INTERNATIONAL STANDARD

ISO 12647-5

Second edition
2015-01-15

Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints —

Part 5: Screen printing

Technologie graphique — Contrôle du processus de confection de sélections couleurs tramées, d'épreuves et de tirages —

Partie 5: Sérigraphie

Reference number
ISO 12647-5:2015(E)

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Published in Switzerland

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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 second edition cancels and replaces the first edition (ISO 12647-5:2001), which has been technically revised.

ISO 12647 consists of the following parts, under the general title *Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints*:

— *Part 1: Parameters and measurement methods*

— *Part 2: Offset lithographic processes*

— *Part 3: Coldset offset lithography on newsprint*

— *Part 4: Publication gravure printing*

— *Part 5: Screen printing*

— *Part 6: Flexographic printing*

— *Part 7: Proofing processes working directly from digital data*

— *Part 8: Validation print processes working directly from digital data*

Introduction

Historically, this International Standard established the process control parameters and their aim values and tolerances for the most important professional printing processes of the graphic arts industry. The initial concept was that the groundwork for the series was laid down in ISO 12647-1. This part of the ISO 12647- series differs from that concept because screen printing has changed significantly since this International Standard was initially conceived.

This edition of this part of ISO 12647 differs from the earlier edition by not defining specific printing condition aims but instead requiring that a specific reference printing condition (characterization data set) be specified. This part of ISO 12647 requires that the colour of the printed product match a characterization data set or a printing condition agreed upon by the provider and the receiver and specifies minimum requirements and tolerances to be communicated and produced. Where specific physical parameters can impact the final result (screen angles, resolution, screen mesh, etc.), specifications and tolerances are provided for these parameters.

Because material produced by screen printing varies widely in both size and nominal viewing distance, a viewing distance metric is introduced as part of all screening and resolution requirements.

Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints —

Part 5: Screen printing

1 Scope

This part of ISO 12647 specifies the requirements for the screen printing of four-colour process-colour material used for display, signage, and graphics using flat bed or cylinder printing equipment. Both the size and resolution of the finished product are unrestricted. The process stages included are

— data preparation and delivery,

— proof production,

— printing forme preparation, and

— production printing.

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 12639, *Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT)*

ISO 12647-1, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods*

ISO 12647-7, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 7: Proofing processes working directly from digital data*

ISO 12647-8, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 8: Validation print processes working directly from digital data*

ISO 13655:2009, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 15930-1, *Graphic technology — Prepress digital data exchange — Use of PDF — Part 1: Complete exchange using CMYK data (PDF/X-1 and PDF/X-1a)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12647-1 apply.

4 Requirements

4.1 Data requirements for screen printing systems

4.1.1 Data delivery

Screen print systems shall accept digital data delivered as PDF/X data files as defined in ISO 15930-1 or TIFF/IT files as defined in ISO 12639.

The intended printing condition shall be either

1) a published Characterized Reference Printing Condition (CRPC) as listed in the ICC registry at www.color.org, or

2) a custom data set where none of the available reference colour characterization data sets are considered appropriate for the intended printing because of the inks, paper, or other factors.

Where the characterization data to be used have a substrate colour (CIELAB values) that does not match the substrate to be used, the data should be adjusted using the tristimulus correction method defined in Annex B.

Prior agreement as to the characterization data and substrate adjustment to be used shall be obtained between all parties involved before copy preparation work is started.

Characterization data sets are the only method recognized by this part of ISO 12647 for the proper identification of the printing condition to be used. Film and/or directly exposed screens shall be generated from digital data and legacy film should be assumed to have been prepared to some agreed upon reference characterization.

4.1.2 Data resolution

Input data should be provided at a data spacing of twice the screen ruling to be used as determined by the scaling criteria, e.g.: 140 cm^{-1} pixels for a 70 cm^{-1} screen ruling.

4.2 Printing forme requirements

4.2.1 Resolution

Printed material produced by screen printing varies widely in both size and nominal viewing distance. For screen printing the reference acceptable image quality criteria shall be based on a 70 cm^{-1} screen ruling viewed at a distance of 42 cm (175 lpi at 16,5 inches). This relationship of distance and screen ruling defines when rosettes are no longer visible to a viewer with 20/20 vision (dot fusion).

This relationship should be scaled for other viewing distances or other screen rulings. For the same viewing quality at different distances, maintain the relationship of resolution to distance.

NOTE For a convenient approximation, divide either the desired distance in meters or the desired resolution in dots per centimetre into 30 to compute the other for that specific pair. This is sometimes referred to as the rule of 30.

The target resolution shall be based on an agreement between the printer and their customer. It should be in accordance with the following three criteria:

1) a minimum screen ruling with dots large enough to reproduce a tonal range from 1 % to 98 % using the mesh as configured, the imaging technique, the emulsion and the ink;

2) a minimum printed dot size that is not less than 1,5x the width of the thread diameter of the mesh;

3) a maximum screen ruling as recommended by the “rule of 30” for the intended viewing condition.

4.2.2 Stencil production

The silver, thermal, or inkjet film used for imaging screens shall have sufficient UV density (>4,0) in printing areas and sufficient UV transparency (<0,1) in the non-printing areas to produce all dots required in 4.2.1. Direct to screen and computer to screen systems (CTS) shall have sufficient resolution be able to produce all dots required in 4.2.1.

NOTE Computer to screen systems (CTS) directly image the stencil and direct to screen systems (DTS) apply an image which is used to create the stencil.

4.2.3 Printing forme orientation

4.2.3.1 Printing forme preparation

The angle of the screen mesh attached to the screen frame shall be at 0° and 90° ± 1° with respect to the frame. The angles of the image shall also be 0° and 90° ± 1° with respect to the frame.

4.2.3.2 Screen angles

For half-tone dots without a principal axis, the nominal difference between the screen angles for cyan, magenta, and black shall be 30°, with the screen angle of yellow separated at 15° from another colour.

For half-tone dots with a principal axis, the nominal difference between screen angles for cyan, magenta, and black shall be 60°, with the screen angle of yellow separated by 15° from another colour.

In all cases, no colour should align within 7,5° of the mesh (frame). If flesh tones are present, the yellow should not be referenced to magenta.

NOTE 1 This is to prevent moiré in flesh tones and to ensure that no row of dots lines up with the mesh, which would destabilize the small dot structure. It is poor practice to use and rotate offset films to produce the forme.

NOTE 2 It is common practice to use frequency modulated screening for the yellow separation with approximately the same size as the dots in the 10 % area of the conventional separations and a different tonal compensation curve.

4.2.4 Image size tolerance

For film based systems, the set of supplied films under common environmental equilibrium shall not differ by more than 0,02 % in the lengths of their diagonals.

4.3 Print production requirements

4.3.1 Visual characteristics of image components

4.3.1.1 Visual appearance of the supplied proof

Supplied proofs shall be prepared in accordance with either ISO 12647-7 or ISO 12647-8 except where indicated below and shall use the same characterization data set chosen for production. The tristimulus correction factor shall be used to adjust for the substrate colour when the production stock is not available. Proofs shall have the proper colour but may have a different size than the intended product. Proof resolution may be finer than the intended product. In this case the rule of 30 shall be followed within the constraints of the proofing equipment assuming the proof to be viewed at 42 cm.

4.3.1.2 Print substrate colour

For the best colour reproduction, the print substrate colour should be restricted as shown in Table 1. All colour measurement shall be made in accordance with ISO 13655:2009, white backing, M1.

NOTE Surface finish, if applied, can severely affect the substrate colour.

Table 1 — Print substrate colour restrictions

$90 \leq L^* \leq 100$
$-3 \leq a^* \leq 3$
$-5 \leq b^* \leq 5$

4.3.1.3 Ink set colours

The screen printing production shall use process inks which best match the solid objective in the referenced characteristic data set.

NOTE If these inks are being used to produce the required reference characterization data set for screen print only applications, use Annex C for suggested values for the solids of different gamut classes. If these inks are being used to match an offset characterization data, it has been demonstrated that the same inks can comply with ISO 12647-2 goals.

4.3.1.4 Ink set gloss

If it is deemed necessary to specify the gloss of solid tone colours, then the specular gloss of the ink set single print solid areas should be measured and recorded at an agreed angle of incidence.

4.3.2 Tolerance for image positioning

The maximum deviation between the image centres of any two printed colours shall not be more than a distance equal to the pitch of the screen ruling used and should not be more than a distance equal to one-half of the pitch of the screen ruling used.

NOTE This tolerance includes any forme generation deviations.

4.3.3 Image reproduction

For the production print, the target colour coordinates of the solids and two colour overprints shall be as given in the selected characterization data set. The deviation from these targets values for an OK sheet or for the average of the production run shall be as specified in Table 2. The variability of the process colour solids throughout the run in production is restricted by the following condition. For at least 68 % of the prints, the colour differences from the OK sheet shall not exceed the appropriate variation tolerance specified in Table 2 and should not exceed one-half of that value. All colour measurement shall be made in accordance with ISO 13655:2009, white backing, M1.

NOTE 1 The secondary colours red, green, and blue are dependent on the print sequence and can vary depending on conditions that include the mechanics of the press, the surface characteristics of the substrate, and the rheological and transparency properties of the inks. Thus, conformance of the primaries to specifications is not sufficient for the conformance of the secondaries.

The production print should exhibit a predictable middle tone weight and colour balance (neutral grey) and should exhibit a predictable tone value transition and balance throughout the colour space.

NOTE 2 There are several methods to achieve this objective. See ISO/TS 10128:2009[2], 4.3, for an assessment of the three optional methods and an example of colour balance.

Table 2 — CIELAB ΔE_{ab} tolerances for the solids of the process colours[1]

Type of tolerance	Black		Cyan		Magenta		Yellow	
	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]
Deviation tolerance	4,0	2,8	5,0	3,5	6,0	4,2	6,0	4,2
Variation tolerance[a]	1,5	1,1	2,0	1,4	3,0	2,1	3,0	2,1

[a] The distribution of CIELAB colour differences is not Gaussian but skewed. For reasons of consistency, the variation tolerance is defined here as the upper limit for 68 % of the production copies. This is analogous to a Gaussian distribution where 68 % are within plus or minus one standard deviation of the mean.

[b] Tolerance values for DE2000 are given for information only.

[1] Measured in accordance with ISO 13655:2009, M1 with white backing.

5 Test method and reporting: Control strip

For process control a multi-colour control strip shall be used. This control strip shall be printed along with the subject on all proofs and should be printed on all production jobs. It shall contain well-defined control patches with accurate tone value designations and meet the quality and resolution requirements of the accompanying image. The screen print colour bar shall include Solid; C, M, Y, K patches; Tonal percentages of C, M, Y, K of 5 %, 10 %, 25 %, 50 %, 75 %, and 90 %; RGB overprints a white patch; and neutral grey C,M,Y patches for 10 %, 25 %, 50 %, 75 %, and 90 % (see Annex A).

The control patches on the stencil, together with the subject matter, should be inspected to ensure that the intended tone values have been achieved. In addition, for information purposes, or the checking of stencil and flooding problems, half-tone control patches may be printed along with the control strip that contain the same half-tone screen values as used in the image area of the print.

NOTE The effective measurement aperture diameters of the densitometers on the print need to be large enough to accommodate and include the required quantity of half-tone dots in each measurement as specified in the documentation of the densitometers' manufacturer. In addition, for measurement with apertures of less than 5 mm diameters the typical practice is to average five readings of every control patch.

For line screens 18 dots per centimeter or less it is recommended that an average of five or more readings in every control patch and the measurement should then be averaged.

Annex A
(informative)

Process control strip example

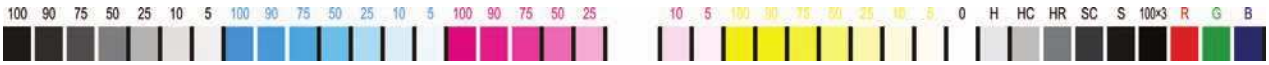

Figure A.1 — Example IDEAlliance Screen control strip

Annex B
(normative)

Correction of colorimetric data for variation in substrate colour

Although there are a number of computational techniques used or proposed for the correction of colorimetric data for variation in substrate colour, the consistent use of a single method enhances the ability of different users to achieve similar results.

One conversion method that produces reasonable results for half-tone type images is based on the observation that when the differences in CIE *X*, CIE *Y*, and CIE *Z* between measurements made of identical patches on two substrates having different colours are plotted versus the CIE *X*, CIE *Y*, and CIE *Z* respectively, for measurements on substrate 1 versus substrate 2, the result is approximately a straight line. This leads to a model for predicting the colour of a print on substrate 2 in the form of a linear conversion. Formulae (B.1) and (B.2) show the predictive conversion for CIE tristimulus *X* for predicting the colour change between substrate 1 and substrate 2.

NOTE 1 The approximate linear relationship fits best when the absorbance of the two substrates are similar.

For CIE *X:*

$$X_2 = X_1 \times \left(1 + C\right) - X_{\min} \times C \tag{B.1}$$

with

$$C = \frac{X_{s2} - X_{s1}}{X_{s1} - X_{\min}} \tag{B.2}$$

where

X_1 is the measured value of *X* of the specimen on substrate 1;

X_2 is the converted value of *X* of the specimen on substrate 2;

C is a constant;

X_{s1} is the measured value of *X* of substrate 1;

X_{s2} is the measured value of *X* of substrate 2;

$X_{\min}$ is the minimum value of *X* of the specimen on substrate 1.

NOTE 2 In practice, the *X*, *Y*, and *Z* values of the four-colour solid are often used as an approximation of the minimum values.

Conversion of CIE *Y* and CIE *Z* is accomplished in an analogous manner and new CIE *L**, *a**, and *b** CIELAB values are computed.

This colorimetric conversion method is referred to as the tristimulus correction method.

NOTE 3 This is similar to, but not necessarily identical to the International Color Consortium method referred to as substrate relative colorimetric transforms.

Annex C
(informative)

Solid patch aims for various gamut options

Table C.1 — CIELAB colour values for solid tones of the primary and secondary colours for screen printing

	Small gamut option			Medium gamut option[b]			Large gamut option		
	L*	***a****	***b****	***L****	***a****	***b****	***L****	***a****	***b****
Black (K)	24	0	0	18	0	0	8	0	0
Cyan (C)	59	−35	−43	52	−33	−51	46	−32	−54
Magenta (M)	51	70	−15	47	74	−5	42	79	10
Yellow (Y)	90	−11	66	89	−9	83	88	−7	100
Red[a] (M + Y)	50	59	42	47	67	50	44	66	47
Green[a] (C + Y)	55	−68	32	49	−65	30	43	−62	28
Blue[a] (C + M)	28	27	−41	21	26	−40	16	29	−39

[a] Colour sequence Yellow, Cyan, Magenta.

[b] According approximately to offset PC1.

Bibliography

[1] ISO 5-3:2009, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

[2] ISO/TS 10128:2009, *Graphic technology — Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data*

[3] ISO 12637-3:2009, *Graphic technology — Vocabulary — Part 3: Printing terms*

[4] ISO 12647-2, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 2: Offset lithographic processes*

ICS 37.100.01

Price based on 9 pages