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

Part 1: Parameters and measurement methods

Technologie graphique — Maîtrise de procédé pour la production des séparations de couleur en ton tramé, des épreuves et des tirages en production —

Partie 1: Paramètres et méthodes de mesure

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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 third edition cancels and replaces the second edition (ISO 12647-1:2004), which has been revised by an update relating to the extensive usage of digital data in the printing and publishing world and a general clean-up towards an updated and stringent structure of the multi-part standard.

ISO 12647 consists of the following parts, under the general title *Graphic technology — Process control for the production 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

When producing a colour reproduction, it is important that the people responsible for colour separation, proofing and printing operations have previously agreed on a minimum set of parameters that uniquely define the visual characteristics and other technical properties of the planned print product. Such an agreement enables the correct production of suitable colour separated data (without recourse to "trial-and-error") and subsequent production of proof prints from these data. The purpose of digital proof prints or press proof prints is to simulate the visual characteristics of the finished print product as closely as possible. It should be further noticed that this International Standard provides aims for printing using typical printing equipment and tools for quality control under the given economical constraints.

It is the purpose of this part of ISO 12647 to list and explain the minimum set of primary process parameters required for process control to uniquely define the visual characteristics and related technical properties for the contract or press proof print as well as the production print. Other parts of ISO 12647 define either specific values for these parameters that are appropriate for specific processes (such as lithography) or define matching tolerances based on a given characterization data set. Given an established fully characterized printing condition by means of a set of characterization data, ISO 12647-7 and ISO 12647-8 specify requirements for systems in order to produce a "Contract proof" or, at a less stringent level, a "Validation print".

For some processes certain parameters are more significant than others and may be specified as mandatory while the remainder are optional. However, in this part of ISO 12647, all parameters are treated equally.

Primary process parameters are defined here as having a direct bearing on the visual characteristics of the image. They depend on the pertinent printing process but typically comprise printing sequence, press, ink, the print substrate and the screening. Those parameters constitute a printing condition to be defined in the pertinent parts of this International Standard. Such a printing condition is characterized by means of associated colorimetric and/or densitometric process control aims. This is usually facilitated by means of defined solid colorations (to be named here colorant descriptions) and tone response curves.

A printing condition is therefore understood to refer to a set of primary process parameters and the resulting colorimetric and/or densitometric characterization.

Subordinate, formerly secondary, parameters are defined as those which may influence the image indirectly by changing the values of primary parameters. They are highly dependent on the relevant printing process. In case of offset printing typical influencing factors are speed, printing additives, blankets, and fountain solution types. Depending on the given combination of materials and machine setup, a press adjustment (also known as process calibration) might be necessary to achieve the colorimetric and/or densitometric process control aims of the printing condition of interest. This is typically accomplished using one-dimensional curve adjustments.

Even under standard conditions, i.e. a suitable data preparation that accounts for the different strengths and weaknesses of the individual printing conditions and a reproducible printing process that has minimal variations both within a run and between runs, it is practically not possible to hit a given set of primary parameters exactly. Differences due to typical production tolerances or due to differences in press, ink or substrate are generally unavoidable and have to be accepted by the print buyer. On the other hand, for global data exchange and colour separation purposes, an elaborate colorimetric characterization of every printing condition is required. Such data can be extracted from one or more prints that were produced under carefully and tightly controlled (nearly laboratory) conditions followed by mathematical correction procedures that are specifically designed to compensate for the differences remaining, i.e. zero tolerance toward given aim values. Such a fully characterized printing condition is suitable to evaluate and examine the colour gamut and should not be confused with the colorant description that only comprises colorimetric definitions of the solids (typically CMYK; MY, CY, CM and CMY).

By facilitating modern methods of electronic data manipulation it is possible, as described, to establish characterization data sets that fully reflect the aim values of a given set of primary process parameters. This allows both process control aims for printing operations (to be connected with a general printing condition) as well as colorimetric aims for digital proofing processes in the prepress arena to be in concert.

Given a fully characterized printing condition and a definition of the achromatic perception (see 3.11) it is possible to extract the exact grey condition, namely the colorimetric values needed (under specified viewing conditions). Such a grey condition (not to be confused with the grey balance that represents the needed tone values for cyan, magenta and yellow in order to achieve a neutral grey) might be used both for process calibration and monitoring the printing process.

The general principles of this International Standard can be easily extended to printing conditions not defined in ISO 12647, e.g. printing with high pigmented inks or the usage of substrates not fully addressed by the relevant parts of ISO 12647.

In order to facilitate communication between prepress, print buyer and printer, it is recommended to use a press proof or digital print compliant to ISO 12647-7 ("Contract proof") or ISO 12647-8 ("Validation print"). The proof print reliably shows the quality of the prepress work and serves as the colour reference for the production run and, if necessary, may be used in case of a dispute between the print buyer and printer.

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

Part 1: Parameters and measurement methods

1 Scope

This part of ISO 12647 defines and explains the minimum set of primary process control parameters required to uniquely specify the visual characteristics and related technical properties of process-specific production prints and process-independent simulations of fully characterized printing conditions.

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 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

ISO 5-4, *Photography and graphic technology — Density measurements — Part 4: Geometric conditions for reflection density*

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.

NOTE For quantities, the preferred unit is given together with the definition. By definition, the unit of the so-called dimensionless quantities is 1.

3.1
achromatic colour
perceived colour devoid of hue, in the perceptual sense

Note 1 to entry: The colour names white, grey and black are commonly used or, for transmitting objects, colourless and neutral.

Note 2 to entry: In printing practice, achromatic colours can be produced either by a single black ink or three chromatic (and one achromatic) inks suitably balanced.

[SOURCE: CIE 17.4, 845-02-26]

3.2
axis of a screen
one of the two directions in which the half-tone pattern shows the highest number of image elements, such as dots or lines, per unit length

3.3
chromatic colour
perceived colour possessing hue, in the perceptual sense

Note 1 to entry: The process inks cyan, magenta and yellow are the chromatic colour inks.

[SOURCE: CIE 17.4, 845-02-27]

3.4
CIEDE2000 colour difference
CIEDE2000 total colour difference ΔE_{00} as defined in ISO 13655

3.5
CIELAB chromaticness difference
difference ΔC_h between two colour stimuli of approximately the same lightness projected onto a constant lightness plane in the CIELAB colour space

Note 1 to entry: This is calculated the same way as ΔEc stipulated in ISO 12646.

3.6
CIELAB colour difference
CIE 1976 ***L*a*b**** colour difference
difference between two colour stimuli defined as the Euclidean distance between the points representing them in *L**, *a**, *b** space

Note 1 to entry: The unit is 1.

[SOURCE: CIE 17.4, 845-03-55]

3.7
CIELAB colour space
CIE 1976 ***L*a*b**** colour space
three-dimensional, approximately uniform colour space produced by plotting *L**, *a**, *b** in rectangular coordinates

[SOURCE: CIE 17.4, 845-03-56]

3.8
control patch
area produced for control or measurement purposes

Note 1 to entry: Important control patches are doubling/slur patches for the assessment of the true rolling condition or ink trap control patches, a relative measure for the average amount of colorant per unit area of the second-down colorant layer that is deposited on to the first down colorant layer.

3.9
control strip
one or two-dimensional array of control patches used for characterization and proof control

3.10
digital proof print
digital proof produced as a reflection copy on a proofing substrate

Note 1 to entry: It usually serves as the reference in dispute, as the colour reference for the production print and as an indicator of the image quality of the content data; also known as Contract Proof.

3.11
grey balance
set of tone values of the data set that appears as an achromatic colour under specified viewing conditions if printed under specified printing conditions

Note 1 to entry: There are three practical definitions for grey: “a colour having the same CIELAB *a** and *b** values as the print substrate”, “a colour that has the same CIELAB *a** and *b** values as a half-tone tint of similar *L** value printed with black ink” and a functional (linear or nonlinear) combination of both.

3.12
grey reproduction
set of colorimetric values of the print that appears as an achromatic colour under specified viewing conditions if printed under specified printing conditions to be used for process control

Note 1 to entry: The printing of composed greys facilitating a fully characterized printing condition, by means of practically identical tone response curves, might result in slightly achromatic appearance. For process control means a slightly different set of tone values of the print than in the characterization data set might be necessary to achieve a neutral reproduction for the specific printing condition.

3.13
ICC colour management
communication, by means of an ICC profile, of the associated data, required for unambiguous interpretation of colour content data and application of colour data conversions using this profile, as required, to produce the intended reproductions

Note 1 to entry: Text, line art, graphics, and pictorial images, in raster or vector form can all contain colour data all of which can be colour managed.

Note 2 to entry: Colour management considers the characteristics of input and output devices in determining colour data conversions for these devices.

[SOURCE: ISO 15076-1, modified]

3.14
ICC profile
set of colorimetric transforms prepared in accordance with ISO 15076

3.15
image orientation
orientation of text and images, designated right-reading if text appears as it is intended to be read and images are in the orientation intended for viewing by the end user and wrong-reading for the opposite

3.16
mid-tone spread
S
difference between maximum and minimum deviations of tone values (print) for chromatic plates and defined by the equation

$$S = \max[(A_c - A_{c0}),(A_m - A_{m0}),(A_y - A_{y0})] - \min[(A_c - A_{c0}),(A_m - A_{m0}),(A_y - A_{y0})]$$

where

A_c is the measured tone value of the cyan process colour image;

A_{c0} is the specified tone value of the cyan process colour image;

A_m is the measured tone value of the magenta process colour image;

A_{m0} is the specified tone value of the magenta process colour image;

A_y is the measured tone value of the yellow process colour image;

A_{y0} is the specified tone value of the yellow process colour image.

EXAMPLE 1 For measured values $A_c = 22$, $A_m 17$ and $A_y = 20$ and specified values $A_{c0} = 20$, $A_{m0} = 20$ and $A_{y0} = 18$):

EXAMPLE 2 $S = \max[(22-20),(17-20),(20-18)] - \min[(22-20),(17-20),(20-18)] = 2-(-3) = 5$

3.17
non-periodic half-tone screen
half-tone screen without a regular half-tone dot pattern; typically known as 'stochastic' or 'frequency modulated' screening

Note 1 to entry: The usage of different screenings within a print job is known as cross modulated screening (XM).

3.18
OK print
OK sheet
production print (during production printing) singled out as the reference for the remaining production run

3.19
OK print tolerance
permissible difference between the *OK print* (3.18) and the values defined by the reference printing condition

Note 1 to entry: The OK print tolerance is often termed as a deviation tolerance.

3.20
press proof print
print produced by press printing (production or conventional proof press) whose purpose is to show the results of the colour separation process in a way that closely simulates the results on a production press

Note 1 to entry: It usually serves as the reference in dispute, as the colour reference for the production print and as an indicator of the image quality of the content data; also known as Contract Proof or wet proofs. But it is more and more replaced by digital proof prints.

3.21
principal axis
axis of a screen that coincides with the direction of the longest diameter of an oblong-shaped (e.g. elliptical or diamond-shaped) half-tone dot

Note 1 to entry: Circular and square shaped half-tone dots do not have a principal axis.

3.22
print substrate
material bearing the printed image

3.23
printing condition
set of primary process parameters which describe the conditions associated with a specific printed output, associated with colorimetric and/or densitometric aim values

Note 1 to entry: Such parameters usually include (as a minimum) printing process, print substrate, printing ink, screening and printing sequence. The aim values typically comprise the colorant description and tone value increase aims.

Note 2 to entry: For the purposes of colour management, a printing condition is fully characterized by giving the relationship between the CMYK digital input values (as defined in ISO 12642-2) and the corresponding measured colorimetric values.

Note 3 to entry: Based on a given set of characterization data according to NOTE 2, and a definition of achromatic perception, a grey condition might be extracted.

3.24
printing forme
physical medium whose surface is prepared such that some parts transfer printing ink whereas other parts do not

3.25
process colours
⟨four-colour printing⟩ cyan, magenta, yellow, black

3.26
production print tolerance
permissible difference between the *OK print* (3.18) and a specified upper limit of selected production copies

Note 1 to entry: Production print tolerance is often termed as a variation tolerance.

Note 2 to entry: Variation tolerance is calculated by standard deviation.

Note 3 to entry: The number of samples to be taken should be defined in the relevant parts of this multipart standard.

3.27
reference direction
⟨image⟩ horizontal direction as viewed by the end user

3.28
spectral reflectance factor
R_λ
ratio of the reflected flux to the absolute reference reflected flux under the same geometrical and spectral conditions of measurement, as a function of wavelength

Note 1 to entry: The unit is 1.

3.29
reflection densitometer
instrument which measures *reflectance factor density* (3.30)

3.30
reflection density
reflectance factor density
D
logarithm to base ten of the reciprocal of the *spectral reflectance factor* (3.28)

Note 1 to entry: This definition for reflection density is taken from ISO 5-4.

Note 2 to entry: This definition for reflection factor density is taken from CIE 17.4.

Note 3 to entry: The unit is 1.

3.31
relative density
density from which the density of a substrate such as the unprinted print substrate, has been subtracted

Note 1 to entry: The unit is 1.

3.32
sampling aperture size
dimensions of the surface area of a specimen that contributes to the measurement, governed by the design of the instrument

3.33
screen angle
angle (for oblong-shaped half-tone dots) which the principal axis of the screen makes with the *reference direction* (3.27), or the smallest angle (for circular and square dot shapes) which an axis of the screen makes with the reference direction

Note 1 to entry: Screen angle is expressed in units of degrees.

3.34
screen frequency
screen ruling
number of image elements, such as dots or lines, per unit of length in the direction of *screen angle*

Note 1 to entry: Screen frequency or screen ruling is expressed in units of reciprocal centimetres or inches.