BS ISO 12647-2:2013

BSI Standards Publication

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

Part 2: Offset lithographic processes

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National foreword

This British Standard is the UK implementation of ISO 12647-2:2013. It supersedes BS ISO 12647-2:2004 which is withdrawn.

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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INTERNATIONAL STANDARD

ISO 12647-2

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

Part 2:
Offset lithographic processes

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

Partie 2: Procédés lithographiques offset

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ISO 12647-2:2013(E)

Contents

Page

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 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

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 which has been extensively revised. The revisions include the following:

a) deletion of film-based requirements;

b) changes in proof requirements;

c) changes in printing conditions;

d) changes in the colouration of the primary and secondary solids;

e) introduction of new tone value increase curves;

f) general clean up.

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

This part of ISO 12647 lists values or sets of values of the primary process parameters specified in ISO 12647-1 and related technical properties of a half-tone offset lithographic print. Primary parameters constitute a general printing condition and are defined here as the substrate description, the colorant description, the screening description, the tone value increase and the ink sequence. Since the printing ink to be used in this International Standard is to conform to ISO 2846-1, it is in general not necessary to name it as a primary process parameter.

Conformance to the specified values in proof and production printing ensures, in principle, a good visual match between specimens produced. A visual and in part measurement-wise "proof-to-print match" is essential for globally consistent printing and publishing workflows in general. A press proof print might be necessary when using specific printing conditions that use different types of surface finishing.

As the printing and publishing world has accepted former editions of this International Standard, it has struggled to implement the different paper types. The paper type specifications by means of tristimulus values, originally defined as a guideline for press proof prints, have been wrongly interpreted as an exclusive prerequisite for papers to be "in conformance with ISO 12647-2". In addition, it has become evident that the paper types defined by this International Standard reflect market papers poorly. Therefore, some industry groups, while using the general principles of this International Standard, have established additional printing conditions with different paper specifications.

When revising this International Standard a new paper categorization was established. This was necessary since there is no agreed upon method to predict the printing behaviour based on colorimetric readings of the unprinted print substrate. When the visual printing characteristics of typical printed papers were analysed, different sets of colorant descriptions were identified. A closer look revealed that these sets corresponded to the surface (CIE whiteness, gloss, and coating) and mass per area characteristics (opacity).

A print is therefore in conformance with this International Standard when:

— the colorimetric aims of the process colours, defined by the general printing conditions and using typical means of inking, are achievable;

— by agreement between all parties, an additional printing condition is established and aim values for this printing condition are clearly communicated, for example by exchanging a characterization.

This International Standard addresses typical industrial printing under feasible economical constraints. The tolerance values have therefore been chosen to provide a reasonable balance between customer expectations (meaning small variations), technical production limits and production costs. Assuming agreements between all parties concerned, tolerances might be tightened especially when primary or secondary process parameters (e.g. paper) can be fixed in the planning stage.

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

Part 2: **Offset lithographic processes**

1 Scope

This part of ISO 12647 specifies a number of process parameters and their values to be applied when producing colour separations, printing formes and print production for four-colour sheet-fed and web-fed offset printing presses excluding coldset offset lithography on newsprint.

The parameters and values are chosen in view of the typical process covering the process stages “colour separation”, “proof production”, “making of the printing forme”, “OK print” and “production printing” on all kinds of commercially available production substrates.

This part of ISO 12647:

— is directly applicable to press proof prints and printing processes that use colour separation printing formes as input;

— is applicable to press proof prints and printing processes with more than four process colours as long as direct analogies to four-colour printing are maintained, such as for data and screening, for print substrates and printing parameters;

— is applicable to printing on cardboard material for packaging;

— is applicable for all kinds of drying methods such as heat-set, infrared, and ultraviolet;

— provides references for quality assurance and quality management.

This part of ISO 12647 is not applicable to processes other than offset such as printing directly from digital data where there is no intermediate image carrier, or where the image carrier can be refreshed for each impression and thus each impression can be different in content.

2 Normative references

The following referenced 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 2846-1, *Graphic technology — Colour and transparency of printing ink sets for four-colour printing — Part 1: Sheet-fed and heat-set web offset lithographic printing*

ISO 8254-1, *Paper and board — Measurement of specular gloss — Part 1: 75 degree gloss with a converging beam, TAPPI method*

ISO 8254-2, *Paper and board — Measurement of specular gloss — Part 2: 75 degree gloss with a parallel beam, DIN method* [alternative to ASTM D7163]

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

ISO 11475, *Paper and board — Determination of CIE whiteness, D65/10 degrees (outdoor daylight)*

ISO 12647-1, *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, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 7: Proofing processes working directly from digital data*

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

ASTM D7163, *Standard Test Method for Specular Gloss of Printed Matter* [alternative to ISO 8254-2]

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
area coverage
ratio of the area covered with ink to the entire area in an ink zone

3.2
calibration
adjustment based on a comparison between a standard and a unit under test

3.3
characterization data
set of tone values and associated colorimetric values that fully describe a given printing process

3.4
tone value
⟨printing forme⟩ percentage of surface area that is covered by printing ink

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 [6][7] 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 is 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}.

Preferred nominal screen frequencies are:

a) 48 cm^{-1} to 80 cm^{-1} for coated paper; and

b) 48 cm^{-1} to 70 cm^{-1} for uncoated paper.

NOTE 1 Outside of the range 48 cm^{-1} to 80 cm^{-1}, the general principles specified in ISO 12647-1 remain valid but specific values might differ.

NOTE 2 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 3 For the black or yellow colour half-tone, 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 4 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. Preferred nominal screen frequencies are a) 120 lpi to 200 lpi for coated paper; and b) 120 lpi to 175 lpi for uncoated paper.

4.2.4 Dot size (non-periodic screens)

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

Preferred nominal screen dot sizes are:

a) 20 µm to 30 µm for coated paper; and

b) 30 µm to 40 µm for uncoated paper.

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 a principal axis, the first link-up should occur no lower than at 40 % tone value and the second link-up no higher than at 60 % tone value.

4.2.7 Tone value sum

The tone value sum for coated print substrates should be less than 330 % but shall not exceed 350% for sheet-fed and should be less than but shall not exceed 300% for heat-set web printing. The tone value sum for other print substrates should be less than but shall not exceed 300 % for sheet-fed and 270 % for heat-set web printing.

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 paper colour (L^*_{paper}, a^*_{paper}, b^*_{paper}) and solid CMY inks overprint (L^*_{cmy}) for each L* in the range from L^*_{paper} to L^*_{cmy}:

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

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

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 11 are not exceeded.

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

4.3 Proof or production print

4.3.1 General

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

Standard printing conditions are shown in Table 1. For all printing conditions described in this part of ISO 12647 the ink set shall be according to ISO 2846-1 and the printing sequence shall be Black – Cyan – Magenta – Yellow.

Table 1 — Standard printing conditions for typical print substrates

Printing condition	Print substrate description (Table 2 and 3)	Colorant description (Table 5 and 6)	Screening description			
			Periodic screens		Non-periodic screens	
			TVI curve	Frequency (cm^{-1})	TVI curve	Spot size (µm)
PC1	PS1	CD1	A	60 to 80	E	20(25)
PC2	PS2	CD2	B	48 to 70	E	25
PC3	PS3	CD3	B	48 to 60	E	30
PC4	PS4	CD4	B	48 to 60	E	30
PC5	PS5	CD5	C	52 to 70	E	30(35)
PC6	PS6	CD6	B	48 to 60	E	35
PC7	PS7	CD7	C	48 to 60	E	35
PC8	PS8	CD8	C	48 to 60	E	35

Additional printing conditions based on commonly used print substrates, different printing sequences and different ink sets should follow the scheme described in this and the following clauses; they should be established by defining combinations of print substrates and colorant descriptions (comparable to Tables 2 and 3 and Tables 5 and 6), screening descriptions and TVI curves (comparable to Table 9 and Figure 3).

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, ink set 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 4.3.2.1, 4.3.2.3, and 4.3.4.1 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.

NOTE 4 Spot sizes for non-periodic screens in parenthesis are recommended for heat-set web offset printing.

4.3.2 Visual characteristics of image components

4.3.2.1 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, uncoated, super-calandered, etc.) 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 and 3. For digital proofing, the requirements defined in ISO 12647-7 apply.

Typical paper characteristics are defined, for information only, in Tables 2 and 3. In order to determine the closest matching printing condition for a given paper type, compare the paper 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 paper comprising a coloration differing from the aim values pertaining to Tables 2 and 3 may not be described by established data characterizations. In this case, a dedicated substrate description using the attributes shown in Tables 2 and 3, and an associated set of characterization data is recommended.

Table 2 — CIELAB coordinates, mass-per-area, and CIE Whiteness for print substrates (informative)

Characteristic	**Paper type and surface**											
	PS1			**PS2**			**PS3**			**PS4**		
Type of surface	Premium coated			Improved coated			Standard glossy coated			Standard matte coated		
Mass-per-area [a] g/m^2	80 to 250 (115)			51 to 80 (70)			48 to 70 (51)			51 to 65 (54)		
CIE Whiteness [b]	105 to 135			90 to105			60 to 90			75 to 90		
Gloss [c]	10 to 80			25 to 65			60 to 80			7 to 35		
Colour [d]	Coordinates			Coordinates			Coordinates			Coordinates		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
White backing	95	1	−4	93	0	−1	90	0	1	91	0	1
Black backing	93	1	−5	90	0	−2	87	0	0	88	0	−1
Tolerance	±3	±2	±4	±3	±2	±2	±3	±2	±2	±3	±2	±2
Fluorescence [e]	moderate			low			low			low		

[a] Values in brackets pertain to the respective colour coordinates given in this table.

[b] Whiteness measurement is in accordance with ISO 11475, outdoor illumination conditions. Note that this single point measurement value is (among other variables) based on D65 viewing conditions. D50 is the standard viewing condition used when printing. Whiteness values should be used for guidance only.

[c] Measurement is in accordance with ISO 8254-1, TAPPI method.

[d] Measurement is in accordance with ISO 13655-D50 illuminant, 2° observer, 0:45 or 45:0 geometry. Measurements should be made using M1.

[e] Typical delta D65 Brightness UV/UV_{ex} evaluated as per ISO 2470-2, and information as recommended in ISO 15397.[8] This indicates the sensitivity of a print to blue shift when compared with a proof under Standard light condition D50 according to ISO 3664. Usual limits for Fluorescence: faint (0–4), low (4–8), moderate (8–14), high (14–25).

NOTE 1 In terms of gloss and colour, the paper types listed in Tables 2 and 3 are representative for the range of print substrates used for the processes covered in this part of ISO 12647.

NOTE 2 If the final product is subjected to surface finishing this could severely affect the print substrate colour and gloss.

Table 3 — CIELAB coordinates, mass-per-area, and CIE Whiteness for print substrates (informative)

Characteristic	**Paper type and surface**											
	PS5			**PS6**			**PS7**			**PS8**		
Type of surface	Wood-free uncoated			Super calendered uncoated			Improved uncoated			Standard uncoated		
Mass-per-area [a] g/m^2	70 to 250 (120)			38 to 60 (56)			40 to 56 (49)			40 to 52 (45)		
CIE Whiteness [b]	140 to 175			45 to 85			40 to 80			35 to 60		
Gloss [c]	5 to 15			30 to 55			10 to 35			5 to 10		
Colour [d]	Coordinates			Coordinates			Coordinates			Coordinates		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
White backing	95	1	−4	90	0	3	89	0	3	85	1	5
Black backing	92	1	−5	87	0	2	86	−1	2	82	0	3
Tolerance	±3	±2	±2	±3	±2	±2	±3	±2	±2	±3	±2	±2
Fluorescence [e]	high			low			faint			faint		

[a] Values in brackets pertain to the respective colour coordinates given in this table.

[b] Whiteness measurement is in accordance with ISO 11475, outdoor illumination conditions. Note that this single point measurement value is (among other variables) based on D65 viewing conditions. D50 is the standard viewing condition used when printing. Whiteness values should be used for guidance only.

[c] Measurement is in accordance with ISO 8254-1, TAPPI method.

[d] Measurement is in accordance with ISO 13655-D50 illuminant, 2° observer, 0:45 or 45:0 geometry. Measurements should be made using M1.

[e] Typical delta D65 Brightness UV/UV_{ex} evaluated as per ISO 2470-2, and information as recommended in ISO 15397.[8] This indicates the sensitivity of a print to blue shift when compared with a proof under Standard light condition D50 according to ISO 3664. Usual limits for Fluorescence: faint (0–4), low (4–8), moderate (8–14), high (14–25).

NOTE 3 For prints on papers or boards whose surface properties are identical to those of paper types Premium coated and Wood-free uncoated but whose mass per area is appreciably higher than the values in parenthesis, the CIELAB colour coordinates given for white backing can be used.

NOTE 4 Examples of typical coated and uncoated papers are given in Table 4.

NOTE 5 Annex B gives more information on handling differences in paper colour.

NOTE 6 The print substrate description (Tables 2 and 3) define 8 printing conditions and does not cover all existing paper or board specifications in the market.

NOTE 7 Print substrate PS3 is the closest print substrate in the specific case of coated board, with typical properties: Grammage above 225 g/m^2, Gloss 30–60, and Colour CIELAB coordinates 90, 0, −2 (white backing), low Fluorescence.

Table 4 — Examples of typical coated and uncoated papers (informative)

	Paper type and surface			
	PS1	**PS2**	**PS3**	**PS4**
Type of surface	Premium coated	Improved coated	Standard glossy coated	Standard matte and semi-matte coated
Typical process	Sheet-fed offset Heat-set web offset	Heat-set web offset	Heat-set web offset	Heat-set web offset
Typical papers	Wood-free coated, gloss, semi-matte, matte (WFC) High and medium weight coated (HWC, MWC)	Medium weight coated (MWC) Light weight coated (LWC Improved)	Light weight coated, gloss and semi-matte (LWC)	Machine finished coated (MFC) Light weight coated, semi-matte (LWC)
	PS5	**PS6**	**PS7**	**PS8**
Type of surface	Wood-free uncoated	Super calendered uncoated	Improved uncoated	Standard uncoated
Typical process	Sheet-fed offset Heat-set web offset	Heat-set web offset	Heat-set web offset	Heat-set web offset
Typical papers	Offset, wood-free uncoated (WFU)	Super calendered (SC-A, SC-B)	Uncoated mechanical improved (UMI) Improved newsprint (INP)	Standard newsprint (SNP)

4.3.2.2 Print substrate gloss

The gloss of the print substrate used for press proof prints should be a close match to that of the production print substrate. It is further important for digital proofing stipulated in ISO 12647-7.

NOTE 1 The gloss values of the paper types described in 4.3.2.1 are given in Tables 2 and 3.

NOTE 2 If the final product is subjected to surface finishing, this will severely affect the gloss. In critical cases, the result of the colour-separation stage is best judged by means of a proof that closely matches the gloss of the final surface finished print product. For processes with off-press finishing, in order to facilitate the matching of the production image to the proof image at the make-ready stage, it is a good plan to provide the press operator with two proof prints: a proof print whose gloss matches that of the (unfinished) production print substrate and a proof print which closely matches the gloss of the final surface-finished print product.

4.3.2.3 Ink set colours (colorant description)

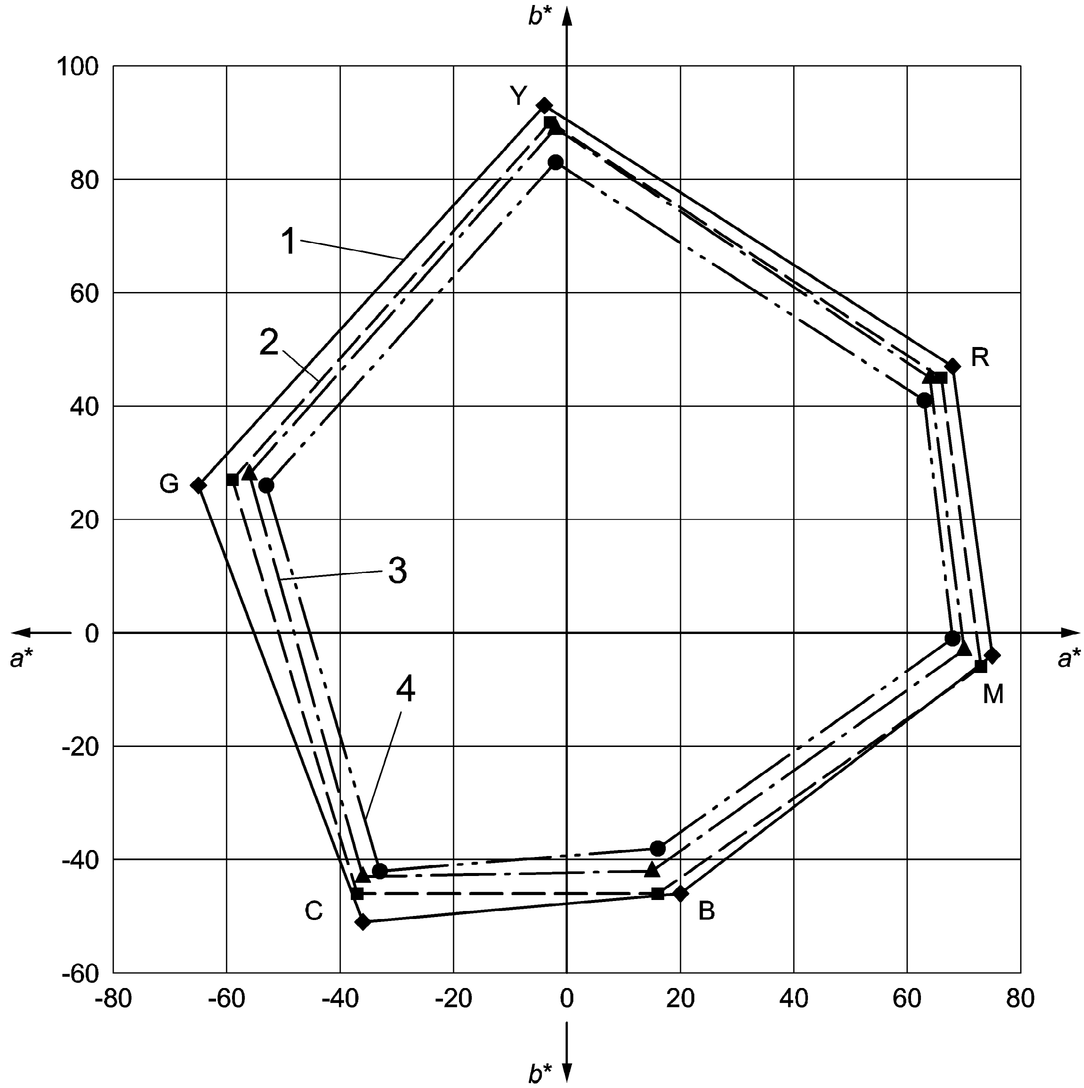
For the typical paper types defined in 4.3.2.1, the CIELAB colour coordinates of the process colour solids shall agree with the white backing aim values and should agree with the black backing aim values specified in Table 5 and Table 6, within the deviation tolerance specified in Table 7. The colour coordinates of the two-colour overprints and the three-colour overprint, both without black ink, should agree with Table 5 and Table 6.

Table 5 — CIELAB coordinates of colours for the printing sequence cyan-magenta-yellow

Characteristic		Colorant description											
		CD1 Premium coated			CD2 Improved coated			CD3 Standard coated glossy			CD4 Standard coated matte		
Colour		Coordinates			Coordinates			Coordinates			Coordinates		
		L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Black	WB	16	0	0	20	1	2	20	1	2	24	1	2
	BB	16	0	0	20	1	2	19	1	2	23	1	2
Cyan	WB	56	-36	-51	58	-37	-46	55	-36	-43	56	-33	-42
	BB	55	-35	-51	56	-36	-45	53	-35	-42	54	-32	-42
Magenta	WB	48	75	-4	48	73	-6	46	70	-3	48	68	-1
	BB	47	73	-4	47	71	-7	45	68	-4	46	65	-2
Yellow	WB	89	-4	93	87	-3	90	84	-2	89	85	-2	83
	BB	87	-4	91	84	-3	87	81	-2	86	82	-2	80
Red	WB	48	68	47	48	66	45	47	64	45	47	63	41
	BB	46	67	45	47	64	43	45	62	43	46	61	39
Green	WB	50	-65	26	51	-59	27	49	-56	28	50	-53	26
	BB	49	-63	25	49	-57	26	48	-54	27	49	-51	24
Blue	WB	25	20	-46	28	16	-46	27	15	-42	28	16	-38
	BB	24	20	-45	27	15	-45	26	14	-41	27	15	-38
Overprint CMY_{100}	WB	23	0	-1	28	-4	-1	27	-3	0	27	0	-2
	BB	23	0	-1	27	-4	-1	26	-3	0	26	0	-2
Measurement is in accordance with ISO 13655-D50 illuminant, 2° observer, 0:45 or 45:0 geometry. Measurements should be made using M1. Values are given for white backing (WB) and black backing (BB) on dry sheets.													

Table 6 — CIELAB coordinates of colours for the printing sequence cyan-magenta-yellow

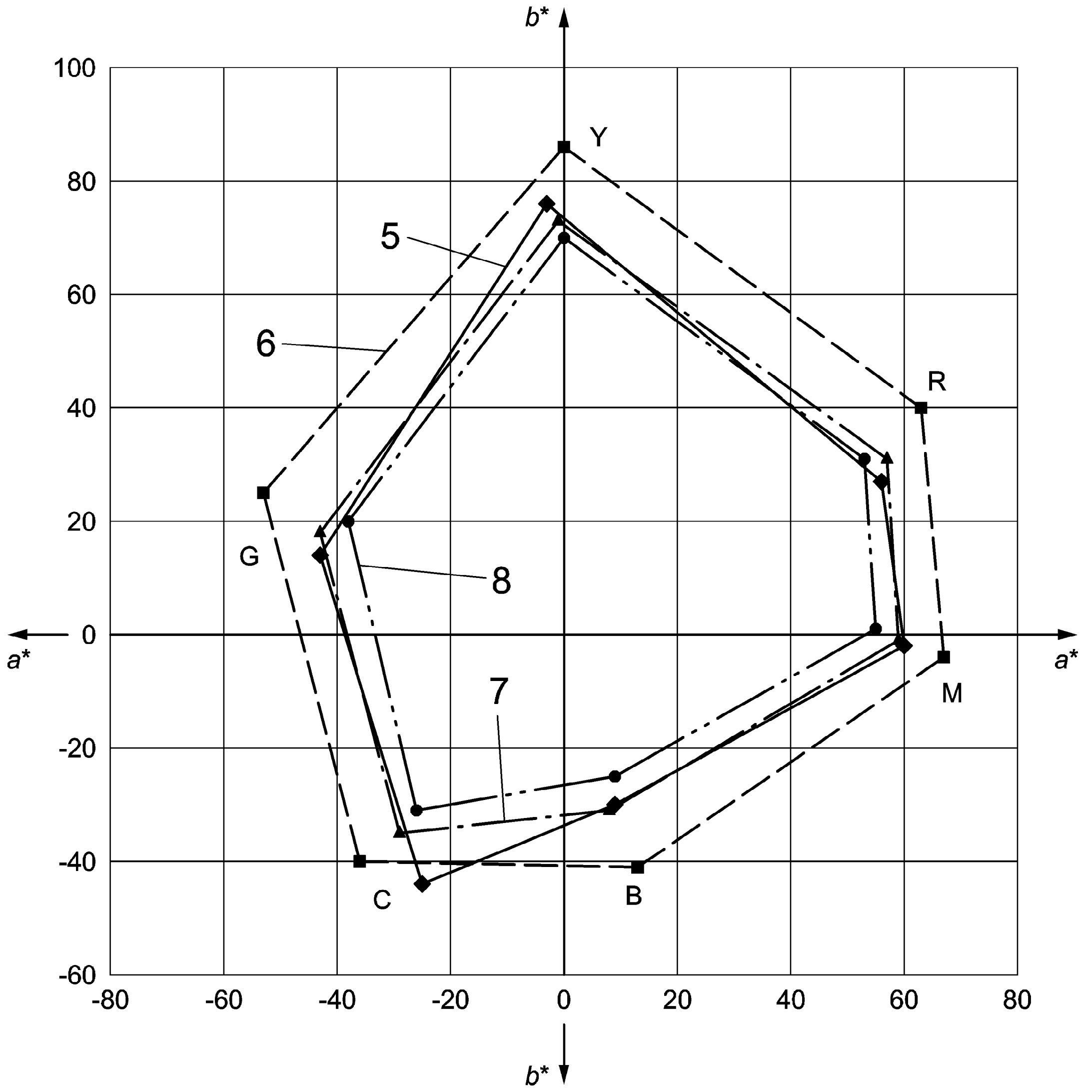
Characteristic		Colorant Description											
		CD5 Wood-free uncoated			CD6 Super calendered			CD7 Improved uncoated			CD8 Standard uncoated		
Colour		Coordinates			Coordinates			Coordinates			Coordinates		
		L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Black	WB	33	1	1	23	1	2	32	1	3	30	1	2
	BB	32	1	1	22	1	2	31	1	3	28	1	2
Cyan	WB	60	-25	-44	56	-36	-40	59	-29	-35	54	-26	-31
	BB	58	-24	-44	54	-35	-40	57	-29	-35	52	-26	-31
Magenta	WB	55	60	-2	48	67	-4	53	59	-1	51	55	1
	BB	53	58	-3	46	65	-4	51	56	-2	50	52	-1
Yellow	WB	89	-3	76	84	0	86	83	-1	73	79	0	70
	BB	86	-3	73	81	0	83	80	-2	70	76	0	67
Red	WB	53	56	27	47	63	40	51	57	31	48	53	31
	BB	51	55	25	46	61	38	49	54	29	47	51	29
Green	WB	53	-43	14	49	-53	25	53	-43	18	47	-38	20
	BB	52	-41	13	48	-52	24	51	-43	17	46	-37	18
Blue	WB	39	9	-30	28	13	-41	37	8	-31	36	9	-25
	BB	37	9	-30	27	12	-40	36	7	-30	34	9	-26
Overprint CMY_{100}	WB	35	0	-3	27	-1	-3	34	-3	-5	33	-1	0
	BB	34	0	-3	26	-1	-4	33	-3	-5	31	-2	0
Measurement is in accordance with ISO 13655-D50 illuminant, 2° observer, 0:45 or 45:0 geometry. Measurements should be made using M1. Values are given for white backing (WB) and black backing (BB) on dry sheets.													



Key

1	CD1
2	CD2
3	CD3
4	CD4
a*	CIELAB green-red coordinate *a**
b*	CIELAB blue-yellow coordinate *b**

Figure 1 — Projection of the defined colorant descriptions according to Table 5 into the CIE a*b*-plane (White backing)



Key

5 CD5

6 CD6

7 CD7

8 CD8

a* CIELAB green-red coordinate *a**

b* CIELAB blue-yellow coordinate *b**

Figure 2 — Projection of the defined colorant descriptions according to Table 6 into the CIE a*b*-plane (White backing)

The deviation of the process colour solids of the OK print of the production run is restricted by the condition that the colour differences between press proof prints and OK print shall not exceed the deviation tolerances specified in Table 7. If no conforming proof, ICC profile, or data set is supplied, the colour values of Table 5 and Table 6 shall provide the aim.

The variability of the process colour solids in production is restricted by the following condition. For at least 68 % of the prints, the colour differences between a production copy and the OK print shall not exceed the pertinent variation tolerances specified in Table 7.

NOTE 1 The distribution of ΔE* values is not Gaussian but skewed. For reasons of consistency, the variation tolerance is defined here as the upper limit for 68 % of the production copies. This is in analogy with a Gaussian distribution where 68 % are within plus or minus one standard deviation of the mean.

EXAMPLE For a given print volume and a sufficient number of measured samples calculate the standard deviation relative to the OK print. If the standard deviation is within the variation tolerance, the colour difference of 68 % of the samples is within ΔE* ≤ 5 and the print run is OK.

NOTE 2 Density values according to ISO 5-3 [2] can be valuable for process control during a print run, where the instrument, the ink and the print substrate remain the same. However, in a general situation, density values do not define a colour to the required degree. Therefore, for the purpose of this part of ISO 12647, reflection density values are only recommended for the determination of tone values. Typically, the production press operator first achieves the correct colour of the solids on the press and then reads the densities with the instrument from the OK print. The densities are then used as aim values for process control during the production run.

NOTE 3 If the final print is subjected to surface finishing, the final colours (and gloss) might deviate appreciably from those of the unfinished print.

NOTE 4 The secondary colours red, green and blue depend on conditions that include the printing sequence, the rheological and transparency properties of the inks, mechanics of the press and the surface characteristics of the print substrate. Thus, it is not possible to state tolerance windows for both solids and overprints.

NOTE 5 In the case that a digital proof print in conformance with ISO 12647-7 is present it should be used as a visual reference for final fine tuning in the make-ready phase.

NOTE 6 In case that the print substrate shows a high fluorescence (e.g. as a result of OBA) it might be necessary to establish a new, appropriate set of solid coloration (colorant description) values. This is especially relevant (but not exclusive) to paper types covered by PS1 and PS5 (colorant descriptions CD1 and CD5).

NOTE 7 The lines connecting the coordinate points in Figure 1 and 2 shows only the relation of the different colorant descriptions and do not represent the colour's gamut.

NOTE 8 The CIELAB colour coordinates of the process colour solids can be extracted from characterization data if necessary.

Table 7 — CIELAB Δ*Eab* tolerances for the solids of the process colours

Process colour	**Deviation tolerance**		**Variation tolerance**		
	OK print		**Production print**		
	Δ*Eab*	Δ*Eoo* [a]	Δ*Eab*	Δ*Eoo* [a]	Δ*H*
Black	5	5	4	4	-
Cyan	5	3,5	4	2,8	3
Magenta	5	3,5	4	2,8	3
Yellow	5	3,5	5	3,5	3

[a] Tolerance values for DE2000 are given for information only

4.3.2.4 Ink set gloss

The gloss of solid tone colours may be specified if deemed necessary.

The specular gloss of the ink set single-print solid areas should be measured with light incident at 60° or 75° and measured accordingly. The instrument used shall conform to either ISO 8254-2 (for 75°) or ASTM D7163 (for the 60°). The method used shall be reported.

4.3.3 Tone value reproduction limits

Half-tone dot patterns within the following tone value limits in the digital data file should transfer onto the print in a consistent and uniform manner:

a) 2 % to 98 % for coated paper (screen ruling 60 cm^{-1} to 80 cm^{-1}, spot size 20 µm);

b) 4 % to 96 % for uncoated paper (screen ruling 60 cm^{-1}, spot size 30 µm).

No significant image parts should rely on tone values outside of the above tone value reproduction limits.

4.3.4 Tone value increase and spread

4.3.4.1 Aim values

The tone value increase for printing and press proof prints shall conform to Table 8; see also Figure 3. For calibration purposes Table 9 should be used (see also Notes 5 and 6).

Table 8 — Tone value increase for the control patches of a control strip

Values in percent

Printing condition	Periodic screens				Non-periodic screens			
	40	50	75	80	40	50	75	80
PC1	15	16	13	11	28	28	18	15
PC2, PC3, PC4	19	19	14	12	28	28	18	15
PC5, PC6, PC7, PC8	22	22	15	13	28	28	18	15

NOTE 1 The values given in Table 8 refer to densitometric measurement according to ISO 5-3 in a control strip, with an ISO Status E response, without polarization. Similar results are achievable when using a polarization filter.

NOTE 2 When using standard inks the measurement of TVI using Status T produces results that are close to those produced when using Status E measurements.

NOTE 3 Given a characterization data set or an ICC profile colorimetric tone values and colorimetric tone value increase values can be calculated. However the concrete values depend on the colour channel and the printing condition and tend to differ from the densitometric tone values. More information on how to link colorimetric toward densitometric tone values can be found in ISO/TS 10128 (see also 4.2.1, fourth paragraph).

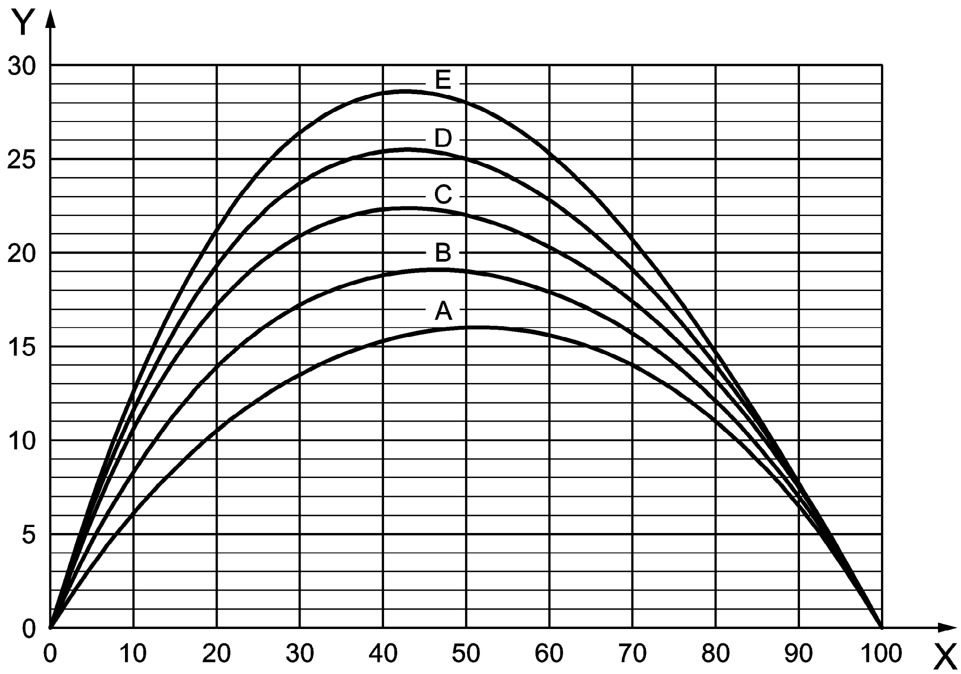


Figure 3 — Tone value increase curves for the printing conditions defined in Table 1

Table 9 — Tone value increase values for the printing conditions defined in Table 1

Tone value	**Tone value increase**				
	A	**B**	**C**	**D**	**E**
%	%	%	%	%	%
0	0,0	0,0	0,0	0,0	0,0
5	3,3	4,6	5,8	6,4	6,8
10	6,1	8,3	10,6	11,6	12,6
20	10,5	13,9	17,2	19,3	21,2
30	13,5	17,2	20,9	23,7	26,4
40	15,3	18,8	22,3	25,4	28,5
50	16,0	19,0	22,0	25,0	28,0
60	15,6	17,9	20,3	22,8	25,3
70	14,0	15,7	17,4	19,1	20,7
80	11,0	12,1	13,2	14,0	14,7
90	6,5	7,0	7,5	7,7	7,7
95	3,5	3,8	4,0	4,0	3,9
100	0,0	0,0	0,0	0,0	0,0

NOTE 4 It is common practice to use a tone value of 40 % or 50 % for the mid-tone range and a tone value of 75 % or 80 % for the shadow region in the pertinent control strip.

NOTE 5 The tone value increase for the 50 % control patch of a control strip was chosen to be an integer value.

NOTE 6 For process calibration and control purposes it is sometimes necessary to calculate the tone value or tone value increase on a print for additional tone values. For this exemplary fourth order polynomials function describing the curves in Figure 3 and Table 9 is given as follows:

$$TVI(x) = 100 * \left(a * x^4 + b * x^3 + c * x^2 + d * x\right)$$

where

TVI	is the tone value increase as a percentage value;
a, *b*, *c*, *d*	are the coefficients of the polynomial;
x	is the tone value normalized between 0 and 1; *x* = TV/100;
TV	is the tone value in % ranging from 0 to 100.

The polynomial coefficients are given in Table 10.

Table 10 — Polynomial coefficients for tone value increase curves in Figure 3

Polynomial coefficient	Tone value increase curve				
	A	**B**	**C**	**D**	**E**
a	−0,3650	−0,5877	−0,7854	−0,4441	−0,0438
b	0,6730	1,3575	1,9934	1,4386	0,7664
c	−1,0108	−1,7678	−2,4956	−2,3805	−2,1929
d	0,7029	0,9980	1,2876	1,3860	1,4703

4.3.4.2 Tone value and mid-tone spread tolerances

The tolerance of the tone value increase and mid-tone spread of an OK print from the specified aim value shall not exceed the tolerances specified in Table 11.

For production printing, for at least 68 % of the prints, the TVI differences between a production copy and the OK print shall not exceed the pertinent variation tolerances specified in Table 11.

The mid-tone spread (variation of tone values between chromatic colours) of at least 68 % of production printing samples shall not exceed the values listed in Table 11.

Table 11 — Tone value increase tolerances and maximum mid-tone spread for proof and production printing

Values in percent

Tone value of control patch	Deviation tolerance	Variation tolerance
	OK print	**Production print**
< 30	3	3
30 to 60	4	4
> 60	3	3
Maximum mid-tone spread	5	5

NOTE 1 The values in Table 11 refer to measurements on a control strip with a screen ruling to be the same as the subject.

NOTE 2 Percentage tolerances are calculated by subtracting the aim value from the measured value.

4.3.5 Tolerance for image positioning

The average of colour register centres shall not exceed 0,10 mm as the largest deviation between any two printed colours.

NOTE Suitable tools for colour register measurement are for example the Vernier scale or electronic measurement equipment.

4.3.6 Conformance

This part of ISO 12647 only defines conformance requirements with respect to those which are necessary to provide repeatable and reproducible conformity assessment results. Additional conformity assessment requirements for product, process, service, persons, systems or bodies are not covered in this part of ISO 12647.

With respect to the evaluation of conformance, the provisions for both an individual production print and the entire print run are summarized as follows. In order to specify the aim values for conformance scrutiny first the printing condition shall be identified by means of the pertinent substrate, the screening used and inking sequence. If a printing condition is used that is not defined in this International Standard the conformance label shall report the solid coloration and tone value increase aim values relating to that printing condition.

An ISO 12647-2 conforming print shall conform to the following requirements:

a) a control strip in conformance with ISO 12647-1 to be positioned across the printing direction covering all ink zones to be used for the printed image;

b) ink set colours (4.3.2.3);

c) tone-value increase and mid-tone spread (4.3. 4).

All control patches of the control strip shall be in conformance with the above requirements.

An ISO 12647-2 conforming print should conform to the following requirements:

— tone value reproduction limits (4.3.3);

— tolerance for image positioning (4.3.5).

For a conforming print run, a minimum of 68 % of randomly selected individual print samples spread across the production run shall conform to all normative criteria of this specification.

NOTE 1 The number of print samples required depends on the print run length and is typically defined by a print certification scheme.

NOTE 2 Ink zones with area coverage less than 5 % for each colour can be excluded for the purposes of conformance evaluation.

NOTE 3 Ink zones with high area coverage that do not allow for reliable tone value measurements can be excluded for the purposes of conformance evaluation of tone value increase and spread.

NOTE 4 All conformance measurements for a production print or an entire print run can be done on white or black backing.

NOTE 5 All conformance measurements for a production print or an entire print run can be done on dry sheets, after some time that depends on the process and materials.

NOTE 6 An additional control strip, to be placed in the printing direction, can be used for additional evaluation only if enough ink consumption is present in the pertinent ink zone.

5 Measurement methods

5.1 Computation of densities, CIELAB colour coordinates and CIELAB colour differences

Both colour and density measurements shall be made in conformance with ISO 13655 and ISO 5-3. If there are differences to be expected between wet and dry density measurements, a polarization filter should be used.

The computation of CIELAB colour coordinates and CIELAB colour differences shall be made in conformance with ISO 12647-1 and ISO 13655.

5.2 Control strip

On each print a control strip conforming to ISO 12647-1, 5.2, shall be used. Additional control strips, usually placed within printing direction, may be used.

Report all results as specified in ISO 12647-1, A.6.

Annex A
(informative)

Grey reproduction and grey balance

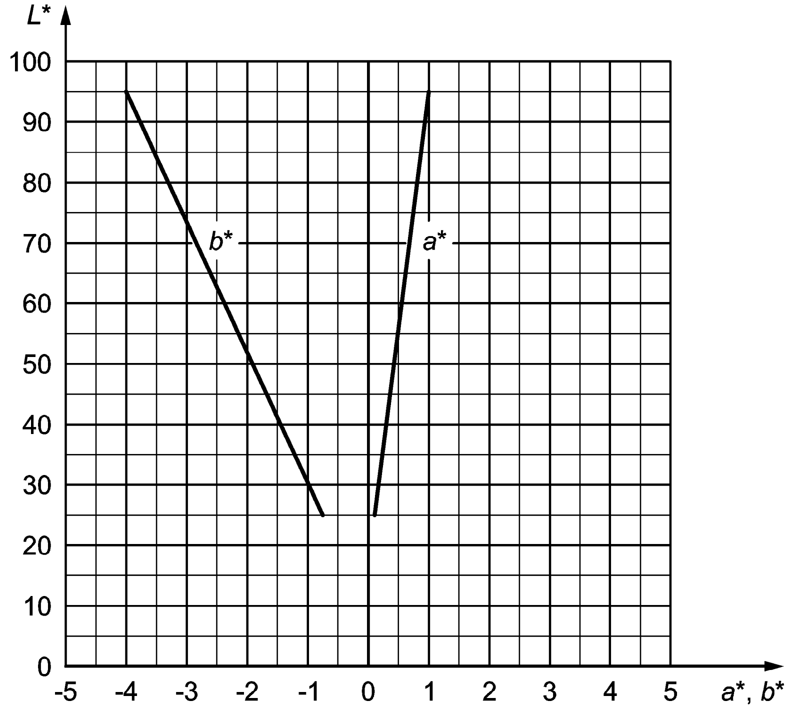
With the aid of colour-management profiles and/or special interpolation techniques that are based on a given printing condition and its characterization data set according to ISO 12642, the grey balance conditions are accessible. A single grey balance condition is usually not sufficient to ensure an achromatic colour for all print substrates and printing inks that are used for a given printing condition. In addition, it usually depends on the particular black composition used.

On the other hand, given a well characterized printing process based on well defined aim values for the tone value increase and the coloration of the solids, it might be useful to evaluate the grey balance of this process. Therefore a well proven definition of a grey reproduction might be necessary.

Older versions of this part of ISO 12647 provide two practical definitions for grey: a colour having the same a^* and b^* CIELAB values as the print substrate and a colour having the same a^* and b^* CIELAB values as a half-tone tint of similar L^* value printed with black ink. The second definition is particularly useful in the mid-tone and shadow, whereas the first is best applied to highlight tones. So it seems useful to define a mixture of both or something similar for a single grey definition.

Most of the commonly used papers have differing amounts of optical brightening agents. This can result in bluish CIELAB values for the paper white when using the colorimetry established for non-fluorescent samples while the visual appearance is nearly neutral for an observer.

The grey definition in 4.2.8, a colour having a^* and b^* CIELAB values ranging from paper white a^* and b^* to less chromatic values for darker grey, is a good compromise between an easy implementation and a more complex colour appearance matching method. For any L^* between the paper white and the lowest achievable neutral L^* for a three-component grey it is possible to calculate a^* and b^* values. Figure A.1 shows the calculated b^* values from a typical print substrate with $a^* = 1$ and $b^* = -4$.



Key

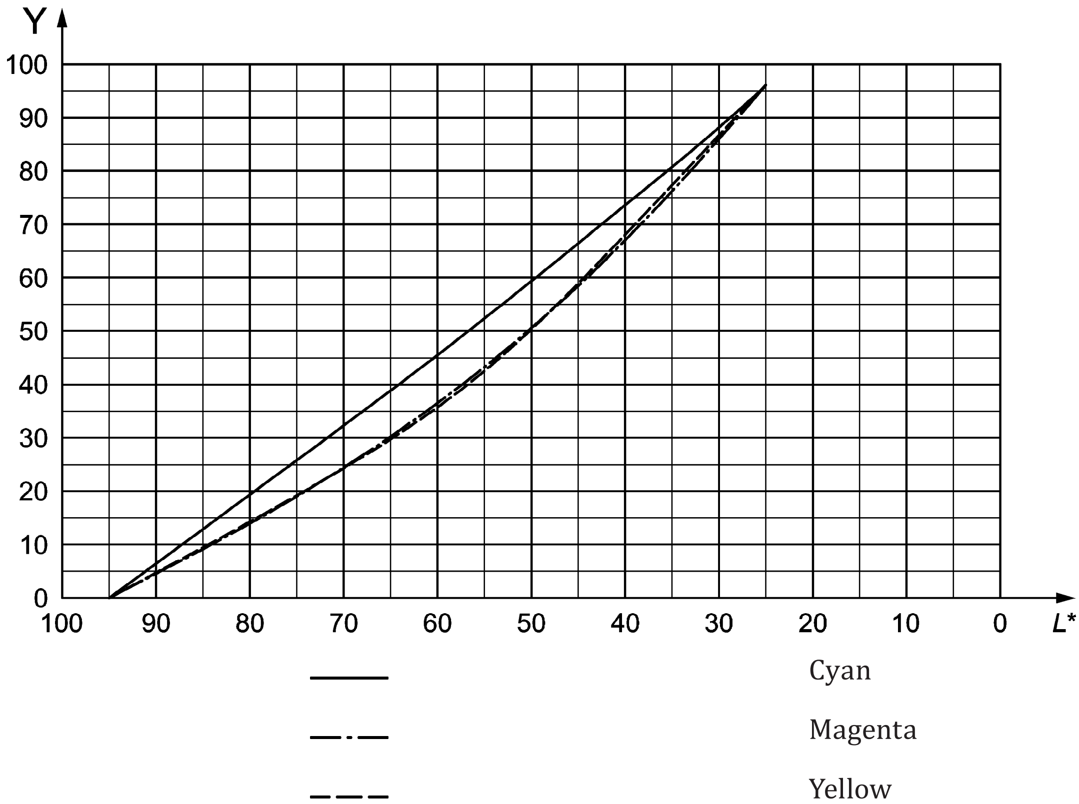
L* CIELAB lightness coordinate *L**

a* CIELAB green-red coordinate *a**

b* CIELAB blue-yellow coordinate *b**

Figure A.1 — Example grey reproduction curve

From a fully characterized printing process it is possible to calculate the corresponding grey balance values. The grey balance curve for a typical reference printing process with periodic screens on a premium coated paper is shown in Figure A.2.



Key

L* CIELAB lightness coordinate L*

Y Tone value coordinate *C, M, Y*

Figure A.2 — Example grey balance curve

From the grey balance curve it is possible to calculate grey balance and grey reproduction values for process calibration and process control purposes as shown in Table A.1.

Tolerance values for grey reproduction can be calculated from a characterized printing process based on the tone value increase tolerances and maximum mid-tone spread for proof and production printing by introducing a chroma difference ΔC_h between the desired grey reproduction chroma (a^*_1 and b^*_1) and the measured chroma of a grey balance control patch (a^*_2 and b^*_2):

$$\Delta C_h = \left[\left(a^*_1 - a^*_2 \right)^2 + \left(b^*_1 - b^*_2 \right)^2 \right]^{1/2} \quad \text{(A.1)}$$

Table A.1 — Example grey balance and grey reproduction values

Grey balance			
Unit	%	%	%
C	25,0	50,0	75,0
M	18,4	40,9	68,9
Y	18,6	40,1	69,9
Grey reproduction			
Unit	1	1	1
L*	75,6	56,7	39,0
a*	0,8	0,5	0,3
b*	−3,1	−2,2	−1,4
Tolerance			
Unit	1	1	1
ΔC_h	3,0	3,8	3,4
The calculation of the grey reproduction values are based on substrate values (White Backing): L* = 95, a* = 1, b* = −4.			

It should be noted that the tolerance values for highlight, mid-tone and shadow depend on the printing process tone value increase and the lightness of the cyan, magenta and yellow overprint and should be calculated for every printing condition separately.

For printing conditions as described in this part of ISO 12647 it is recommended to create standard characterization data sets. From these data sets grey balance and grey reproduction data and special control aids as well as profiles for colour separation can be derived.

Annex B
(informative)

Handling differences in paper colour

In some cases the paper selected for production does not match the reference exactly and in these cases it might be necessary to adjust some of the printing aim values. There is currently no reliable method to determine whether such an adjustment is necessary and furthermore there is no universally agreed method for making these adjustments. For small differences in paper colour no correction is necessary and aim values and tolerances defined in this part of ISO 12647 should be used with no modification. For larger differences some adjustment might be necessary and this annex provides some information about one method that has had some success. There are other methods in use today, some of which might produce more accurate results or are easier to use and these other methods might be preferred by some users.

If necessary, the substrate correction should be applied to the values in Tables 2, 3, 5 and 6 and these corrected values should be used for process control. Printing tolerances should not be modified.

One conversion method that produces reasonable results is based on the observation that if the differences of CIE *X*, CIE *Y*, and CIE *Z* between measurements made of identical images on substrates having different colours are plotted versus CIE *X*, CIE *Y*, and CIE *Z* for measurements on either substrate, the best fit result is approximately a straight line. This leads, as an approximation, to a linear conversion.

For CIE *X*:

$$X_2 = X_1 * \left(1 + C\right) - X_{\text{min}} * C \tag{B.1}$$

with

$$C = \left(X_{S2} - X_{S1}\right) / \left(X_{S1} - X_{\text{min}}\right) \tag{B.2}$$

where

X_1 is the measured value of *X* of a coloured patch on substrate 1;

X_2 is the estimated value of *X* of an equivalent coloured patch on substrate 2;

C is a constant;

X_{S1} is the measured value of *X* of substrate 1;

X_{S2} is the measured value of *X* of substrate 2;

X_{min} is the minimum value of *X* for any patch printed on substrate 1.

Conversion of CIE *Y* and CIE *Z* is accomplished analogously and new CIE *L**, *a** and *b** CIELAB values are computed.

This colorimetric conversion method is referred to as the tristimulus correction method.

NOTE This is similar to the ICC method referred to as substrate relative colorimetric transforms and is identical to that method where the Black Points of both substrates have CIE X = CIE Y = CIE Z = 0,0.

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[1] Research or trade organization that publishes fully characterized printing conditions: - Fogra, Graphic Technology Research Association (www.fogra.org), - IDEAlliance, International Digital Enterprise Alliance (www.idealliance.org), - WAN-IFRA, World Association of Newspapers and News Publishers (www.wan-ifra.org), - JPMA, Japan Printing Machinery Association (www.jpma-net.or.jp), - ICC, International Color Consortium, (www.color.org).

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

[3] ISO 12642-1, *Graphic technology — Input data for characterization of four-colour process printing — Part 1: Initial data set*

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

[5] ISO 15076-1:2010, *Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2010*

[6] ISO 15930-4:2003, *Graphic technology — Prepress digital data exchange using PDF — Part 4: Complete exchange of CMYK and spot colour printing data using PDF 1.4 (PDF/X-1a)*

[7] ISO 15930-7:2010, *Graphic technology — Prepress digital data exchange using PDF — Part 7: Complete exchange of printing data (PDF/X-4) and partial exchange of printing data with external profile reference (PDF/X-4p) using PDF 1.6*

[8] ISO 15397, *Graphic Technology — Communication of graphic paper properties*

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