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

Part 5: Screen printing

Technologie graphique — Contrôle du processus de confection de sélections couleurs tramées, d'épreuves et de tirages —

Partie 5: Sérigraphie

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 12647 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12647-5 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

ISO 12647 consists of the following parts, under the general title *Graphic technology — Process control for the manufacture 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 and letterpress on newsprint*

— *Part 4: Publication gravure process*

— *Part 5: Screen printing*

— *Part 6: Flexographic printing*

— *Part 7: Processes using digital printing or reproductions made on various traditional printing processes from digital files*

Annex A of this part of ISO 12647 is for information only.

Introduction

When producing a half-tone colour reproduction it is important that the colour separator, proofer and printer have previously specified a minimum set of parameters that uniquely define the visual characteristics and other technical properties of the planned print product. Such an agreement enables the correct production of suitable separations (without recourse to “trial and error”) and subsequent production of off-press or on press proof prints from these separations whose purpose is to simulate the visual characteristics of the finished print product as closely as possible.

It is necessary to distinguish between primary and secondary parameters. Whereas primary parameters, which are described in this part of ISO 12647, are defined here as having a direct bearing on the visual characteristics of the image, secondary parameters only influence the image indirectly by changing the values of primary parameters. Secondary parameters include:

— colour separation film thickness;

— film polarity (negative or positive);

— roughness of the emulsion surface;

— presence of colour marking or register marks.

It is the purpose of ISO 12647-1 to list and explain the minimum set of process parameters required to uniquely define the visual characteristics and related technical properties of a half-tone proof or production print produced from a set of half-tone separation films.

It is the purpose of this part of ISO 12647 to list suggested values or sets of values of the primary parameters specified in ISO 12647-1 and related technical properties of a half-tone screen print produced from a set of half-tone colour separation films. Secondary parameters are also recommended for specification where deemed useful.

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

Part 5: Screen printing

1 Scope

This part of ISO 12647 specifies a number of process parameters and their values to be applied when preparing colour separations for four-colour screen process printing when producing four-colour proof and production prints by flat bed or cylinder screen printing.

The parameters and values are chosen in view of the complete process covering the following process stages:

— colour separation,

— making of the printing forme,

— proof production,

— production printing,

— surface finishing.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12647. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12647 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5-3, *Photography — Density measurements — Part 3: Spectral conditions*

ISO 2846-4, *Graphic technology — Colour and transparency of printing ink sets for four-colour printing — Part 4: Screen printing*

ISO 12637-5, *Graphic technology — Multilingual terminology of printing arts — Part 5: Screen printing terms*

ISO 12647-1:1996, *Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods*

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

3 Terms and definitions

For the purposes of this part of ISO 12647, the terms and definitions given in ISO 12647-1 and ISO 12647-5 apply.

4 Requirements

4.1 General

The following subclauses are arranged according to the order set out in ISO 12647-1; they also depend on it for the definition of parameters and test methods.

4.2 Colour separation films

4.2.1 Quality

Unless otherwise specified, the core density shall be at least 3,5 above the transmission density of the clear film (film base plus fog). The transmission density in the centre of a clear half-tone dot shall not be more than 0,1 above the corresponding value of a large clear area. The transmission density of the clear film shall not be higher than 0,15. Both measurements shall be made with a (UV) transmission densitometer whose spectral products conform to ISO type 1 printing density as defined in ISO 5-3. The fringe width shall not be greater than one fortieth of the screen width; the half-tone dot shall not be split up in distinct parts. The colour separation film quality shall be evaluated according to ISO 12647-1:1996, annex B.

NOTE 1 The clear film density requirement is based on the understanding

— that the density range of the clear areas of all films that are to be exposed onto a screen printing forme, for consistent work, needs to be less than 0,10;

— that 0,05 represents the lowest commonly found value for ISO type 1 printing density.

In order to minimize the impact of the use of half-tone films with clear film densities above this range, agreements between the supplier of colour separations and the recipient are required. Contacting or duplicating can also be used to bring half-tone films with dissimilar clear film densities into agreement.

NOTE 2 As a practical guide, a core density of 3,5 above the clear film density will normally be achieved if the density of large solid areas is more than 4,5 above the clear film density.

NOTE 3 If a user wishes to use a blue filter for transmission density measurements it is necessary to determine, for the particular film type and processing conditions, the correlation between densities obtained with the blue filter and those obtained with an ISO type 1 printing density instrument. For the measurement of core density an ISO type 2 printing instrument may be used.

4.2.2 Screen ruling

The screen ruling (screen frequency) shall be within the range 20 cm^{-1} to 40 cm^{-1}.

NOTE 1 Outside of the 20 cm^{-1} to 40 cm^{-1} range the general principles of this part of ISO 12647 remain valid but specific values may differ.

NOTE 2 With computer generated screening, the parameters “screen ruling” and “screen angle” may be varied slightly in conjunction, from one process colour to another, in order to minimize moiré patterns.

4.2.3 Screen angle

The angles of the screen mesh shall be 0° and 90° with respect to the frame.

For half-tone dots without a principal axis, the nominal difference between the screen angles for cyan, magenta and black shall be 30°, with the screen angle for yellow separated by 15° from another colour. A typical example is shown in Figure 1. No colour should align with mesh warp or weft, or diagonal. In order to achieve this, one colour should be rotated by 7,5° with respect to the mesh. These values refer to the films; right reading, emulsion up.

For half-tone dots with a preferential axis, the nominal difference between the screen angles for cyan, magenta and black shall be 60°, with the screen angle for yellow separated by 15° from another colour. A typical example is shown in Figure 2.

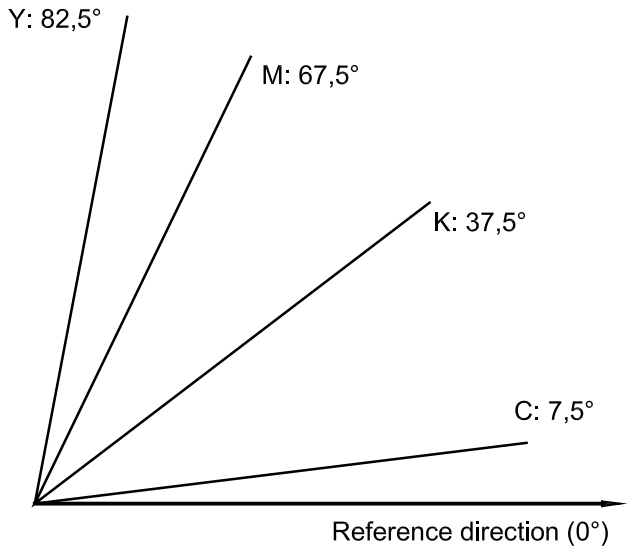

Figure 1 — Typical screen angles for half-tone dots without a principal axis

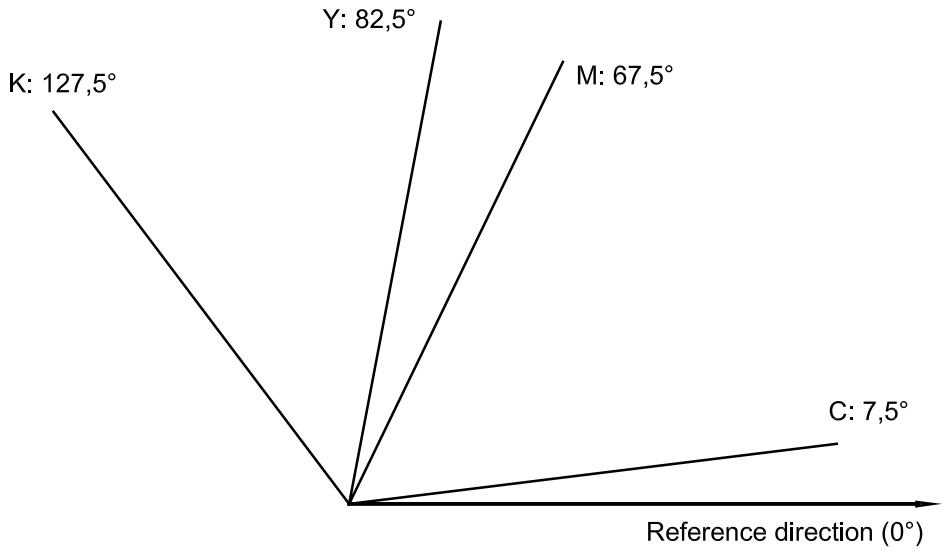

Figure 2 — Typical screen angles for half-tone dots with a principal axis

4.2.4 Dot shape and its relationship to tone value

Where elliptical half-tone dots are used, the first link up shall occur no lower than at 35 % tone value and the second linkup no higher than at 65 % tone value.

4.2.5 Image size tolerance

For a set of colour separation films in common environmental equilibrium, the lengths of the diagonals shall not differ by more than 0,02 %.

NOTE This tolerance includes image-setter repeatability and film stability.

4.2.6 Tone value sum

There is no restriction on the tone value sum.

NOTE Tone value sums between 300 % and 400 % may be used. However, in order to match products from other processes, a lower tone value sum may be appropriate.

4.2.7 Grey balance

Grey balance, unless otherwise specified, should be given by the tone value combinations of Table 1.

Table 1 — Grey balance

Tone value	Cyan %	Magenta %	Yellow %
25 % tone	25	15	15
50 % tone	50	40	40
75 % tone	75	64	64

4.3 Print

4.3.1 Visual characteristics of image components

4.3.1.1 Print substrate colour

For the three gamut classes defined in 4.3.1.3, the print substrate colour shall be white with the colorimetric properties shown in Table 2. The print substrate used for proofing should be identical to that used for the production. If that is not possible the print substrate used for proofing shall be a close match to that used for the production in terms of colour, gloss, type of surface (such as paper, plastic, board) and mass per area.

NOTE If the final product is to be surface finished, this may severely affect the substrate colour.

Table 2 — Print substrate colour restrictions

$100 \geqslant L^{*}$ [a] $\geqslant 90$
$-3 \leqslant a^{*}$ [a] $\leqslant 3$
$-5 \leqslant b^{*}$ [a] $\leqslant 5$
[a] Measured according to ISO 12647-1:1996, 5.6.

4.3.1.2 Print substrate gloss

The gloss of the substrate used for proofing should be a close match to that of the production substrate.

NOTE If the final product is to be surface finished this will severely affect the gloss. In critical cases, the result of the colour separation stage may be judged by means of a proof that closely matches the gloss of the final surface finished print product. 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 production printer with an additional proof copy whose gloss matches that of the production substrate.

4.3.1.3 Ink set colours

Using process inks in accordance with ISO 2846-4, the CIELAB colour co-ordinates L^{*}, a^{*}, b^{*} of the process colour solid tones on the proof shall be as given in Table 3, and within the deviation tolerance values specified in Table 4. The colour co-ordinates of the two colour overprints without black should be as given in Table 3.

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 from the OK sheet shall not exceed the appropriate variation tolerance specified in Table 4 and should not exceed one half of that value.

Table 3 — CIELAB coordinates of solid colours

Colour	Gamut class								
	1			2			3		
	L^* [a]	a^* [a]	b^* [a]	L^* [a]	a^* [a]	b^* [a]	L^* [a]	a^* [a]	b^* [a]
Cyan	59	− 35	− 43	52	− 33	− 51	46	− 32	− 54
Magenta	51	70	− 15	47	74	− 5	42	79	10
Yellow	90	− 11	66	89	− 9	83	88	− 7	100
Black	24	0	0	18	0	0	8	0	0
Red [b]	50	59	42	47	67	50	44	66	47
Green [b]	55	− 68	32	49	− 65	30	43	− 62	28
Blue [b]	28	27	− 41	21	26	− 40	16	29	− 39

[a] Measured according to ISO 12647-1:1996, 5.6.

[b] Colour sequence yellow, cyan, magenta.

NOTE 1 The provision of colour co-ordinates for three gamut classes in Table 3 reflect the wide range of products produced by graphic screen printing. Gamut class 1 is appropriate for low saturation applications. Gamut class 2 is appropriate for medium saturation applications such as when it is necessary to match other printing processes. Gamut class 3 is appropriate for high saturation applications such as point of sale.

NOTE 2 If a white backing is used instead of a black backing, the colour co-ordinates a^* and b^* of Table 3 remain essentially the same. However, the L^* values may be higher, dependent on substrate opacity.

NOTE 3 If the final print product is to be surface finished, the colours may deviate appreciably from those of the unfinished print.

NOTE 4 The secondary colours red, green, blue are dependent on the print sequence and can vary depending on conditions that include the mechanics of the press, the surface characteristics of the substrate and the rheological and transparency properties of the inks. Thus, conformance of the primaries to specifications is not sufficient for the conformance of the secondaries.

NOTE 5 Annex A (informative) gives the reflection densities of the process colour solids.

Table 4 — CIELAB ΔE^*_{ab} tolerances for the solids of the process colours

Type of tolerance	Black	Cyan	Magenta	Yellow
Deviation tolerance	4	5	6	6
Variation tolerance [a]	1,5	2,0	3,0	3,0

[a] The distribution of CIELAB colour differences 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 analogous to a gaussian distribution where 68 % are within plus or minus one standard deviation of the mean.

4.3.1.4 Ink set gloss

If it is deemed necessary to specify the gloss of solid tone colours then the specular gloss of the ink set single print solid areas should be measured and recorded at an agreed angle of incidence.

4.3.2 Tone value reproduction limits

Half-tone dot patterns within the tone value limits shall transfer onto the print in a consistent and uniform manner in accordance with Table 5 and should transfer in accordance with the values in Table 6. No significant image parts shall rely on tone values outside of the tone value range of Table 6 on the colour separation film.

Table 5 — Tone value ranges (on film) required to transfer

Screen ruling	Solvent inks	Air-dried water-based inks	UV inks	Water-based UV inks
cm^{-1}	%	%	%	%
20	10 to 90	10 to 90	5 to 95	10 to 90
40	20 to 80	20 to 80	10 to 90	15 to 85

Table 6 — Tone value ranges (on film) recommended to transfer

Screen ruling	Solvent inks	Air-dried water-based inks	UV inks	Water-based UV inks
cm^{-1}	%	%	%	%
20	6 to 95	6 to 95	3 to 96	5 to 94
40	10 to 90	10 to 90	8 to 92	10 to 90

NOTE In most graphic applications, particularly when printing onto paper, it is normally possible to achieve the wider tone value ranges shown in Table 6. The tone value range depends on the screen mesh used for printing. With a coarser mesh (with thicker threads) the tone value range is narrower. The tone value range narrows considerably as the screen ruling increases from 20 cm^{-1} to 40 cm^{-1}. This is particularly true for solvent inks and air-dried water-based inks.

4.3.3 Tolerance for image positioning

The maximum deviation between the image centres of any two printed colours shall not be more than 0,02 % of the printing forme diagonal.

4.3.4 Tone value increase

The tone value increase (dot gain) aim values for proof and production printing shall be as specified in Table 7. The test method shall be as specified in clause 5. The values refer to a control strip as specified in 5.1, that is with a screen ruling of 30 cm^{-1} and circular half-tone dots. If one of the value sets specified in Table 7 is observed, the print characteristic curves of the subject matter will closely resemble the corresponding curve in Figure 3 or Figure 4.

At film tone values of 25 %, 50 % and 75 %, the deviation of the tone value of a proof or an OK print from the specified value shall not exceed 5 %.

The statistical standard deviation of the tone values of a production run should not exceed 4 % (68 % of production to be within 4 % of the OK print). The spread (variation of tone value increase between chromatic colours) of proof and production printing shall not exceed 5 %.

NOTE Differences in substrates may require minor press adjustments to produce identical curves for each substrate.

Table 7 — Tone value increase characteristic for production printing, measured at 30 cm^{-1}

Type of UV	Tone value increase on print [a], %					
	Tone value on film					
	15	25	50	60	75	85
Water-based UV, conventional solvent	– 5	– 1	2	3	9	7
Conventional UV, water-based air-dried	3	7	13	14	12	8

[a] As measured with status E or T, with or without polarization.

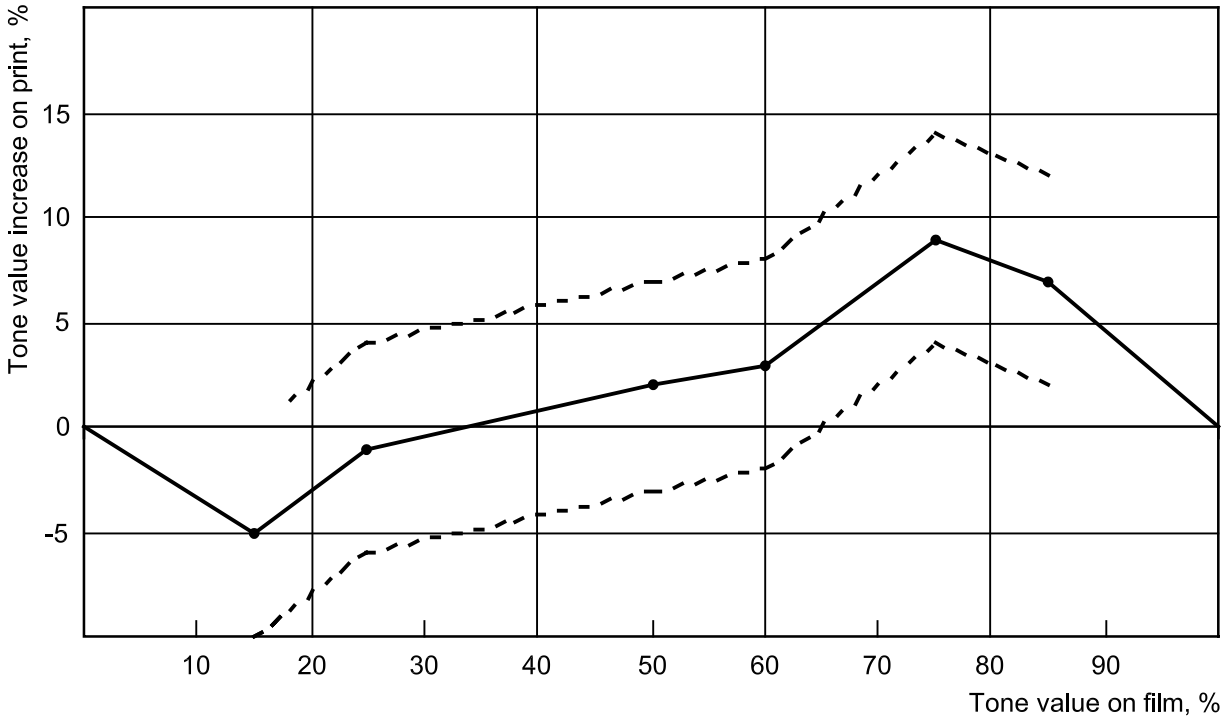

Figure 3 — Typical tone value increase curves for water-based UV and solvent ink (solid) and tolerances (broken), as measured at 30 cm^{-1}

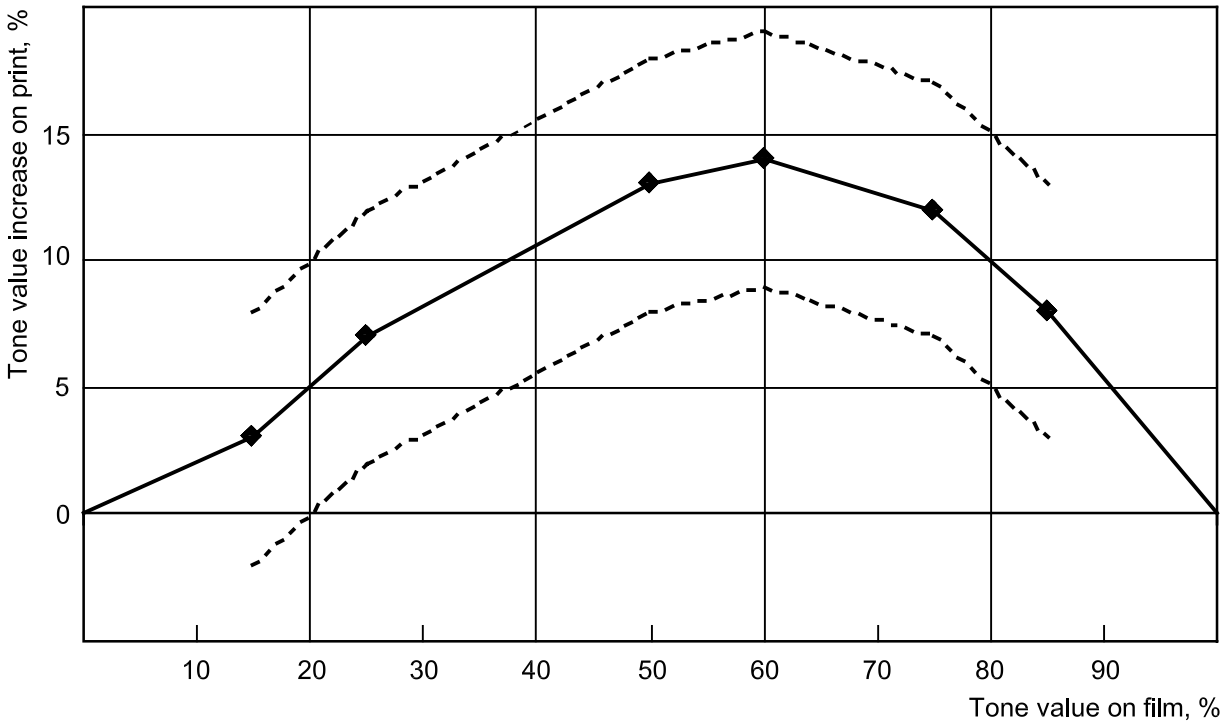

Figure 4 — Typical tone value increase curves for conventional UV and water-based air-dried ink (solid) and tolerances (broken), as measured at 30 cm^{-1}

5 Test method and reporting: Tone value measurements on a print

5.1 Film-based and digitally generated control strips

Refer to ISO 12647-1:1996, 5.3 and 5.4 and note the following additional requirements:

For process control during proof and production printing, a multi-colour control strip shall be printed along with the subject. It shall contain well-defined control patches with accurate tone value designations and meet the film quality requirements of 4.2.1. Further, the shape of the half-tone dots should be circular, the screen ruling shall be 30 cm^{-1}. The tone value ranges shall be at least those given in Table 5. For non-periodic screens, the minimum dot diameter should be 50 µm. If a digital control strip is exposed on film, together with the subject matter, the control patches should be inspected on film to ensure that the intended tone values and the requirements of this subclause have been achieved.

In addition, for information purposes, or the checking of stencil and flooding problems, half-tone control patches may be printed along with the control strip that contain the same half-tone screen type as used for the subject.

The effective measurement aperture diameter of the densitometer on the print should be at least 5 mm and shall be at least 3,3 mm.

NOTE 1 The use of a moderate chain dot shape may produce slightly (up to 1 %) higher tone values than the use of a circular dot shape.

NOTE 2 The tone value depends slightly on the instrument conditions, especially with the yellow process colour image where differences of up to 2 % may be observed in the mid-tone between wide-band instruments without polarization and narrow-band instruments with polarization.

NOTE 3 PostScript programming options permit the screen ruling and half-tone dot shape of control patches to be set independently of the screen ruling and dot shape used for the subject matter.

NOTE 4 For measurement apertures of less than 5 mm diameter it is recommended to average over five readings in every control patch.

5.2 Reporting of results

Together with the measured tone value in percent, report the tone value of the control patch (on the film or in the data), the spectral response of the instrument used, the sampling aperture size and whether polarization was used.

Annex A
(informative)

Ink set colours as measured under non-normative conditions

Table A.1 — Reflection densities of the process colour solids specified in Table 3

	Gamut class 1		Gamut class 2		Gamut class 3	
	Polarization		Polarization		Polarization	
	without	with	without	with	without	with
ISO status E reflection densities [a]						
Cyan	1,12	1,28	1,43	1,64	1,86	2,14
Print substrate	0,06	0,06	0,06	0,06	0,06	0,06
Magenta	1,14	1,54	1,45	1,96	1,88	2,54
Print substrate	0,06	0,06	0,06	0,06	0,06	0,06
Yellow	0,69	0,72	1,14	1,20	1,58	1,64
Print substrate	0,06	0,06	0,06	0,06	0,06	0,06
ISO status T reflection densities [a]						
Cyan	1,10	1,27	1,40	1,61	1,80	2,07
Print substrate	0,06	0,06	0,06	0,06	0,06	0,06
Magenta	1,10	1,49	1,40	1,89	1,80	2,43
Print substrate	0,06	0,06	0,06	0,06	0,06	0,06
Yellow	0,55	0,58	0,80	0,84	1,05	1,10
Print substrate	0,05	0,05	0,05	0,05	0,05	0,05
ISO visual reflection densities [a]						
Black	1,30	1,63	1,50	1,88	1,90	2,4
Substrate	0,08	0,08	0,08	0,08	0,08	0,08

[a] Responses according to ISO 5-3.

Bibliography

[1] CIE Publication 15.2-1986, *Colorimetry*

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