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Graphic technology — Measurement and calculation of spot colour tone value

Technologie graphique — Mesurage et calcul de la valeur de tons des couleurs d'accompagnement

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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 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 the following URL: www.iso.org/iso/foreword.html.

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

This corrected version of ISO 20654:2017 incorporates the following corrections:

— Introduction: final paragraph removed;

— Formula (6) revised.

Introduction

This document defines a new metric Spot Colour Tone Value (SCTV) for the determination of the tone value of a spot colour ink. Spot colours in this document are defined as non-process colours (process colours being the CMYK 4-colour primary inks). This method produces approximately uniform visual spacing of the tones between the unprinted substrate and the 100% coverage, known as the solid ink. This metric is calculated from either the measured spectral reflectance factors or from colorimetric values computed from the same spectral data.

Historically, spot colours have been managed by measuring the solid ink value only, with no clear guidelines or methodology for measuring intermediate halftones. For artwork that only incorporates the spot ink at full coverage, this can be a reasonable practice; however, for artwork that includes gradations of the spot colour, which can print alone or in combination with the other inks, a formal strategy for managing the spot colour tone is required. This solution has been to print linear scales and use those values as a reference tone for alignment. This practice renders different results from each print supplier.

In the past, spot colour tones have been measured using the standard process colour tones methodology based on ISO status density measurement using a set of spectral products optimised for cyan, magenta and yellow inks. This method does not work well with intermediate tones of spot colours and in many cases produced a tone scale far from being perceptually uniform. Hence, there is a need for a new metric that will quantify the intermediate tones of spot colours in a more perceptually uniform way.

Graphic technology — Measurement and calculation of spot colour tone value

1 Scope

This document defines a metric for assessing intermediate tones of a spot ink. This method for the calculation of Spot Colour Tone Value (SCTV) produces approximately uniform visual spacing of tones between substrate and solid. It can be calculated from spectral reflectance or colorimetric measurements of the solid ink, substrate and one or more patches of intermediate tones to be measured.

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 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 terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
colour exchange format
CxF/X
standard defining a format for the communication of spot ink characterisation data (CxF/X-4)

3.2
spot colour ink
ink which is not part of the set of process inks

Note 1 to entry: Spot colour inks are often used when printing brand colours.

[SOURCE: ISO 12647-7, 3.9]

3.3
Spot Colour Tone Value
SCTV
value which describes the apparent halftone area for a non-process ink

Note 1 to entry: The series of all possible tone values between the unprinted substrate and the fully covered, solid tone will produce an approximately uniform visual spacing of the colours of the printed tones. The range of this metric is 0 % to 100 %, where 0 represents substrate and 100 represents solid spot colour.

4 Requirements

4.1 Calculation of spot colour tone value

This subclause defines a formula for Spot Colour Tone Value (SCTV) that depends on standard colorimetric variables. Two sub-clauses then outline the steps for calculating SCTV from spectral reflectance data and from CIELAB values.

For back-lit materials, spectral transmittance should be used in place of spectral reflectance.

NOTE The calculation of SCTV can be generalized to the measurement of regular transmittance or diffuse transmittance factor for use in the determination of tone values of printed back-lit signs. The details of making such measurements are beyond the scope of this document.

The SCTV of an intermediate tone of a spot ink is defined as a substrate-relative metric composed of three "value" components and normalized between substrate (0 %) and spot ink solid (100 %), as shown in Formula (1):

$$\mathrm{SCTV} = 100 \times \sqrt{\frac{\left(V_{\mathrm{xt}} - V_{\mathrm{xp}}\right)^2 + \left(V_{\mathrm{yt}} - V_{\mathrm{yp}}\right)^2 + \left(V_{\mathrm{zt}} - V_{\mathrm{zp}}\right)^2}{\left(V_{\mathrm{xs}} - V_{\mathrm{xp}}\right)^2 + \left(V_{\mathrm{ys}} - V_{\mathrm{yp}}\right)^2 + \left(V_{\mathrm{zs}} - V_{\mathrm{zp}}\right)^2}} \tag{1}$$

where

V_{xs}, V_{ys}, V_{zs} are V_{x}, V_{y}, V_{z} values calculated for the spot ink solid;

V_{xp}, V_{yp}, V_{zp} are V_{x}, V_{y}, V_{z} values calculated for the substrate;

V_{xt}, V_{yt}, V_{zt} are V_{x}, V_{y}, V_{z} values calculated for the spot ink tone.

The value components are defined to have functional form similar to that of CIE L*, as shown in Formulae (2)–(6):

$$V_{\mathrm{x}} = f\left(\frac{X}{X_n}\right) \times 116 - 16 \tag{2}$$

$$V_{\mathrm{y}} = f\left(\frac{Y}{Y_n}\right) \times 116 - 16 \tag{3}$$

$$V_{\mathrm{z}} = f\left(\frac{Z}{Z_n}\right) \times 116 - 16 \tag{4}$$

where

X, Y, Z are tristimulus values calculated as specified in ISO 13655;

X_n, Y_n, Z_n are tristimulus values of the selected illuminant and observer, which will normally be D50 for graphic arts applications as specified in ISO 13655.

and where

$$f(u) = (u)^{\frac{1}{3}} \qquad \text{if } u > \left(\frac{6}{29}\right)^3 \tag{5}$$

$$f(u) = \left(\frac{841}{108}\right) \cdot (u) + \left(\frac{4}{29}\right) \qquad \text{if u} \leq \left(\frac{6}{29}\right)^3 \tag{6}$$

is the same compression function defined in ISO 13655 in the derivation of CIELAB.

4.2 Steps for obtaining SCTV from spectral reflectance measurements

Where possible, spectral reflectance data should be used for spot colour measurement and communication, especially for package printing since it provides a basis to predict illuminant inconstancy in colour reproduction.

ISO 17972-4 (CxF/X-4) provides a standard format for the communication of spot ink characterization data and a suitable set of measurements for the calculation of SCTV. Where possible, spot colour measurements should be communicated as CxF/X-4.

Calculation of SCTV from spectral reflectance measurements shall be performed as follows:

Step 1: Measure the spectral reflectance factor of the substrate ($R_{\lambda p\lambda}$), the spot ink solid ($R_{\lambda s\lambda}$) and the spot ink tone ($R_{\lambda t\lambda}$) and select or measure the spectral power distribution of the illuminant (S_λ) to be used for viewing the print. For graphic arts, this illuminant is normally D50.

Step 2: For each of these measurements, calculate *X,Y,Z* as specified in ISO 13655 to obtain

X_s, Y_s, Z_s, the *X*, *Y*, *Z* values for the spot ink solid,

X_p, Y_p, Z_p, the *X*, *Y*, *Z* the values for the substrate, and

X_t, Y_t, Z_t, the *X*, *Y*, *Z* the values for the spot ink tone.

For some use cases, it may be appropriate to use *X*, *Y* and *Z* provided by the spectrophotometer.

Step 3: From these tristimulus values, calculate the values V_{xs}, V_{ys}, V_{zs}, V_{xp}, V_{yp}, V_{zp}, V_{xt}, V_{yt}, V_{zt} using Formulae (2)–(4) and use these values as shown in Formula 1 to calculate SCTV.

4.3 Steps for obtaining SCTV from CIELAB measurements

In cases where spectral reflectance data are not available, SCTV may be calculated from CIELAB measurements. In this case, SCTV is only valid for a single viewing environment and standard observer for which the CIELAB values were measured. For graphic arts use, this should be D50/2°.

Calculation of SCTV from CIELAB measurements shall be performed as follows:

Step 1: Measure CIELAB of the substrate (L_p, a_p, b_p), of the spot ink solid (L_s, a_s, b_s) and of the spot ink tone (L_t, a_t, b_t).

Step 2: Use Formula (7)–(9):

$$V_x = L + \left(\frac{116 \times a}{500}\right) \tag{7}$$

$$V_y = L \tag{8}$$

$$V_z = L - \left(\frac{116 \times b}{200}\right) \tag{9}$$

to calculate V_x, V_y and V_z for each of the measurements in Step 1 to obtain

V_{xs}, V_{ys}, V_{zs}, the V_x, V_y, V_z values calculated for the spot ink solid,

V_{xp}, V_{yp}, V_{zp}, the V_x, V_y, V_z values calculated for the substrate, and

V_{xt}, V_{yt}, V_{zt}, the V_x, V_y, V_z values calculated for the spot ink tone.