FINAL
DRAFT

TECHNICAL SPECIFICATION

ISO/DTS 10128

ISO/TC **130**

Secretariat: **SAC**

Voting begins on:
2023-09-01

Voting terminates on:
2023-10-27

Graphic technology — Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data

Technologie graphique — Méthodes d'ajustage de la reproduction de couleurs d'un système d'impression pour correspondre à un ensemble de données de caractérisation

Reference number
ISO/DTS 10128:2023(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword iv
Introduction v
1 Scope 1
2 Normative references 1
3 Terms and definitions 1
4 Procedures 2
4.1 General 2
4.1.1 Overview 2
4.1.2 Printing specifications 3
4.1.3 Ink specifications 3
4.1.4 Establishing printing conditions 3
4.1.5 Characterization data and ICC Profiles 4
4.1.6 Determination of tone value 4
4.2 Matching of tone value curves 4
4.2.1 General 4
4.2.2 Press evaluation 5
4.2.3 Press calibration 5
4.3 Use of near-neutral scales 5
4.3.1 General 5
4.3.2 Reference near-neutral scale 5
4.3.3 Press evaluation 6
4.3.4 Press calibration 7
4.4 Colour-optimised correction curve set 7
4.4.1 General 7
4.4.2 Selection of set of colours 7
4.4.3 Press evaluation 8
4.4.4 Press calibration 8
4.5 Use of CMYK to CMYK multi-dimensional transforms 9
4.5.1 General 9
4.5.2 Press evaluation 9
4.5.3 Press calibration 9
5 Conversion options and workflows 9
5.1 General 9
5.2 Process control data 10
Annex A (informative) **Tone value** 11
Bibliography 14

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*.

This second edition cancels and replaces the first edition (ISO/TS 10128:2009), which has been technically revised.

The main changes are as follows:

— addition of colour tone value (CTV) as a measure of printed tone;

— addition of colour-optimised correction curve set method for press calibration;

— updates to the Introduction and Bibliography.

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

Today, with digital data input, it is recognized that modification of that digital data can be used to compensate (adjust) for some of the differences in press, ink and paper between various printing sites and between the actual conditions at a specific site and the reference or standard printing condition.

As part of the introduction of digital technology, the printing industries (and its standards activities) have established reference characterization data corresponding to various printing specifications and conditions. Characterization data is generally defined as the relationship between the CMYK digital input values (in the data file exchanged) and the measured colorimetric values for the colour printed in response to these values.

Four general methods have been identified by which compensation for differences in printing conditions can be accomplished. Three of these make use of individual one-dimensional transforms (also known as plate curves) for each printing channel but differ in the method by which these transforms are determined. These are referred to as matching of tone value curves, use of near-neutral scales and colour optimised correction curve sets. The fourth method makes use of multi-dimensional transforms such as International Color Consortium (ICC) device-link profiles.

The features and general methodology for use of these adjustment techniques is the subject of this document. The goal is to provide a common understanding of these procedures across the industry, to allow consistency between implementations, and to facilitate communication of the adjustments used/desired in particular workflows.

It must be recognized that these are not competitive solutions, but each have different strengths and weaknesses in individual workflow applications. It is the choice of the individual print facility and/or the involved trade associations to decide how to best apply these capabilities, made possible through the use of digital data.

The basic assumption behind the use of characterization data and these correction techniques is that a printing process can be repeatedly restored to a prior printing condition and that condition can be maintained both within a run and between runs. A variety of process control methods can be used to achieve this repeatability. Solid ink density and tone value increase based on the specific materials involved, and tied back to the conditions established during characterization, are common process control tools that are used in addition to the data adjustment techniques described in this document. These adjustment techniques work together with process control to achieve the printing quality desired.

Graphic technology — Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data

1 Scope

This document describes four methods for the adjustment of the digital content data that is input to a printing system to achieve consistency in the printed results among a number of presses printing to the same general aim conditions. These four methods are generally identified as:

1) matching of tone value curves (TVI and CTV),

2) use of near-neutral scales,

3) colour-optimised correction curve set, and

4) use of CMYK to CMYK multi-dimensional transforms.

The procedures for establishing the aim condition for the necessary correction curves, the procedures for determining the individual correction curves, and a comparison of the applicability of these four methods are included.

These adjustment procedures are intended for use with printing systems that use CMYK colourants. Such systems are not restricted to those that use traditional ink on paper printing but can involve other marking technologies such as those used for proofing and/or digital printing.

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*

ISO 15076, *Image technology colour management — Architecture, profile format and data structure*

ISO 20654, *Graphic technology — Measurement and calculation of spot colour tone value*

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

[SOURCE: ISO 12647-2:2013, 3.3]

3.2
colour tone value
CTV
value which describes the apparent half-tone area for a colour using ISO 20654

Note 1 to entry: The range of this CTV metric is 0 % to 100 %, where 0 represents substrate and 100 represents solid colour. With a linear CTV curve, the series of tone value patches between the unprinted substrate and the fully covered, solid tone will produce an approximately uniform visual spacing of the colours of the printed tones. For example, a 50 % CTV patch is perceptually approximately halfway between the substrate and the solid.

Note 2 to entry: The scope of ISO 20654 defines this method only for the use with spot colours but it can be used for process colours in the same manner.

3.3
digital printing
printing directly from digital data where there is no intermediate image carrier, or the image carrier is refreshed for each impression, and thus each impression can be different in content if desired

3.4
grey balance
set of tone values for cyan, magenta and yellow that are expected to appear as an achromatic grey under specified viewing conditions, when printed using the specified printing conditions

Note 1 to entry: There are two practical definitions for grey: "a colour having the same CIELAB a* and b* values as the print substrate" and "a colour that has the same CIELAB a* and b* values as a half-tone tint of similar L* value printed with black ink". The colorimetric definition of grey is where the CIELAB a* and b* values both equal 0.

[SOURCE: ISO 12647-1:2013, 3.11, modified — The definition specifies cyan, magenta and yellow. The note to entry specifies only 2 definitions of grey.]

3.5
tone value
percentage of the surface which appears to be covered by colorant of a primary colorant as described in ISO 12647-1

3.6
tone value increase
TVI
difference between a tone value (printing) measured on a printed sheet and the tone value (data) in the digital data file as described in ISO 12647-1

4 Procedures

4.1 General

4.1.1 Overview

Printing standards, in general, specify the ink and paper to be used and the process control parameters in colorimetric terms. Where the inks are well characterized, densitometric aims may also be included for reference. ISO 2846-2 provides the mechanism to specify the colour and transparency of the ink. Specification of paper is not well defined and is generally limited to an identification of colour, translucency or grammage, and a reference to industry grades or classifications.

The printable colour gamut is defined by the combination of the colour of the paper, the colour of solids of the primary inks, the overprinted solids of two primary inks, and the colour of the overprinted solids of three primary inks in combination with the black ink. These are included in the printing conditions defined in the ISO 12647 family of standards and are also typically included in other printing specifications along with reference aims for densitometric data and tone value increase. Characterization data associated with such printing standards are usually prepared from print test

data or data from earlier tests. In either case, it is typically modified and smoothed so that it matches the specified values for the aim parameters and represents smooth transitions within the colour volume.

In some situations, a printing system can be adjusted to match a reference by adjusting tone value increase to match the reference. The principal assumptions are:

a) when the primary and secondary colour solids are correct, the printing gamut will be correct;

b) when the tone curves for the individual single colour scales match those of the reference printing condition, then the internal overprint data will also match the reference;

c) within limits, differences in the tone value increase between presses (or between a press and the reference printing condition) can be compensated for by a series of single channel changes in the input tone values.

The first three methods described in this document use such single channel changes and differ only in the procedure used to determine the individual channel corrections.

The fourth method assumes that there is substantial interaction between channels such that a series of single channel corrections are not sufficient. It makes use of an ICC device-link transform (or other mechanism which maps the device-dependent printing data of one system into the device-dependent printing data of another system) which essentially is a predefined four-dimensional transform. The reason that an ICC device-link is used instead of classic ICC colour management is that the transforms included in a device-link profile can be tuned to preserve the black channel (single colour black stays as a single colour). Classic ICC colour management converts the CMYK data back into profile connection space (PCS) data and then re-computes the individual colour separations to create a new set of CMYK data.

All four methods depend on the use of the specified paper and ink, and that the correct colorimetric values of the process colour solids and two-colour overprint solids are achieved.

Although the descriptions that follow refer to the "press to be used for actual printing" it is recognized that often process control within an organization is tight enough or that presses of a single family are similar enough that the same set of corrections can be applied more broadly than to a single press. Further, although the term press is used throughout this document to refer to the intended printing device, these procedures may be used with proofing devices or with digital printing devices operated in traditional halftone, continuous tone, or non-traditional imaging modes.

4.1.2 Printing specifications

Printing standards should use the printing conditions defined by the applicable part of ISO 12647 or be based on these.

4.1.3 Ink specifications

The various parts of ISO 12647 specify use of inks appropriate to the type of printing described in each part. However, even when the printing specifications used are not based on ISO 12647, the ink specified should be based on the appropriate part of ISO 12647 or use similar testing procedures for its definition.

4.1.4 Establishing printing conditions

To match the colour reproduction of a printing system to the reference printing condition using tone value curves, it is important to measure press performance using the inks and paper type specified for the reference printing condition being matched. Because the ink, paper, and press combination being used may not result in solids that exactly match the CIELAB colour coordinates specified, it is important to determine the local process control aims that provide the closest match to the colorimetric aims of the process colour solids.

This can be achieved by printing an ink film thickness series (often referred to as a density series) for each ink on the reference paper either by tagging on to the end of a production printing job using the same materials or by a specific test. The key issue is that it is important to measure and compute both density and colorimetry over a varying range. The colour difference between the colour achieved and the aim colour (ΔE) can be used to select a new aim colour for process control. These aims represent the best that can be achieved with the ink, paper, and press being used to match the CIELAB colour coordinates of the aim solids. If during this test the two colour overprints do not match the CIELAB colour coordinates specified within the tolerances given (the tolerances in the appropriate part of ISO 12647 should be used as a guide) then the inks or process should be investigated and the press evaluation should not be completed until both solids and two colour overprints are achieved within the specified tolerance.

NOTE The method described in 4.5 can be used in cases where it is not possible to match the reference press substrate or ink solids with sufficient accuracy.

4.1.5 Characterization data and ICC Profiles

All characterization data should be based on the ink value data sets defined in either ISO 12642-1 or ISO 12642-2. Measurement of printed samples of these ink value data set shall be accomplished in accordance with ISO 13655.

NOTE 1 One widely used source of characterization data sets for standardized printing conditions is the International Color Consortium characterization data registry[13].

Colour management profiles (ICC profiles) based on such characterization data often provide a more convenient source of reference colour data. Where these are used, they shall be created in accordance with ISO 15076. Users should note that the two do not generally contain exactly the same data as the process of ICC Profile creation often applies a total ink coverage limit and requires interpolation of the characterization data set. Nevertheless, for most practical purposes, if the ICC Profiles are well-formed, the two can be considered to be equivalent.

NOTE One widely used source of ICC profiles for standardized printing conditions is the International Color Consortium profile registry[14].

4.1.6 Determination of tone value

Where printing conditions provide colour tone values (CTV), these should be used as specified in ISO 20654. When using characterization data or ICC Profiles, colour tone values calculated from measurements of single-colour scales should be used.

NOTE 1 Tone value is traditionally calculated from density data and is an estimate of the percentage of the surface which appears to be covered by a uniform layer of a colourant of a single colour (if light scattering in the substrate and other optical phenomena are ignored). The choice of which density filter set to use (density status) is generally not an issue as long as both the reference characterization data and the press evaluation data are based on the same density status.

NOTE 2 Use of a spectrophotometer, adjusted so that its spectral passband is centred on the wavelength region where the print exhibits its maximum light absorbance provides the best estimate of apparent tone value. However, for process control of a running press, in the past, status density data was preferred, and for that reason some tone value (and thus tone value increase) aims are based on densitometric data. Annex A provides additional information about and computational techniques for conversion between colorimetric tone value and density-based tone value.

4.2 Matching of tone value curves

4.2.1 General

The principal assumption used in this method is that, once the correct process colour solids and two-colour solid overprints are achieved, a satisfactory overall result can be reached by simply matching

the tone value curve to the reference tone value curve for each printing primary as long as both sets of tone values are measured in the same way, that is using either TVI or CTV for both (see 4.1.6).

NOTE Because single colour tone value curves and single colour tone value increase curves are directly related either can be used. For many users, tone value increase curves are easier to visualize and thus are more commonly used.

4.2.2 Press evaluation

Once the printing conditions are established that provide the best match to the agreed upon colorimetric aims for the process colour solids (see 4.1.4), measurement of a printed image of an ISO characterization test chart (see ISO 12642 series) will provide a set of characterization data. This data defines the press characteristics at the operating condition that represents the best match that can be achieved to the gamut of the reference printing condition.

The difference between the single colour tone value curve achieved on press and that of the reference printing condition is the tone value correction curve that must be applied to all colour critical content data. This correction should be determined and applied independently for each channel (C, M, Y and K).

4.2.3 Press calibration

Press colour adjustment using tone value curves is simply the systematic application of the tone value correction curves determined in 4.2.2 to all content data. This is typically accomplished using plate-setter curves but may also be accomplished using any other digital data manipulation step available in the particular workflow being used.

4.3 Use of near-neutral scales

4.3.1 General

While the matching of tone value curves, described in 4.2, is adequate in many situations, it only takes into account one of the many factors that impact the colour of two and three colour over-prints. While the tone value curve clearly is the most significant, the printed colour is also impacted by ink-trapping, ink transparency, ink-water-press interaction, halftone screen, etc. These can all vary between the press, ink and paper used to create reference printing condition characterization data and the press, paper and ink used for the production printing.

A comparison of the colorimetric data of the reference characterization data and that of the intended production printing for a reference near-neutral scale allows individual transforms (tone value adjustment curves) to be determined for each ink channel. While similar to the tone value correction curves of the method described in 4.2, they provide the ability to compensate for some of these secondary variations that also impact the three-colour neutral scale.

Where the reference characterization data used has been designed to produce desired grey balance for a reference near-neutral scale this approach also allows the printing process to be monitored using grey balance in addition to, or in place of, using tone value curves.

4.3.2 Reference near-neutral scale

The use of near-neutral scales to determine the required tone value adjustment curves can be used with any reference characterization data. As noted above, if the characterization data to be matched has been designed to produce good grey balance for a particular reference near-neutral scale, grey balance patches of that near-neutral scale can be used with process control procedures based on grey balance.

NOTE See ISO/PAS 15339 series for details of press calibration using near neutral scale. Future versions of ISO 12647-2 are also expected to specify press calibration using near neutral scale.