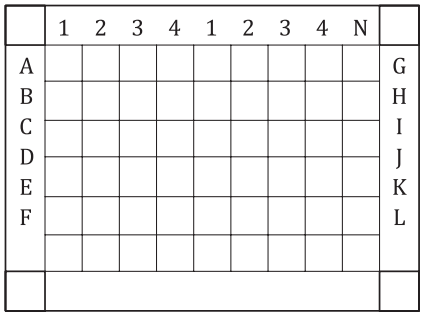
NOTE Targets bearing the designation IT8.7/1-1993 are prepared in accordance with ANSI IT8.7/1-1993 whose technical requirements are identical to those of this document.

If provided as individually mounted transparencies, this same information shall be repeated on the mount.

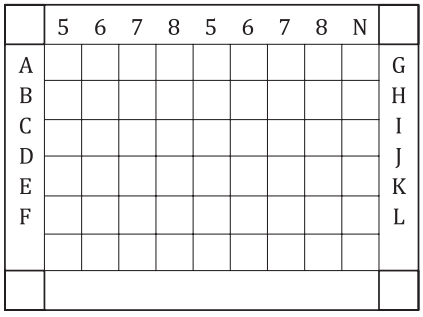
The frame numbering and reference lines shall be high in density and as shown in Figure 5.



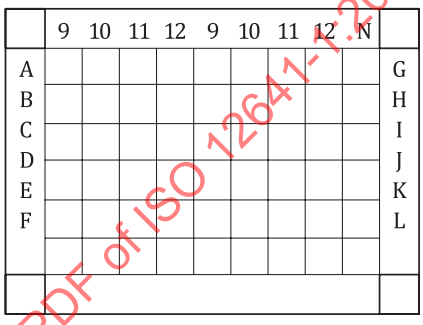
a) Frame 35-1



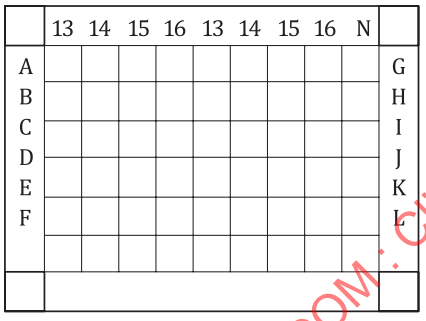
b) Frame 35-2



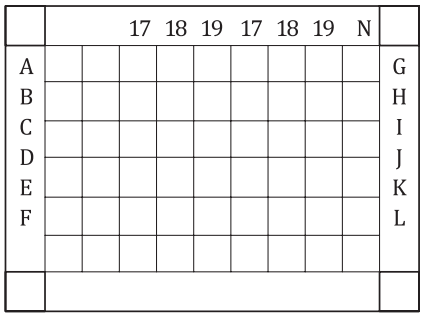
c) Frame 35-3



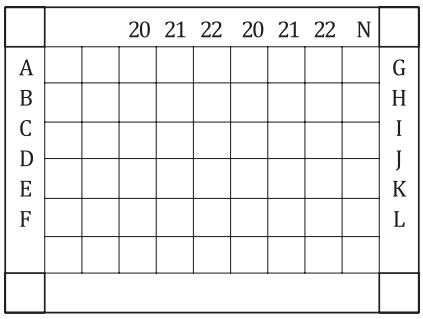
d) Frame 35-4



e) Frame 35-5



f) Frame 35-6



g) Frame 35-7

Figure 4 — Layout, Type 2 colour transmission target

Figure 5 — Type 2 target, row and column numbering

Divider lines shall be included in Frame 35-1 between D_{min} and step 1 of the neutral scale, and step 22 of the neutral scale and D_{max}.

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

4.3.1.3 Type 3, 35 mm film version of Type 1 target (optional): A 35 mm version of the Type 1 target may be provided at the discretion of the film vendor. If provided, it shall contain labelling information to ensure that scanned data from the 35 mm version of the target cannot be confused with scanned data from the full size version of the target. This target shall be a reduced size version of the Type 1 target, but shall not be required to meet the colorimetric requirements of this specification. Colours achieved will be the best efforts of the manufacturer.

NOTE See Annex B for recommendations on use of this format of the test target.

4.3.2 Patch size

The transmission targets shall be made with patch dimensions as follows:

— Type 1: 4,5 mm × 4,5 mm;

— Type 2: 3,2 mm × 3,2 mm.

The Dmin area, the 22-step neutral scale, and the Dmax area shall be two patches high.

4.3.3 Colour gamut mapping

The hue angle, lightness, and chroma of the target patches contained in the sampled colour area portion of the target, Rows A through L and Columns 1 through 12, shall be in accordance with Table 1 under the measurement conditions of 4.6.

Where a product is not capable of achieving specific chroma values indicated in this specification, the patch corresponding to that value shall be exposed as a background neutral as defined in 4.3.1.1. In all cases, patches in columns 4, 8, and 12, as shown in Table 1, shall be included.

4.3.4 Neutral and dye scale values

The specific values of patches A13 through L19 shall be defined by the manufacturer of the film used to create a specific target. The batch mean (for uncalibrated targets) or measured CIE X Y Z and CIE metric lightness, *metric chroma,* metric hue angle *(L^* C^*_{ab} h_{ab})* values (for calibrated targets) of these patches shall be reported by the manufacturer in accordance with 4.7.

The criteria by which the aim values for these patches shall be determined (under the measurement conditions of 4.5) are as follows:

Patch A16 shall be the minimum neutral density ($C^*_{ab} = 0$) that the product can normally achieve.

Patch L16 shall be the maximum neutral density ($C^*_{ab} = 0$) that the product can normally achieve.

Patch B16 through K16 shall be equally spaced in L^* between the L^* values of patches A16 and L16.

Patches A13 through L13 shall contain the same amounts of cyan dye as used to create the neutral patches of A16 through L16.

Patches A14 through L14 shall contain the same amounts of magenta dye as used to create the neutral patches of A16 through L16.

Patches A15 through L15 shall contain the same amounts of yellow dye as used to create the neutral patches of A16 through L16.

Patches A17 through L17 shall contain the same amounts of magenta and yellow dye (will appear red) as used to create the neutral patches of A16 through L16.

Patches A18 through L18 shall contain the same amounts of cyan and yellow dye (will appear green) as used to create the neutral patches of A16 through L16.

Patches A19 through L19 shall contain the same amounts of cyan and magenta dye (will appear blue) as used to create the neutral patches of A16 through L16.

NOTE It is recognized that it will be difficult to achieve these aim dye amounts, particularly in patches of high density, because of overlapping spectral sensitivities. Manufacturers are expected to achieve these goals to the extent possible.

Table 1 — Metric hue angle, lightness and chroma for transmission target

Row	Hue angle	L1	C1	C2	C3	C4	L2	C1	C2	C3	C4	L3	C1	C2	C3	C4
A	16	15	10	21	31	(1)	35	15	30	44	(1)	60	8	16	24	(1)
B	41	20	11	23	34	(1)	40	17	34	51	(1)	65	7	15	22	(1)
C	67	30	11	22	34	(1)	55	20	40	60	(1)	70	9	17	26	(1)
D	92	25	9	18	27	(1)	50	17	35	52	(1)	75	23	46	69	(1)
E	119	30	11	22	33	(1)	60	20	39	59	(1)	75	12	25	37	(1)
F	161	25	10	21	31	(1)	45	17	35	52	(1)	65	12	25	37	(1)
G	190	20	7	14	21	(1)	45	14	29	43	(1)	65	11	23	34	(1)
H	229	20	7	15	22	(1)	40	13	25	48	(1)	65	7	15	22	(1)
I	274	25	14	27	41	(1)	45	10	21	31	(1)	65	6	12	17	(1)
J	299	10	17	34	51	(1)	35	13	27	14	(1)	60	7	14	21	(1)
K	325	15	10	26	39	(1)	30	17	35	52	(1)	55	12	23	35	(1)
L	350	15	10	21	31	(1)	30	16	33	49	(1)	55	10	21	31	(1)
	Column		1	2	3	4		5	6	7	8		9	10	11	12

(1) These values are specific to the product used to create the target and equal to maximum C^*_{ab} available at the hue angle and L^* specified. They are to be defined by the manufacturer of the product used to make the target.

4.3.5 Neutral scale mapping

The neutral scale lying along the bottom of the target shall have the following L^* aim values, based on the measurement conditions of 4.6, reading from left to right across the target. C^*_{ab} aim values shall be 0.

Step 1	82	Step 2	78
Step 3	74	Step 4	70
Step 5	66	Step 6	62
Step 7	58	Step 8	54
Step 9	50	Step 10	46
Step 11	42	Step 12	38
Step 13	34	Step 14	30
Step 15	26	Step 16	22
Step 17	18	Step 18	14
Step 19	10	Step 20	6
Step 21	4	Step 22	2

The patch located to the left of Step 1 of the grey scale (column 0) shall be at the D_{min} of the product. The patch to the right of Step 22 (column 23) of the grey scale shall be at product D_{max}.

4.4 Reflection targets

4.4.1 Target layout and physical characteristics

The layout of the colour reflection input calibration target shall be as shown in Figure 6. This layout shall be used on material having a basic format of 5 in × 7 in (12,7 cm × 17,8 cm) in accordance with ISO 1008.

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.

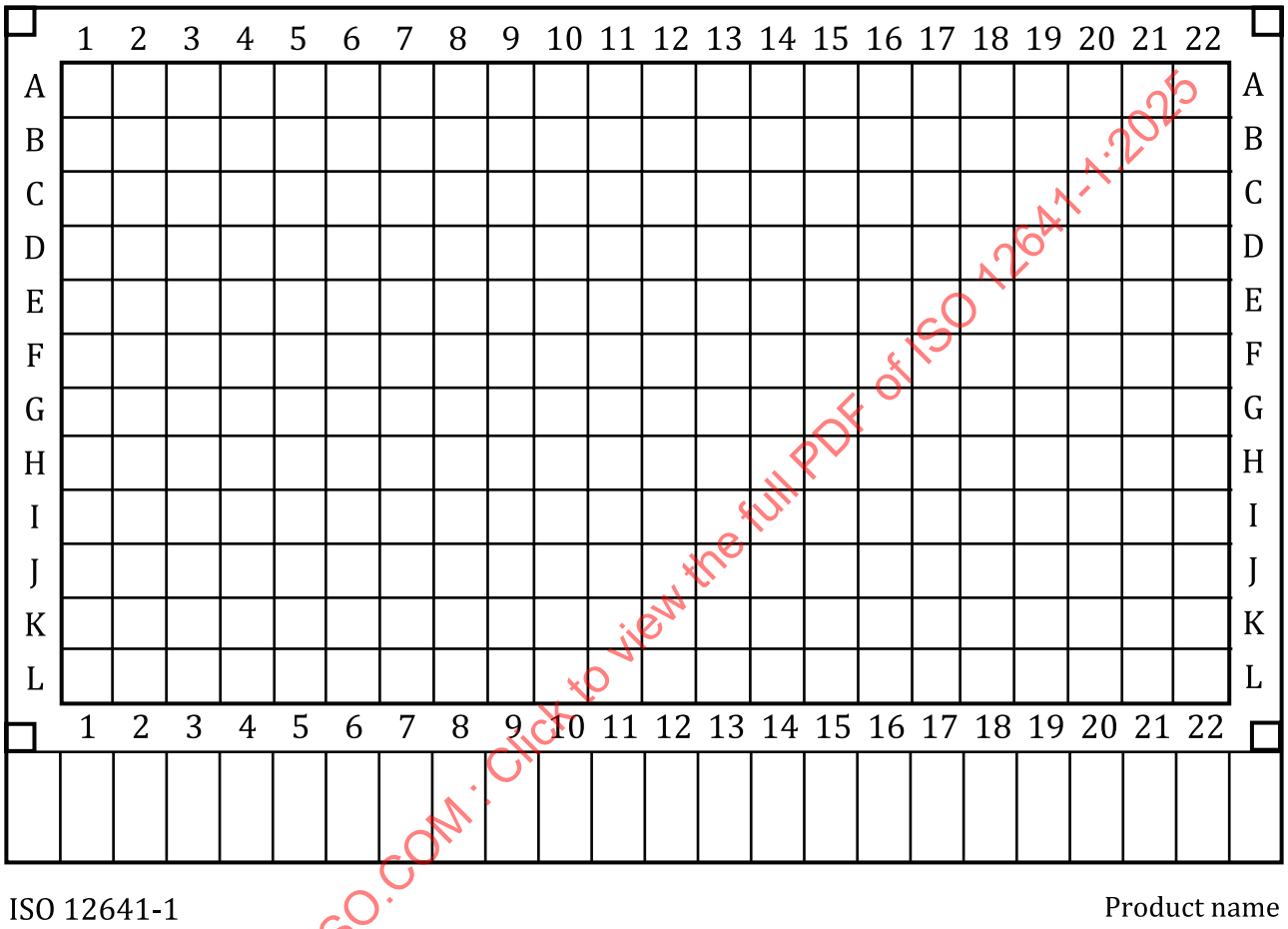


Figure 6 — Layout, colour reflection target

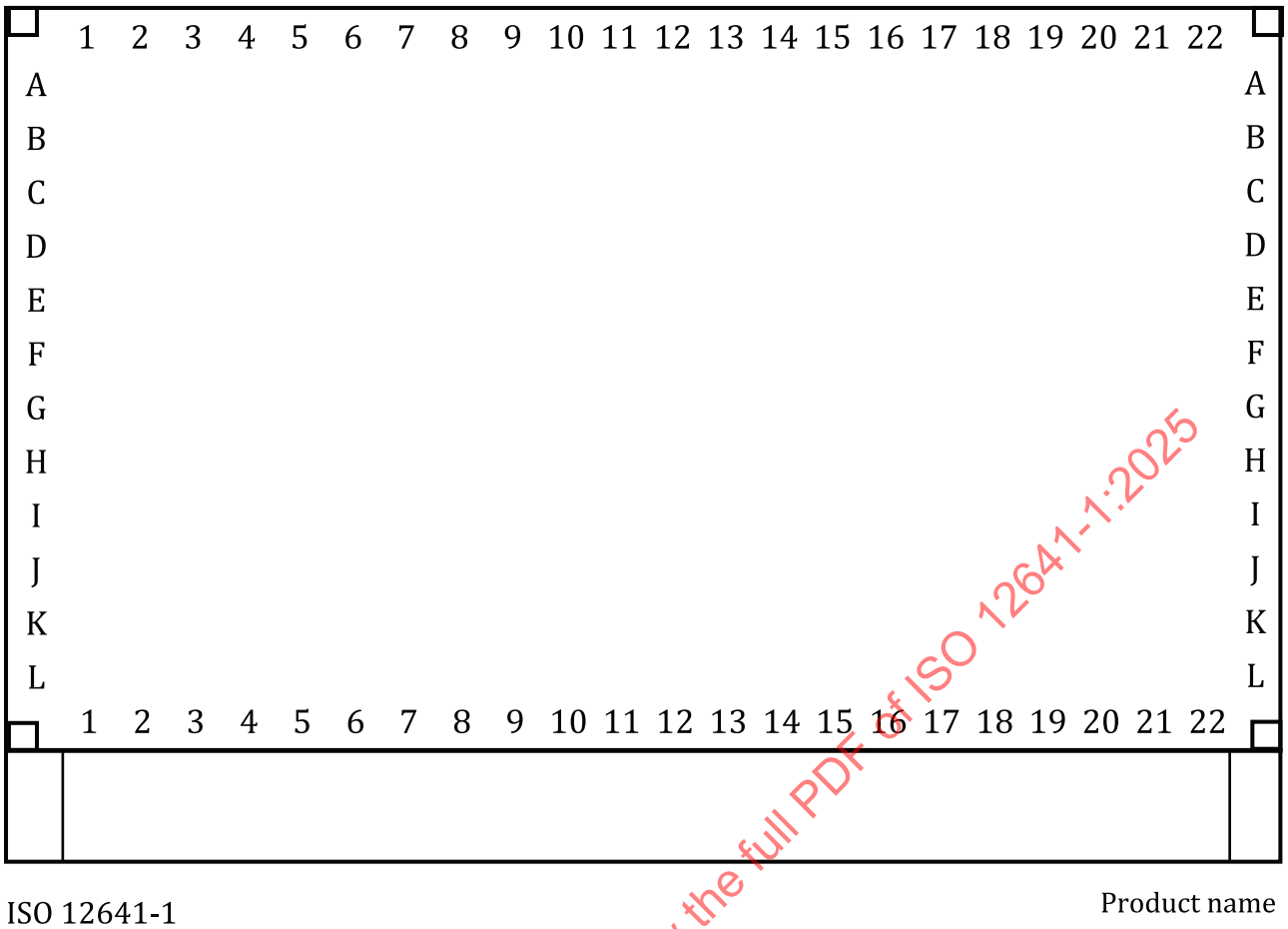


Figure 7 — Reflection target, row and column numbering

Target row and column numbering shall be of high density and as shown in Figure 7. 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 D_{min} area from the first step and the D_{max} 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 background.

Fiducial marks shall be included in each corner of the main body of the target as shown in Figure 8. These shall be arranged such that they "point" toward the inside or centre of the target.

Because target patches are 6,5 mm × 6,5 mm in size (see 4.4.2) the intersection of the lines of the fiducial marks shall be offset 6,5 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 white lines on the neutral background and shall be approximately 0,1 mm in width.

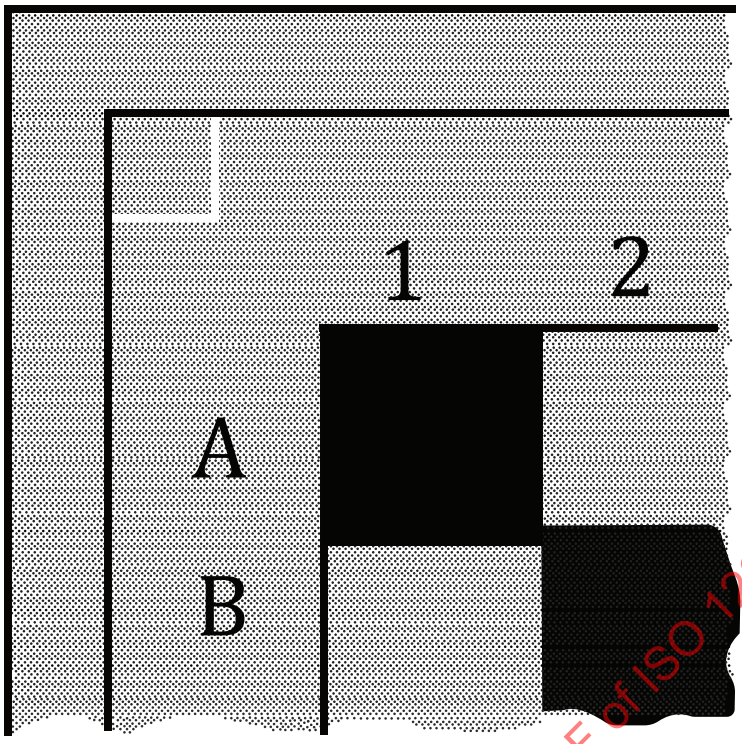


Figure 8 — Fiducial mark design

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

a) a reference to this document, i.e. IS0 12641-1:2025;

b) the name of the paper 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 IT8.7/2-1993 are prepared in accordance with ANSI IT8.7/2-1993 whose technical requirements are identical to those of this document.

4.4.2 Patch size

The reflection target shall be made with patch dimensions of 6,5 mm × 6,5 mm.

The D_{min} area, the 22-step neutral scale, and the D_{max} area shall be two patches high.

4.4.3 Colour gamut mapping

The hue angle, lightness, and chroma of the target patches contained in the sampled colour area portion of the target, Rows A through L and Columns 1 through 12, shall be in accordance with Table 2 under the measurement conditions of 4.6.

Where a product is not capable of achieving specific chroma values indicated in this specification, the patch corresponding to that value shall be exposed as a background neutral as defined in 4.4.1. In all cases, patches in columns 4, 8, and 12 as shown in Table 2, shall be included.

4.4.4 Neutral and dye scale values

The specific values of target patches A13 through L19 shall be defined by the manufacturer of the paper used to create a specific target. The batch mean (for uncalibrated targets) or measured CIE X Y Z and CIE *L**

a^* b^* values (for calibrated targets) of these patches shall be reported by the manufacturer in accordance with 4.6.

The criteria by which the aim values for these patches shall be determined (under the measurement conditions of 4.6) shall be as follows:

Patch A16 shall be the minimum neutral density ($C^*_{ab} = 0$) that the product can normally achieve.

Patch L16 shall be the maximum neutral density ($C^*_{ab} = 0$) that the product can normally achieve.

Patches B16 through K16 shall be equally spaced in L^* between the L^* values of patches A16 and L16.

Patches A13 through L13 shall contain the same amounts of cyan dye as used to create the neutral patches of A16 through L16.

Patches A14 through L14 shall contain the same amounts of magenta dye as used to create the neutral patches of A16 through L16.

Patches A15 through L15 shall contain the same amounts of yellow dye as used to create the neutral patches of A16 through L16.

Patches A17 through L17 shall contain the same amounts of magenta and yellow dye (will appear red) as used to create the neutral patches of A16 through L16.

Patches A18 through L18 shall contain the same amounts of cyan and yellow dye (will appear green) as used to create the neutral patches of A16 through L16.

Patches A19 through L19 shall contain the same amounts of cyan and magenta dye (will appear blue) as used to create the neutral patches of A16 through L16.

NOTE It is recognized that it will be difficult to achieve these aim dye amounts, particularly in patches of high density, because of overlapping spectral sensitivities. Manufacturers are expected to achieve these goals to the extent possible.

Table 2 — Metric hue angle, lightness and chroma for reflection target

Row	Hue angle	L1	C1	C2	C3	C4	L2	C1	C2	C3	C4	L3	C1	C2	C3	C4
A	16	20	12	25	37	(1)	40	15	30	44	(1)	70	7	14	21	(1)
B	41	20	12	24	35	(1)	40	20	36	54	(1)	70	8	16	24	(1)
C	67	25	11	21	32	(1)	55	22	44	66	(1)	75	10	20	30	(1)
D	92	25	10	19	29	(1)	60	20	40	60	(1)	80	10	21	31	(1)
E	119	25	11	21	32	(1)	45	16	32	48	(1)	70	9	18	27	(1)
F	161	15	9	19	28	(1)	35	14	28	42	(1)	70	6	12	18	(1)
G	190	20	10	20	30	(1)	40	13	25	38	(1)	70	6	13	19	(1)
H	229	20	9	18	27	(1)	40	12	24	36	(1)	70	7	13	20	(1)
I	274	25	12	24	35	(1)	45	9	19	28	(1)	70	5	10	15	(1)
J	299	15	15	29	44	(1)	40	11	22	33	(1)	70	6	11	17	(1)
K	325	25	16	33	49	(1)	45	14	28	42	(1)	70	8	16	24	(1)
L	350	20	13	26	38	(1)	40	16	32	48	(1)	70	8	15	22	(1)
	Column		1	2	3	4		5	6	7	8		9	10	11	12

(1) These values are specific to the product used to create the target and equal to maximum C^*_{ab} available at the hue angle and L^* specified. They are to be defined by the manufacturer of the product used to make the target.

4.4.5 Neutral scale mapping

The neutral scale lying along the bottom of the target shall have the following L^* aim values, based on the measurement conditions of 4.6, reading from left to right across the target. C^*_{ab} aim values shall be 0.

Step 1	87	Step 2	83
Step 3	79	Step 4	75
Step 5	71	Step 6	67
Step 7	63	Step 8	59
Step 9	55	Step 10	51
Step 11	47	Step 12	43
Step 13	39	Step 14	35
Step 15	31	Step 16	27
Step 17	23	Step 18	19
Step 19	15	Step 20	11
Step 21	9	Step 22	7

The patch located to the left of step one of the grey scale (column 0) shall be at the D_{min} of the product. The patch to the right of step 22 (column 23) of the grey scale shall be at product D_{max}.

4.5 Allowable tolerances on patch values

4.5.1 Uncalibrated targets

4.5.1.1 For all targets manufactured: For the patches contained within A1 through L3, A5 through L7, and A9 through L11, 99 % shall be within 10 ΔE^*_{ab} of the aim values specified in Table 1 or Table 2 as appropriate.

4.5.1.2 For each manufacturing batch: 99 % of the patches within the manufacturing batch shall be within 5 ΔE^*_{ab} of the reference as follows:

— the references for patches A1 through L19, D_{min} and D_{max} shall be the reported batch mean;

— for the 22-step neutral scale the reference shall be the values specified in 4.3.5 or 4.4.5 as appropriate.

Although the user is most concerned with the statistics of the patches on a particular target, the manufacturer of targets should apply statistics to the individual patches within a manufacturing run. These statistics apply to individual patches within the run and not to patches on a particular target. The above requirements, therefore, should not be interpreted that 99 % of the patches on each target are within the tolerances specified in this document. Details of quality control statistical procedures used may be requested from the manufacturer of targets.

4.5.2 Calibrated targets

Calibrated targets are uncalibrated targets which have been measured. The measured values for each patch shall be provided together with a certificate as to the degree of conformance of the measuring laboratory to an accredited measurement assurance program (MAP) sponsored by a recognized national standardizing laboratory. The goal is that all measurements will be accurate within $\Delta E_{00} \leq 1$.

4.6 Spectral measurement and colorimetric calculation

Measurement of the target shall be carried out in accordance with ISO 13655.

4.7 Data reporting

For all targets, the batch-specific mean and standard deviation colorimetric data for each patch shall be available from the originator of targets manufactured in accordance with this document. Mean and standard deviation values shall be provided as *X*, *Y*, *Z* tristimulus values. Mean values shall also be provided as L^*, a^*, b^* and 95th percentile in units of CIEDE2000, ΔE_{00}. All values shall be provided to two decimal places.

When calibrated targets are offered, the measured colorimetric data for all target patches shall be provided. These data shall be reported as *X*, *Y*, *Z* tristimulus values, to two decimal places. Measurements shall be in accordance with 4.6.

The data shall be available digitally in the data format specified in 4.8. Other data may be provided as optional information (e.g. CIELAB, other illuminants, etc.).

4.8 Data file format

4.8.1 File format

The file format shall be an ASCII format keyword value file. The first 7 characters in the file shall be: ISO 12641.

Fields within the file shall be separated by white space. Valid white space characters are space (position 2/0 of ISO/IEC 646), carriage return (position 0/13 of ISO/IEC 646), newline (position 0/10 of ISO/IEC 646), and tab (position 0/9 of ISO/IEC 646). Keywords may be separated from values using any valid white space character. Only the space or tab shall precede a keyword on a line. Comments shall be preceded by a single comment character (a single character keyword). The comment character is the "#" (position 2/3 of ISO/IEC 646) symbol. Comments may begin any place on a line, and shall be terminated by a newline, or carriage return. Keywords and data format identifiers are case sensitive and shall be upper case.

4.8.2 Keyword syntax and usage

The specific syntax and usage information for each keyword follows.

All files shall contain the required keywords given in Table 3.

Table 3 — Required keywords

ORIGINATOR	Identifies the specific organization or system that created the data file
DESCRIPTOR	Describes the purpose or contents of the data file
CREATED	Date of creation of data file
MANUFACTURER	Identifies the manufacturer of the input scanner calibration target
PROD_DATE	Identifies year and month of production of the target in the form yyyy:mm
SERIAL	Serial number of individual target
MATERIAL	Identifies material used in creating input scanner calibration target
NUMBER_OF_FIELDS	Number of fields (data format identifiers) that are included in the data format definition that follows
BEGIN_DATA_FORMAT	Begins definition of field position/interpretation of a data set
END_DATA_FORMAT	Ends data format definition
NUMBER_OF_SETS	Number of repeats or sets of data corresponding to the data format fields that are included in the data to follow
BEGIN_DATA	Marks the beginning of the stream of data sets
END_DATA	Marks the end of the stream of data sets

Additionally defined, but not required, keywords are given in Table 4.

Table 4 — Additional keywords

#	Single character indicating comment follows
KEYWORD	Used to define vendor specific keywords
INSTRUMENTATION	Used to report the specific instrumentation used (manufacturer and model number) to generate the data reported
MEASUREMENT_SOURCE	Identifies the illumination used for spectral measurements
ILLUMINANT	Defines the illuminant used when calculating tristimulus values
OBSERVER	Defines whether 2” or 10” observer has been used in the calculation of tristimulus values
FILTER_STATUS	Defines spectral response of the instrument used for densitometry

Unless otherwise noted, each keyword has a character string value associated with it. All character string values shall be enclosed in quotes (position 2/2 of ISO/IEC 646) regardless of whether or not there is white space contained within the string. Enclosed in quotes means beginning and ending the character string with the ” symbol. The ” symbol itself shall be represented within a string as “”.

Comments shall be preceded by the comment character (#), and shall end with a new line, or carriage return. Comments need not be enclosed in ” symbols.

The value associated with keywords NUMBER_OF_FIELDS and NUMBER_OF_SETS shall be an integer.

The BEGIN_, END_ keywords do not have explicit values associated with them but enclose either the data format definition or associated data streams.

4.8.3 Data format identifiers

The data format (enclosed by BEGIN_DATA_FORMAT and END_DATA_FORMAT) describes the meaning of each field of data within a set. Data formats shall be composed of identifiers listed below or defined keywords. Unknown entries in the data format definition shall be read, but may be ignored by automated readers. Data format identifiers shall be uppercase. The data type associated with each data format shall be assumed to be real (may contain a decimal point) unless separately defined as integer (I) or character string (CS). Character string data shall be enclosed in quotes except in the case of SAMPLE — ID where the quotes are not required if the sample identifier does not contain white space.

Each set of data (data repeat) shall end with a line terminator character (newline or carriage return).

The data format identifiers are given in Table 5.

Table 5 — Data format identifiers

SAMPLE_ID (CS)	Identifies sample which data represents
STRING (CS)	Identifies label, or other non-machine readable value; value shall begin and end with a ” symbol
D_RED	Red filter density
D_GREEN	Green filter density
D_BLUE	Blue filter density
D_VIS	Visual filter density
RGB_R	Red component of *RGB* data
RGB_G	Green component of *RGB* data
RGB_B	Blue component of *RGB* data
SPECTRAL_NM	Wavelength of measurement expressed in nanometres
SPECTRAL_PCT	Percentage reflectance/transmittance at the wavelength specified in
SPECTRAL_NMXYZ_X	*X* component of tristimulus data
XYZ_Y	*Y* component of tristimulus data

Table 5 *(continued)*

XYZ_Z	*Z* component of tristimulus data
XYY_X	*x* component of chromaticity data
XYY_Y	*y* component of chromaticity data
XYY_CAPY	*Y* component of tristimulus data
LAB_L	*L** component of CIELAB data
LAB_A	*a** component of CIELAB data
LAB_B	*b** component of CIELAB data
LAB_C	C^*_{ab} component of CIELAB data
LAB_H	h_{ab} component of CIELAB data
LAB_DE	CIEDE2000, ΔE_{00}
STDEV_X	Standard deviation of *X* (tristimulus data)
STDEV_Y	Standard deviation of *Y* (tristimulus data)
STDEV_Z	Standard deviation of *Z* (tristimulus data)
STDEV_L	Standard deviation of *L**
STDEV_A	Standard deviation of *a**
STDEV_B	Standard deviation of *b**
PERCNT_DE	95th percentile of CIEDE2000 ΔE_{00}

Although not required, it is strongly recommended that data format identifiers be placed on a single line. However, the maximum line length shall not exceed 240 characters. In addition, the data associated with a data format should use the same location(s) for carriage return and/or line feeds to enhance human readability.

4.9 Useable target life

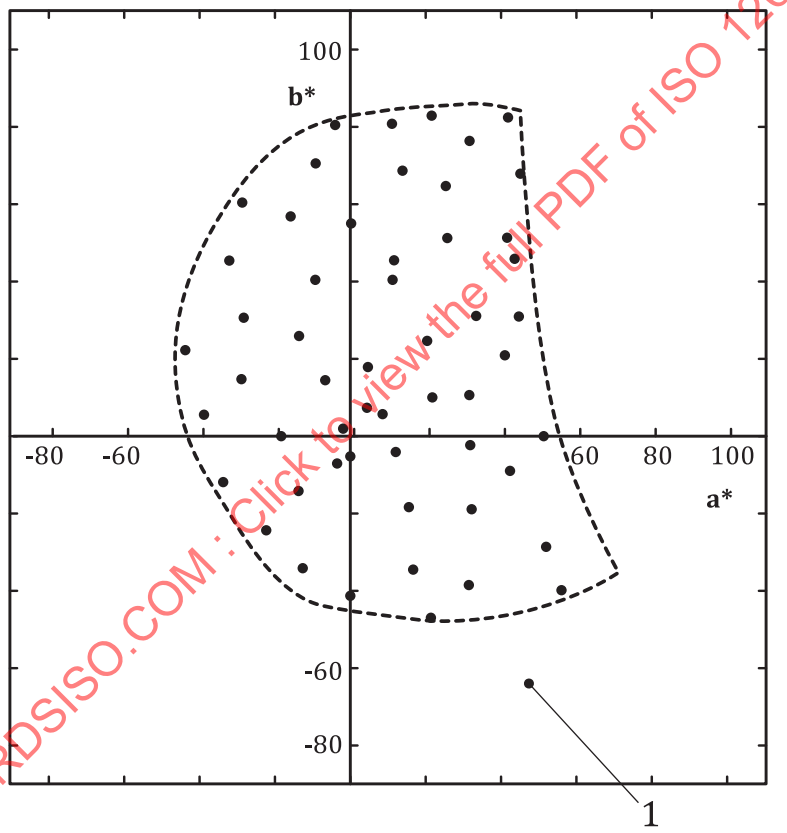
The useable life of a target is a function of its exposure to light and the storage conditions used. Each manufacturer shall provide the monitoring procedure to be used for each target type as part of the documentation of the target.

Annex A
(informative)

Gamut mapping — Computational reference

A.1 General

When cyan, magenta, and yellow dyes are mixed, the mixture results in a specific colour and the tristimulus values can be determined by the usual CIE procedure. The mixture colour can then be plotted as one point in colour space. If mixtures with different mixing amounts are successively produced, the tristimulus values will be contained within a finite range, called a colour gamut. The tristimulus values representing the boundary of the colour gamut may be determined by producing and measuring a large number of dye mixtures. Figure A.1 shows a cross-section of such a colour gamut.



Key
1 arbitrary L*

Figure A.1 — Colour gamut

Using the above procedure for calculating colour gamuts is rather cumbersome and not very precise. Instead, a computer algorithm, used to trace the outer boundary of colour gamut by successive colour matching, has been developed and used by the companies who participated in the development of this document. This allows the colour gamut to be computed directly. In an attempt to space target colours as a function of visual response, the CIELAB colour space was chosen to be used for target colour selection. In addition, the 12 hue angles previously used in the Kodak Q60TM target were chosen for use in these targets. It should be noted that the colour gamut obtainable by the three dyes depends upon their spectral absorption bands. The three dyes currently used in colour photography are different from one manufacturer to another, and