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

Part 9:
Metal decoration printing processes using offset lithography

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 12647 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

ISO 12647-1 serves to provide definitions, general principles, the general order and materials to be covered in ISO 12647-2 to ISO 12647-9, the definition of the data, the measurement conditions, and the reporting style.

This part of ISO 12647 relates to the subject of offset printing on coated metallic substrates and establishes the printing requirements for the metal decoration market. This market includes metal boxes and cans in which the printing is performed directly onto the white coated surface of the metal prior to the formation of a container.

This part of ISO 12647 specifies aim values (or sets of aim values) and tolerances, for the primary parameters specified in ISO 12647-1 for digital proof printing. Primary parameters that define a printing condition include screening parameters (where applicable), the colours of the solids, the colour of the print substrate, colours of intermediate tint values and the tone curve. Adherence to these values essentially ensures that a grey which at the colour separation stage was composed for a specified printing condition also prints as a grey colour when both proofing and printing. Remaining deviations from grey due to differences in trapping can then be removed by adjusting the colouration within the tolerances provided. This part of ISO 12647 also specifies test methods for those properties of prints and their substrates that are considered relevant for stable and reliable metal deco reproduction.

Typically, the specified printing condition is defined through an International Color Consortium (ICC) profile or the associated characterisation data set, both of which relate the source data and the colorimetrically defined printed colour. Such data may be derived from printing conditions conforming to the pertinent process standard of the ISO 12647 series by industry trade groups or individuals.

Printing on metallic substrates poses some unique challenges. Sometimes, the metal surface is pre-coated with an opaque white and then the coloured inks are printed on top of the white coating. Other times the coloured inks are printed directly onto the metallic surface and the nature of the bare metal, shininess, texture or polishing marks may be observed and measured through the ink layer. Most metallic substrates are ETP (electrolytic tinplate), TFS (tin free steel) and aluminium, all coated with a white coating or pre-printed with a printing white ink before being printed with coloured inks. This document considers only the substrates, which are pre-coated with a white coating.

Historically, there has been no consistency in the way that either the characterisation data or the criteria and limits for a satisfactory match have been provided. This has led to significant redundancy and inconsistencies in the evaluation of proofing systems for different, but similar, applications, and a cost and time burden on the industry. This International Standard therefore attempts to provide guidance in this area by providing specifications and associated testing procedures.

Part 9 of this International Standard defines requirements for printing offset on metallic substrates that have been pre-coated with a white coating. Bare metallic substrates have not been included because of the complexity of the specular and surface reflection requirements. Also, the grey nature of the substrate means that it will always be restricted in gamut and difficult to manage. The industry does not print much process imagery on bare metal.

This document does not specifically consider the production of spot colours from a process printing approach. However, such colours can be generated from such an approach and the tolerances should be agreed between the buyer and the seller. Spot Colour management is defined in this document to utilize spectral data in an .xml schema defined by ISO 17972-1, Graphic technology — Colour data exchange format — Part 1: Relationship to CxF3 (CxF/X) and ISO 17972-4, Graphic technology — Colour data exchange format (CxF/X) — Part 4: Spot colour characterization data (CxF/X-4). ISO 17972-4 includes exchange specifications for spot colour characterization data to facilitate the communication of spot colour data.

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

Part 9:
Metal decoration printing processes using offset lithography

1 Scope

This part of ISO 12647 specifies requirements for systems that are used to produce offset prints for process colour reproduction on metallic substrates, which have been printed with a white coating. It is intended for flat printed sheet metal applications (it does not cover shaped or pre-formed metal such as pre-formed cans). Recommendations are provided with regard to appropriate test methods associated with these requirements.

This part of ISO 12647 differs from the method used to produce an offset print on paper or board in Part 2 in that it considers the colour values of a typical white coated metal substrate intended for metal decoration, using offset lithography and substrates that are independent of backing colour.

2 Normative references

The following referenced documents are indispensable for the application 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 12647-1:2013, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods*

ISO 12647-7:2016, *Graphic technology — Process control for the production of halftone colour separations, proof and production prints — Part 7: Proofing processes working directly from digital data*

ISO 13655:2017, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

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

ISO 17972-1:2018, *Graphic technology — Colour data exchange format — Part 1: Relationship to CxF3 (CxF/X)*

ISO 17972-4:2018, *Graphic technology — Colour data exchange format (CxF/X) — Part 4: Spot colour characterisation data (CxF/X-4)*

3 Terms and definitions

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

3.1
total print area
ratio of the area covered with ink to the entire area in an ink zone

3.2
characterization data
set of tone values and associated colorimetric values that fully describe a given printing process

3.3
metal decoration
printing on metals to produce a graphic image on the metal surface,

Note 1 to entry: The term does not exclude printing on metal for functional or promotional reasons

3.4
spot colour
non-process colour that is used in addition to, or in place of, a process colour and is normally applied with a single impression

Note 1 to entry: When associated with a corporate product identity, a spot colour is also known as brand colour.

4 Requirements

4.1 General

Digital data files delivered for printing should be accompanied by a digital proof print, a press proof print, or an OK print from a previous print run.

Note Press proof prints are test prints of the data files on a printing press which may serve as a reference for subsequent printing. While most proofs are digital proofs, for colour- or content-critical work there is a need for press proof prints with the same setup as the production print.

4.2 Data files and printing formes

4.2.1 Data delivery

Data delivered for printing shall be in the colour formats CMYK or three-component and should be exchanged using PDF/X data formats.

The intended printing condition shall be indicated. In case of PDF/X the mechanisms provided by the specified data format shall be used. In case of other data formats, a printing condition description, a characterization data set[3][4] or an International Colour Consortium (ICC) output profile[5] shall be communicated.

If the data are other than CMYK, the data shall be defined by colorimetric descriptions using an ICC profile or another mechanism and an ICC CMYK output profile shall be included. The rendering intent to be used for each data element shall be communicated.

If the characterization data or ICC output profile provided conflicts with the printing conditions defined in this part of ISO 12647 one of the methods defined in ISO/TS 10128 shall be used for data adjustment prior to print production. The aims for process control should be taken from characterization data, if agreed between all parties. Where this is done, densitometric tone values are not usually available and colorimetric tone values should be used. Further information on the relationship between colorimetric and densitometric tone values can be found in ISO/TS 10128.

Note 1 A printing condition is defined here as a print substrate description, a colorant description, a screening description, an ink set and a printing sequence.

Note 2 Quality control of the content of a print job prior to final production checks are recommended since PDF/X conformance does not necessarily ensure a suitable image resolution or other production dependent criteria.

Note 3 Additional spot colours are allowed but this part of ISO 12647 does not make provisions for tolerances.

4.2.2 Printing forme quality

The resolution of the plate setter should be selected to ensure that at least 150 tone value steps are reproduced.

EXAMPLE If, for a screen employing single half-tone cell modulation, the intended nominal screen ruling is 80 cm–1, the resolution of the plate setter should not be less than 1 000 cm–1. For a screen with super-cell technology, it is possible to set the resolution to a smaller value.

4.2.3 Screen frequency (periodic screens)

For four-colour work, the screen frequency (screen ruling) for periodic screens should be within the range from 48 cm^{-1} to 80 cm^{-1}; 69 cm^{-1} (175 lines per inch) is the most common plate frequency.

Note 1 The screen frequency is often varied slightly from one process colour to another in order to minimize moiré patterns. For example, there might be a difference of up to 6 % of the nominal screen frequency between the colours C, M, Y.

Note 2 For the black or yellow colour halftone, a screen frequency is sometimes used which is substantially finer than the nominal screen ruling of the remaining colours, for example, 84 cm^{-1} versus 60 cm^{-1}.

Note 3 Screen frequencies are often required or given in lpi (lines per inch). To convert between screens per cm and lines per inch a conversion factor of 2,54 should be used.

EXAMPLE The requirement 4.2.3 given in lpi will read as follows (rounded to commonly used integral numbers): for four-colour work, the screen frequency (screen ruling) for periodic screens should be within the range from 120 lpi to 200 lpi.

4.2.4 Dot size (non-periodic screens)

For four-colour work, the screen dot size for non-periodic screens shall be within the range 20 µm to 40 µm and should be within the range 20 µm to 30 µm.

Note Outside of the range 20 µm to 40 µm, the general principles specified in ISO 12647-1 remain valid but specific values might differ.

4.2.5 Screen angle (periodic screens)

For half-tone dots without a principal axis, the nominal difference between the screen angles for cyan, magenta and black should be 30°, with the screen angle of yellow separated at 15° from another colour. The screen angle of the dominant colour should be 45°.

For half-tone dots with a principal axis, the nominal difference between screen angles for cyan, magenta and black should be 60°, with the screen angle of yellow separated by 15° from another colour. The screen angle of the dominant colour should be 45° or 135°.

4.2.6 Dot shape and its relationship to tone value (periodic screens)

For periodic screens, circular, square or elliptical half-tone dot shapes should be used. For half-tone dots with elliptical dot shape, the first link-up should occur no lower than at 40 % tone value and the second linkup no higher than at 60 % tone value.

4.2.7 Tone Value Sum

Tests should be run to determine tone value sum, depending on the printing equipment, and drying, tone value sum can vary from 180- 300. This should be tested on production equipment.

Note Press problems might be encountered at high levels of tone value sum. There might be poor ink trapping, back transfer and set-off due to insufficient ink drying.

4.2.8 Grey reproduction and grey balance

The tone values of cyan, magenta and yellow that lead to a visually neutral grey should be calculated from the standard printing condition or actual printing condition or the associated profiles by the following formula describing the grey reproduction (L*, a*, b*) with respect to a given substrate colour (L*substrate, a*substrate, b* substrate) and solid CMY inks overprint (L^*_{cmy}) for each L* in the range from L* substrate to L^*_{cmy}:

$$a^* = a^*_{substrate} \times \left[\frac{1 - 0{,}85 \times \left(L^*_{substrate} - L^* \right)}{\left(L^*_{substrate} - L^*_{cmy} \right)} \right]$$

$$b^* = b^*_{substrate} \times \left[\frac{1 - 0{,}85 \times \left(L^*_{substrate} - L^* \right)}{\left(L^*_{substrate} - L^*_{cmy} \right)} \right]$$

Note 1 A single grey balance condition is usually not sufficient to ensure an achromatic colour for all print substrates and printing inks that can be used with a given printing process. Therefore, the grey balance has to be determined for each printing condition separately based on a well-defined grey reproduction. See Annex A for more details.

Note 2 The grey balance of a given printing process can be used for process calibration and process control as long as the tolerances for tone value increase and mid-tone spread as defined in Table 8 are not exceeded.

Note 3 The multiplying factor of 0,85 represents a visual adaptation of 85 % to the substrate white.

4.3 Proof or production print

4.3.1 General

A printing condition for sheet-fed offset printing shall be communicated by a print substrate description, a colorant description, a screening description and a printing sequence.

Standard printing conditions are shown in Table 1. For all printing conditions described in this part of ISO 12647 the printing sequence should be Black – Cyan – Magenta – Yellow.

Table 1 — Standard printing conditions for typical print substrates

Metal Printing condition (MPC)	Print substrate description (Table 2)	Metal Colorant description (MCD) (Table 3)	Screening description			
			Periodic screens		Non-periodic screens	
			TVI curve	Frequency (cm^{-1})	TVI curve	Spot size (µm)
MPC1	White coated metal	MCD1	A	60 to 80 150 – 200 (lpi)	B	20 - 40
MPC2 MPC3 MPC4	White coated metal	MCD2	C	60 TO 80 150 – 200 (lpi)	D	20 - 40

Standard printing conditions are usually characterized by collecting (smoothing and averaging where appropriate) colour measurement data from one or more printing presses that have been carefully set up to a given printing condition. Such a collection of measurement data along with associated metadata describing the characterized printing condition is known as a characterization data set. When such characterization data are used to describe one of the printing conditions defined by this part of ISO 12647 the print substrate, colorant, screening and printing sequence for the printing condition from which the characterization data was collected shall be clearly indicated.

Note 1 Colorimetric characterization data, as specified in ISO 12642-1 and ISO 12642-2, contain all the data to be specified in accordance with 4.3.2, 4.3.3, and 4.3.5.1 of this part of ISO 12647.

Note 2 A characterization data set or an ICC profile derived from it, is required when making proofs according to ISO 12647-7. In practice this means that characterization data sets provide a convenient means for the communication of standard printing conditions. Characterization data for standard printing conditions are available from research or trade associations[1].

Note 3 Work separated for periodic screens can be printed using non-periodic screens where there is a moiré problem on press. In some cases, moiré might introduce tone contouring artefacts and colour shift deficiencies in primary and secondary half-tones.

4.3.2 Visual characteristics of image components - Print substrate colour

The print substrate used for press proof prints should be identical to that of the production print. If this is not possible, the properties of the print substrate for press proof prints should be a close match to those of the production print in terms of colour, CIE Whiteness, gloss, type of surface (coated with white) and mass-per-area.

Evaluate the match of the press proof print substrate and the production print substrate using the attributes listed in Table 2. For digital proofing, the requirements defined in ISO 12647-7 apply.

Typical substrate characteristics are defined, for information only, in Table 2. In order to determine the closest matching printing condition for a given substrate type, compare the substrate to be used for printing with the parameters in these tables and select the closest matching reference print substrate. This procedure ensures an easy match of the associated colorant description and therefore the visual appearance.

Production metallic substrates comprising a coloration differing from the aim values pertaining to Table 2 may not be described by established data characterizations. In this case, a dedicated substrate description using the attributes shown in Table 2, and an associated set of characterization data is recommended.

Table 2 — CIELAB coordinates and CIE Whiteness for print substrates (informative)

— Characteristic	Metal Coating Type											
	MC1			MC2			MC3			MC4		
Type of surface	White coating without varnish			Pinkish coating without varnish			Bluish coating without varnish			Neutral coating without varnish		
CIE Whiteness (D50/2°)[a]	86 ±4			95 ±5			95 ±10			95 ±10		
Gloss (60°)	30 ± 20			80 ± 20			80 ± 20			80 ± 20		
Colour (D50/2°)	Coordinates											
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Aims	86	-2	-6	83	3	-8	81	-2	-9	89	-2	-3
Tolerance[b]	±4	±2	±2	±5	±2	±2	±5	±2	±2	±5	±2	±2
[a] ASTM E 313 provides guidance on CIE whiteness under other daylight illuminants [b] ISO13655:2017 and Annex B describes how to transform the primary colour targets on substrates outside these tolerances.												

4.3.3 Ink set colours (colorant description)

For the typical substrates defined in 4.3.2, the CIELAB colour coordinates of the process colour solids shall agree with the aim values specified in Table 3, within the deviation tolerance specified in Table 4. The colour coordinates of the two-colour overprints and the three-colour overprint, both without black ink, should agree with Table 3. The tolerances on these colour aims can be found in Table