PD ISO/PAS 15339-2:2015

BSI Standards Publication

Graphic technology — Printing from digital data across multiple technologies

Part 2: Characterized reference printing conditions, CRPC1–CRPC7

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PAI/43, Graphic technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 90004 4

ICS 35.240.30; 37.100.99

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 September 2015.

Amendments issued since publication

Date	Text affected

PD ISO/PAS 15339-2:2015

PUBLICLY AVAILABLE SPECIFICATION

ISO/PAS 15339-2

First edition
2015-08-15

Graphic technology — Printing from digital data across multiple technologies —

Part 2: Characterized reference printing conditions, CRPC1–CRPC7

Technologie graphique — Impression à partir de données numériques via des technologies multiples —

Partie 2: Conditions d'impression de référence caractérisées, CRPC1–CRPC7

Reference number
ISO/PAS 15339-2:2015(E)

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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.

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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*.

ISO/PAS 15339 consists of the following parts, under the general title *Graphic technology — Printing from digital data across multiple technologies*:

— *Part 1: Principles* [Publicly Available Specification]

— *Part 2: Characterized reference printing conditions, CRPC1–CRPC7* [Publicly Available Specification]

Introduction

ISO/PAS 15339 is based on the premise that in the printing and publishing industries, electronic data are the intermediary for content storage and exchange throughout production including copy preparation, job assembly, proofing, and process printing. It further assumes that data preparation can be largely process-independent and that the choice of the printing process or processes to be used for final production will be based primarily on run-length requirements and the substrates to be used. There are various tools in place to both define the relationship of digital data to printed colour for specific instances of printing and to manipulate data such that similar results can be obtained between and among different printing processes (see ISO/TS 10128). These specific instances of printing are typically described by colour characterization data, which is the relationship between CMYK input data and colour measured on the printed sheet. Where such a set of colour characterization data are used as a reference it is referred to as a characterized reference printing condition (CRPC).

ISO/PAS 15339-1 describes the principles involved in developing and working with CRPCs.

This part of ISO/PAS 15339 defines a set of CRPCs associated with the initial publication of ISO/PAS 15339. It is intended that if changes in, or additions to, these data sets are needed in the future, they will be documented in additional parts of ISO/PAS 15339 so that changes in the data sets are possible without losing traceability to earlier data sets.

Not all printing processes that can achieve the same colour gamut are subject to the same limitations. Offset, gravure, flexography, electrophotographic, ink-jet, etc. each have limitations that may have to be considered in the final data preparation. These typically include limitations of total ink coverage, and minimum and maximum printable dot sizes. Should general guidance be needed, additional parts of ISO/PAS 15339 can be prepared to assist in the communication or standardization of the handling of such limitations.

Graphic technology — Printing from digital data across multiple technologies —

Part 2: Characterized reference printing conditions, CRPC1–CRPC7

1 Scope

This part of ISO/PAS 15339 specifies a limited number of characterized reference printing conditions that span the expected range of colour gamuts used for the production of printed materials from digital data, regardless of the printing process used. Their use is described in ISO/PAS 15339-1.

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 12642-2, *Graphic technology — Input data for characterization of 4-colour process printing — Part 2: Expanded data set*

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

ISO/PAS 15339-1, *Graphic technology — Printing from digital data across multiple technologies — Part 1: Principles*

ISO 28178, *Graphic technology — Exchange format for colour and process control data using XML or ASCII text*

CGATS TR015:2013, *Graphic technology — Methodology for Establishing Printing Aims Based on a Shared Near-neutral Gray-scale*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/PAS 15339-1 apply.

4 Requirements

As defined in ISO/PAS 15339-1, unless otherwise agreed between sender and receiver, the characterized reference printing condition (CRPC) used for data preparation and data exchange shall be one of the data sets defined in this or subsequent parts of ISO/PAS 15339.

The characterization data associated with the characterized reference printing conditions identified in this part of ISO/PAS 15339 are presented as data files “ISO15339-CRPC1.txt” to “ISO15339-CRPC7.txt” (see Clause 5).

Although a normative part of this International Standard, they may be freely used and distributed provided that the header of all distributed files indicates that they are part of ISO/PAS 15339.

NOTE 1 When additional CRPCs are published in subsequent parts of ISO/PAS 15339, it is expected they will follow the same sequential naming scheme to avoid confusion, i.e. ISO15339-CRPC8 would be the next named data set.

The characterized reference printing conditions included in these data files have been selected to be near the middle of both the general class of printing that is expected to make use of each characterized reference printing condition and the colour of the substrates used. It is also expected that adjustments for substrate colour (see ISO/PAS 15339-1) will allow each characterized reference printing condition to meet a wide variety of needs and be independent of the actual printing process to be used.

The tone reproduction curves used are based on the procedures defined in CGATS TR015 and are dependent on the reflectance of the substrate and of the black and 3-colour solids. The equations of CGATS TR015 provide the CIE Y tristimulus value corresponding to a particular cyan tone value of a near neutral scale.

To provide a consistent relationship between the substrate corrected neutral scales of the various data sets created for this part of ISO/PAS 15339, the CMY triplets defined by Formula 1 were mapped to the substrate corrected neutral scale of all data sets:

$$M = Y = 0{,}7470C - 4{,}100 \times 10^{-4} C^2 + 2{,}940 \times 10^{-5} C^3 \quad (1)$$

In addition, the densitometric tone value curves (computed according to A.3) for the three chromatic colourants were adjusted to have the same tone value increase (see Table A.1).

The data given, for information only, in Tables 1 to 3 are taken from the CRPC data files and are shown in these tables and figures for information. The CIELAB a*-b* projection of the characterization data of each of these characterized reference printing conditions is shown in Figure 1.

All colorimetry is defined to be measurement condition M1, according to ISO 13655, with white backing.

NOTE 2 To facilitate the use of the correction of colorimetric data for variations in substrate colour as described in ISO/PAS 15339-1, the header of each file contains the CIELAB values for both the substrate and a reference black point of the data set. The values for the substrate are ID 1 in each data set and as described in ISO/PAS 15339-1 the value in ID 1286 (the 4-colour solid) is used as a reference black point.

The substrate, single colour solids, and two-colour overprints that are the aims for the characterization data set are as shown in Table 1 and Table 2.

The colorimetrically computed mid-tone TVI for each of the single colour scales of each of the characterized reference printing conditions is listed in Table 3 for information. More extensive TVI curves can be computed directly from the CRPC data if desired. Annex A shows the computed densitometric TVI and provides the computations used to derive both densitometric and colorimetric TVI.

NOTE 3 A spreadsheet that will extract process control data from a CRPC data set, do substrate correction computations, and derive both densitometric and colorimetric TVI curves is available at http://www.npes.org/Programs/StandardsWorkroom/ToolsBestPractices.aspx.

Table 4 lists, for information only, typical use conditions, and a convenient name, for each of these characterized reference printing conditions. These characterized reference printing conditions have been selected to be near the middle of both the general class of printing that is expected to make use of each characterized reference printing condition and the colour of the substrates used. It is expected that adjustments for substrate colour (see ISO/PAS 15339-1) will allow each characterized reference printing condition to meet a wide variety of needs and be independent of the printing process to be used.

Table 1 — Characterized reference printing conditions — Primary colour aims

CRPC	Substrate colour			Printed solid colours											
				Cyan			Magenta			Yellow			Black		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
1	85	1	5	59	−24	−26	56	48	0	80	−2	60	37	1	4
2	87	0	3	57	−28	−34	52	58	−2	82	−2	72	30	1	2
3	96	1	−4	60	−26	−44	56	61	−2	89	−3	76	32	1	1
4	89	0	3	55	−36	−38	47	66	−3	83	−3	83	23	1	2
5	92	0	0	57	−37	−44	48	71	−4	87	−4	88	19	0	1
6	95	1	−4	56	−37	−50	48	75	−4	89	−4	93	16	0	0
7	97	1	−4	54	−42	−54	47	79	−10	90	−4	103	14	0	0

Table 2 — Characterized reference printing conditions —Two-colour overprint aims

CRPC	Red			Green			Blue		
	L*	a*	b*	L*	a*	b*	L*	a*	b*
1	54	44	25	55	−35	17	42	7	−22
2	51	55	32	51	−44	19	36	9	−32
3	54	56	28	54	−43	15	38	10	−31
4	46	62	39	49	−54	24	28	14	−39
5	48	65	45	51	−62	26	27	17	−44
6	47	68	48	50	−66	26	25	20	−46
7	47	75	54	50	−72	29	20	26	−53

Table 3 — Colorimetric TVI

CRPC	Colorimetric TVI @ 50 % input TV %			
	C	M	Y	K
1	24,3	26,1	26,1	26,2
2	17,3	19,2	19,2	22,0
3	16,8	19,1	19,0	22,1
4	15,9	19,1	19,0	22,1
5	15,0	16,0	16,0	19,1
6	13,4	16,0	16,0	19,0
7	11,6	16,1	16,1	19,1

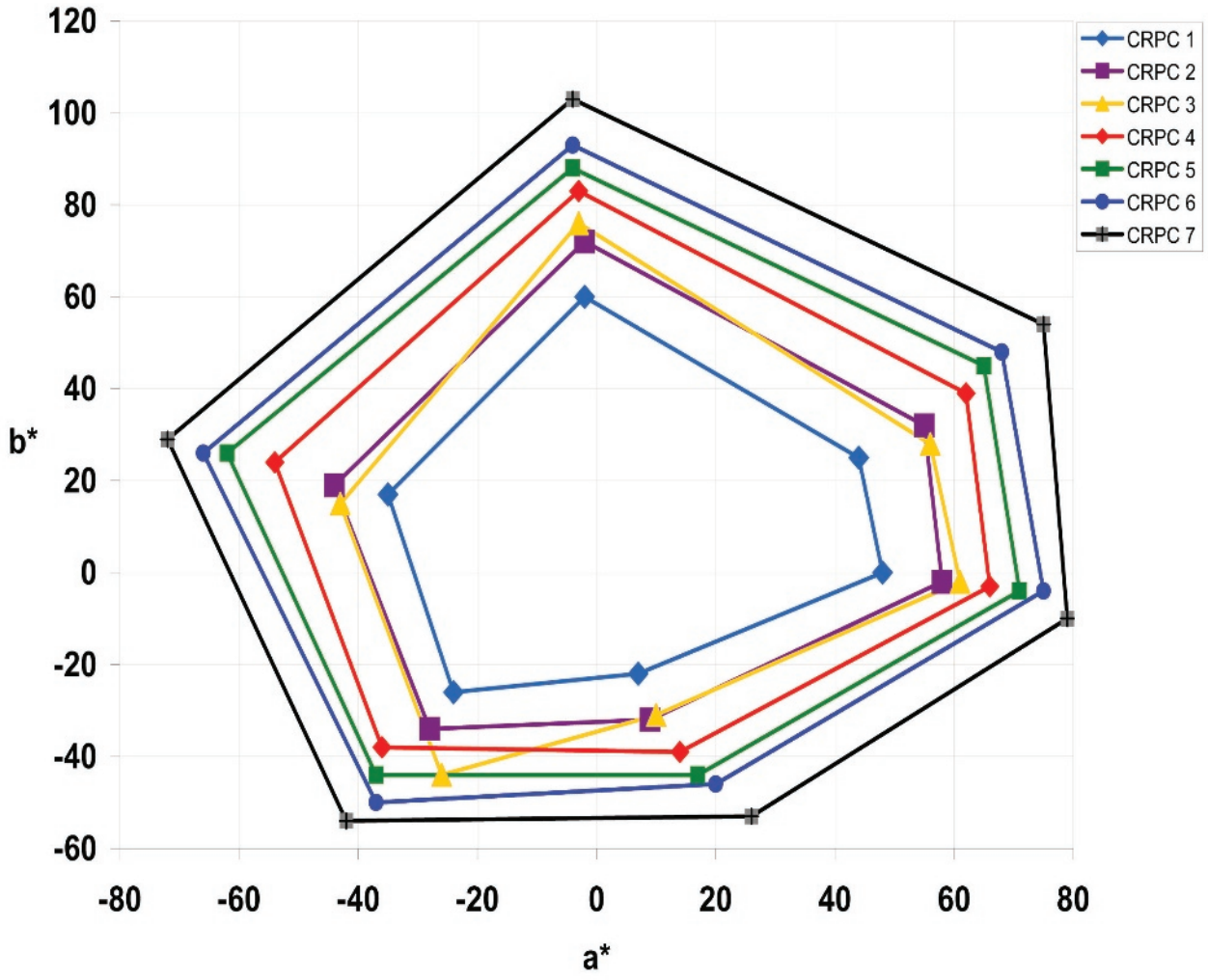

Figure 1 — Projection of the defined colourant descriptions given, for information only, in Tables 1 and 2 onto the CIE a*b*-plane

Table 4 — Characterized reference printing conditions, typical uses

CRPC	Name	Typical use
1	Typical ColdsetNews	Small gamut printing (newsprint)
2	Typical HeatsetNews	Moderate gamut printing on improved newsprint type paper
3	Typical PremUncoated	Utility printing on a matt uncoated type paper
4	Typical SuperCal	General printing on super-calendared paper
5	Typical PubCoated	Typical publication printing
6	Typical PremCoated	Large gamut (typically commercial) printing
7	Typical Extra Large	Extra-large gamut printing processes

5 Data files

The following data files are a normative part of this part of ISO/PAS 15339:

— ISO15339-CRPC1.txt

— ISO15339-CRPC2.txt

— ISO15339-CRPC3.txt

— ISO15339-CRPC4.txt

— ISO15339-CRPC5.txt

— ISO15339-CRPC6.txt

— ISO15339-CRPC7.txt

They are formatted in accordance with ISO 28178, and contain patch ID numbers, and CIE LAB data for each element of the ISO 12642-2 characterization target.

They are available at

http://standards.iso.org/iso/15339/

As indicated in Clause 4, these files may be freely used and distributed provided that the header of all distributed files indicates that they are part of ISO/PAS 15339.

NOTE 1 Although earlier characterization data files have included both CIEXYZ and CIELAB data, the current CRPC files only include CIELAB data. This is consistent with recent ICC recommendations that CIELAB data be used as the primary reference and XYZ data be considered informative.

NOTE 2 Where profiles are created based on these CRPCs, and there is a desire to include a reference to the CRPC in the profile name, the suggested form is (name of profile owner)-ISO15339-CRPCX.icc, as in the following example.

EXAMPLE IFRA-ISO15339-CRPC1.icc

Annex A
(normative)

Tone value increase

A.1 General

Tone value, better known to some as apparent dot area, is a measure of the relative changes in tone reproduction of an image as it moves through the various stages of reproduction to a printing plate, and eventually to the printed image. It was initially tied to halftone images that used centre-weighted dot patterns. It is an estimate of the fractional area coverage that has the same light absorption as the sample being measured. For reference, absorption is equal to 1 minus the reflectance. In computing the apparent fractional area coverage, the sample is assumed to be composed of areas that have either the absorption of the substrate (clear film or bare paper) or that of uniform areas of a fixed absorption level equivalent to the maximum exposed reflectance density of the film or the solid area of the ink. This is an important assumption because halftone images on either film or paper are not uniform and in addition images on paper include an effect called optical gain. Optical gain is associated with the scattering of light within the paper substrate and results in more absorption of light than is accounted for by the actual area covered by ink.

Integrated reflectance measurements combine optical gain, non-uniformities in the solid areas, and variations in absorption at the edges of dots etc. In addition this is further complicated by the fact that the absorption (reflectance) of paper, film, ink, etc. varies as a function of the wavelength of the light being measured.

Traditionally, status reflectance density (see ISO 5) was the common tool available to measure both film and paper and it is often used to provide the estimates of tone value. From an ideal point of view, measurements made over a very narrow wavelength band at the point of maximum absorption of the ink or marking (light absorption) media used are probably the most accurate measure to use to estimate tone value. When available, colorimetric data can also be used to estimate tone value. Any measure that is directly related to the absorption of light by the marking media being used is a valid candidate. In general, the closer the spectral band pass of the measurement system matches the wavelengths of maximum absorption of the marking medium, the more consistent the estimate of tone value will be.

NOTE 1 The concept of TVI was developed on the basis of offset lithography and flexography, but both concept and equations are equally applicable to other print processes, including those that use multi-level screening (often called greyscale inkjet or variable size dots, etc.).

NOTE 2 This Annex is based on, and is similar to, ISO/TS 10128:2009, Annex A.

A.2 Computation of tone value

Because reflectance density is defined as the negative log (base 10) of the reciprocal of reflectance, the equations for computing tone value from reflectance density appear to be different from those that compute directly from reflectance data. However, they are not.

The apparent tone value, A_{ATV}, expressed as a percentage, is calculated with respect to absorption and reflectance as shown in Formula (A.1):

$$A_{ATV} = 100 \times \frac{\left(\alpha_t - \alpha_{pap}\right)}{\left(\alpha_s - \alpha_{pap}\right)} = 100 \times \frac{\left(R_{pap} - R_t\right)}{\left(R_{pap} - R_s\right)} \quad \text{(A.1)}$$

where

α_t is the absorption of the halftone tint area;

α_{pap} is the absorption of the paper;

α_s is the absorption of the area of solid ink or marking media coverage;

R_{pap} is the reflectance of the paper;

R_s is the reflectance of the area of solid ink or marking media coverage;

R_t is the reflectance of the halftone tint area.

In each case the absorption or reflectance is spectrally weighted by the appropriate densitometric, narrow band, or colorimetric function.

When reflectance density is substituted for reflectance in Formula (A.1), and appropriately rearranged, the relationship is as shown in Formula (A.2)

$$A_{ATV} = 100 \times \left[\frac{1 - 10^{-\left(D_t - D_{pap}\right)}}{1 - 10^{-\left(D_s - D_{pap}\right)}} \right] \quad \text{(A.2)}$$

where

D_{pap} is the reflectance density of the paper;

D_s is the reflectance density of the area of solid ink or marking media coverage;

D_t is the reflectance density of the halftone tint area.

Table A.1 shows the parameters typically used for printing inks for the three methods of computing tone value discussed.

Table A.1 — Parameters used for tone value computation

Colour	Reflectance density[a]	Colorimetry	Narrow band
Cyan	Red	X	640 nm
Magenta	Green	Y	530 nm
Yellow	Blue	Z	420 nm
Black	Visual	Y	460 nm

[a] Typically, Status T density (as defined in ISO 5-3) is used in some parts of the world and Status E density (as defined in ISO 5-3) with or without polarization in others.

A.3 Matching between methods

Both the reference characterization data being matched and the measurements of the printing sample need to be based on the same measurement parameter (reflectance density, colorimetry, or narrow band). When this is not practical, it becomes important to provide correlation between the various measures of tone value. For purposes of traceability, or when data are compared between sites, communication of the chosen measuring method and the correlation methodology used is important.

A common situation encountered is having reference characterization available as colorimetric data and printing process control based on densitometric data. For black ink, the apparent tone values are usually within a few tenths of a tone value unit of each other regardless of the parameter used (e.g. ± 0,2 or 0,3 in tone value). For magenta and yellow the tolerance is typically up to ± 1 tone value unit between any two of the methods described.

For cyan, the difference is larger, particularly between the values based on colorimetric data and either narrow band or densitometric data. One simple correction, that reduces this uncertainty to approximately the same magnitude as is found with the other two chromatic ink colours, is to use $X - (0{,}55 \times Z)$ in place of the X value alone in the computation of cyan tone value. This is referred to as the Cyan TVI Z correction.

NOTE In observing the spectral shape of the X tristimulus function, in the region above 575 nm it shows that the absorption of the cyan ink determines the response. However below 575 nm, the response is primarily due to the paper. This simple correction, is based on the assumption that when measuring a cyan ink, the Z tristimulus response is a relative measure of the unwanted spectral response of the X tristimulus function to the paper instead of the cyan ink. The value 0,55 is based on the average value for a sampling of printing inks.

More accurate predictions of densitometric tone value from colorimetric date are possible, for all four ink colours and the various density options, but these typically require correlation of densitometric and colorimetric data measured from the specific ink and paper being used.

A.4 CRPC Densitometric tone value

Using the computations described in A.2 and A.3 the densitometric tone valve increases of CRPC 1 through 7 were computed and are shown in Table A.2.

Table A.2 — Densitometric TVI for CRPC 1–7

CRPC	Densitometric TVI @ 50 % input TV %			
	C	M	Y	K
1	26,1	26,1	26,1	26,2
2	19,1	19,2	19,2	22,0
3	19,0	19,1	19,0	22,1
4	19,0	19,1	19,0	22,1
5	16,0	16,0	16,0	19,1
6	16,0	16,0	16,0	19,0
7	16,1	16,1	16,1	19,1

NOTE A spreadsheet is available at

http://www.npes.org/Programs/StandardsWorkroom/ToolsBestPractices.aspx

which will perform these calculations.

Bibliography

[1] ISO 5-3, *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*

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