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

Part 1:
Parameters and measurement methods

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

Partie 1: Paramètres et méthodes de mesure

Reference number
ISO 12647-1:1996(E)

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.

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.

International Standard ISO 12647-1 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 processes*

Annex A forms an integral part of this part of ISO 12647. Annexes B and C are for information only.

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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 the purpose of this part of ISO 12647 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. Other parts of ISO 12647 define specific values for these parameters which are appropriate for specific processes (such as offset or gravure). For some processes certain parameters are more significant than others and may be specified as mandatory whilst the remainder are optional. However, in this part of ISO 12647 all parameters are treated equally.

It is also necessary to distinguish between primary and secondary parameters. This part of ISO 12647 describes only primary parameters. Whereas primary parameters are defined 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;

— image orientation (wrong-reading or right-reading);

— film polarity (negative or positive);

— roughness of the emulsion surface;

— presence of colour marking or register marks.

Where necessary, for specific process applications, secondary parameters may be specified in addition to primary parameters but they are not included in this part of ISO 12647 except in the definitions.

During the process of colour separation for multi-colour half-tone printing, a set of half-tone separation films is normally produced from a multi-coloured continuous-tone original. This usually consists of a photographic transparency or a reflection copy print though any graphic material, in analogue or digital form, may be used.

The process of colour separation does not provide a unique transformation of the colour values of the original into those of the production print. For every distinguishable spot of the original, the colour (characterizable by three colorimetric values, e.g. X, Y, Z or L^*, a^*, b^* or hue, saturation and lightness) has to be converted into tone values (dot areas) for four or more process colour separation films. However, in most cases the density range (and, hence, colour gamut) of the original is wider than that achievable in press printing. As a result, the colour separation process requires some degree of interpretation of the original by the colour separator and the resultant transformation may differ from one original to another.

Whatever freedom there exists for the colour separation process, it is important that the values of the process parameters of the printing press to be used for production are taken into account. This is because the process steps that follow colour separation, namely proofing (on- and off-press), production of the printing forme (for on-press proofing or production printing), production printing and print surface finishing, are normally carried out with a rigid set of process parameters which include

— the properties of the print substrate;

— the optical properties of solid prints of the process inks;

— the tone value increase curve.

Maintaining consistent values for the parameters at all steps in the process is important to ensure predictable reproduction. Any unforeseen variation of these values is usually to the detriment of the visual characteristics of the image.

The technical background discussed so far shows that the processes of colour separation and proofing require prior knowledge of the values of the process parameters encountered in production printing. Since it is virtually impossible to print all jobs with the same set of process parameters, irrespective of the type of press, printing forme, or substrate used, there has to be an efficient information exchange between the colour separator, the proof printer and the production printer which defines the specific parameters for that job.

To facilitate the information interchange, this part of ISO 12647 defines a number of parameters whose values should be specified when a set of colour separation films, with accompanying proof print, is being ordered. Specific values for each parameter are assigned in other parts of ISO 12647; this part is concerned with definitions and test methods only.

Because the proof print is the principal means of communication between pre-press and printing, it is important that

— the proof print be made using the best achievable simulation of the intended printing parameters and

— production printing attempt to match the visual characteristics of the approved proof print.

One of the major variations between and within printing processes is between tone value increase curves (or "dot gain curves"), examples of which are shown schematically in figure 1. One such curve, with appropriate tolerances, may be specified for every process colour for each specific combination of substrate and printing process.

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

Part 1: Parameters and measurement methods

1 Scope

ISO 12647 specifies parameters which define printing conditions for the various processes used in the graphic arts industry. The values of the parameters specified may be used in the exchange of data to characterize the intended printing condition and/or for the process control of printing by practitioners wishing to work to common goals.

This part of ISO 12647

— defines vocabulary and establishes a minimum set of process parameters that uniquely determine a printed four-colour half-tone image. (These apply to others parts of ISO 12647 as well.) The parameters were selected in view of the process stages "colour separation", "making of the printing forme", "proofing", "production printing" and "surface finishing" being directly applicable to proofing and printing processes that use colour separation films as input;

— is directly applicable to proofing and printing from printing surfaces produced by filmless methods and to gravure printing as long as direct analogies to film production systems are maintained;

— is applicable to printing with more than four process colours as long as direct analogies to four-colour printing are maintained;

— is applicable to line screens and, where relevant, to those that do not have regular screen angles or regular screen rulings.

Other parts of ISO 12647 cover specifications for individual printing processes or groups of these, such as

— four-colour proof and production printing on heat-set web, sheet-fed and continuous forms offset presses, offset proofing for half-tone gravure;

— coldset offset and letterpress proof and production printing and off-press proof printing on newsprint;

— gravure printing;

— screen printing;

— flexo printing.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12647. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12647 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5-2:1991, *Photography — Density measurements — Part 2: Geometric conditions for transmission density.*

ISO 5-3:1995, *Photography — Density measurements — Part 3: Spectral conditions.*

ISO 5-4:1995, *Photography — Density measurements — Part 4: Geometric conditions for reflection density.*

ISO 13655:1996, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images.*

CIE 17.4 (1987), *International lighting vocabulary.*

3 Definitions

For the purposes of ISO 12647, the following definitions apply.

NOTE 1 For quantities, the preferred unit is given together with the definition. By definition, the unit of so-called dimensionless quantities is 1.

3.1 achromatic (perceived) colour: Colour devoid of hue, in the perceptual sense. [CIE 17.4, 845-02-26]

NOTES

2 The colour names white, grey and black are commonly used or, for transmitting objects, colourless and neutral.

3 In printing practice, achromatic colours can be produced either by a single ink or three chromatic inks suitably balanced.

3.2 axis of a screen: One of the two directions in which the half-tone pattern shows the highest number of image elements, such as dots or lines, per unit of length.

3.3 chromatic (perceived) colour: Perceived colour possessing hue, in the perceptual sense. [CIE 17.4, 845-02-27]

NOTE 4 The process inks cyan, magenta and yellow are the chromatic colour inks.

3.4 CIELAB colour difference; CIE 1976 L^*, a^*, b^* colour difference ΔE^*_{ab}: Difference between two colour stimuli defined as the Euclidean distance between the points representing them in L^*, a^*, b^* space. [CIE 17.4, 845-03-55] Unit: 1.

3.5 CIELAB colour space; CIE 1976 L^*, a^*, b^* colour space: Three-dimensional, approximately uniform colour space produced by plotting L^*, a^*, b^* in rectangular coordinates. [CIE 17.4, 845-03-56]

3.6 colorimeter: Instrument for measuring colorimetric quantities, such as the tristimulus values of a colour stimulus. [CIE 17.4, 845-05-18]

NOTE 5 A photoelectric colorimeter achieves this by the analogue integration of the spectral product of object reflectance or transmittance factor, illuminant and filters which are defined by standard illuminant and the standard observer functions. A spectrophotometric colorimeter achieves this by calculation from the spectral data.

3.7 colour separation film: One of a set of black-and-white half-tone films for process printing that pertains to one process colour.

NOTE 6 There are usually four colour separation films in a set.

3.8 control patch: Area produced for control or measurement purposes.

3.9 control strip: One-dimensional array of control patches.

3.10 core density (on a half-tone film)**:** Transmittance density in the centre of an isolated opaque image element such as a half-tone dot or line. Unit: 1.

3.11 deviation tolerance: Permissible difference between the OK print from a production run and the reference value.

3.12 film emulsion orientation: Orientation of a colour separation film relative to the observer with respect to the emulsion side.

NOTE 7 Normal orientation is emulsion up, i.e. towards the observer.

3.13 film polarity: Positive if clear and solid areas on the film correspond to unprinted and solid areas on the print, respectively. Negative if clear and solid areas on the film correspond to solid and unprinted areas on the print, respectively.

3.14 fringe width (of an isolated opaque image element)**:** Average distance between the density contour lines corresponding to 10 % and 90 % of the minimum core density specified for the printing process under consideration. Unit: µm.

3.15 grey balance: Set of tone values for cyan, magenta and yellow on the colour separation films is in grey balance if a print produced under specified printing conditions appears as an achromatic colour under specified viewing conditions.

3.16 half-tone film: Film for use with a half-tone printing process showing image elements like dots or lines.

3.17 hard dot film: Colour separation film with half-tone dots that reproduce reliably in film duplication and production of the printing forme.

3.18 image orientation: Images are referred to as right-reading (opposite: wrong-reading) if text appears as it is intended to be read and images are in the orientation intended for viewing by the end-user.

NOTES

8 The film emulsion orientation requires specification as well: "emulsion up", or "emulsion down" is stated. "Emulsion up" is usually assumed if there is no film emulsion orientation statement.

9 A typical reference is "wrong-reading emulsion up" which is equivalent to "right-reading emulsion down".

3.19 mid-tone spread, S**:** Quantity defined by the following equation:

$$S = \max.\,[(A_c - A_{c0}),\,(A_m - A_{m0}),\,(A_y - A_{y0})] -$$
$$- \min.\,[(A_c - A_{c0}),\,(A_m - A_{m0}),\,(A_y - A_{y0})]$$

where

A_c is the measured tone value of the cyan process colour image.

A_{c0} is the specified tone value of the cyan process colour image.

A_m is the measured tone value of the magenta process colour image.

A_{m0} is the specified tone value of the magenta process colour image.

A_y is the measured tone value of the yellow process colour image.

A_{y0} is the specified tone value of the yellow process colour image.

NOTE 10 Example for the calculation of the mid-tone spread:

measured values (c,m,y)	= (22, 17, 20)
specified values (c,m,y)	= (20, 20, 18)
max. [(22-20), (17-20), (20-18)]	= 2
min. [(22-20), (17-20), (20-18)]	= −3
S	= (max. − min.) = 5

3.20 moiré pattern: Unwanted periodic structure produced by interference between two or more two-dimensional periodic structures.

3.21 OK print; OK sheet: During production printing, the production print singled out as reference for the remaining production run.

3.22 off-press proof print: Print produced by a method other than press printing whose purpose is to show the results of the colour separation process in a way that closely simulates the results on a production press.

NOTE 11 Also known as artificial or pre-press proof.

3.23 on-press proof print: Print produced by press printing (production or proof press) whose purpose is to show the results of the colour separation process in a way that closely simulates the results on a production press.

3.24 principal axis: The axis of a screen that coincides with the direction of the longest diameter of an oblong-shaped (e.g. elliptical or diamond-shaped) half-tone dot.

NOTE 12 Circular and square-shaped half-tone dots do not have a principal axis.

3.25 print substrate: Material bearing the printed image.

3.26 printing forme: Tool whose surface is prepared such that some parts transfer printing ink whereas other parts do not.

3.27 process colours (for four-colour printing)**:** Yellow, magenta, cyan and black.

3.28 reference direction (of an image)**:** Horizontal direction as viewed by the end-user.

3.29 reflectance factor, R**:** Ratio of the measured reflected flux from the specimen to the measured reflected flux from a perfect-reflecting and perfect-diffusing material located in place of the specimen. [ISO 5-4] Unit: 1.

3.30 reflection density[1]**; reflectance factor density**[2]**:** Logarithm to base ten of the reciprocal of the reflectance factor. Unit: 1.

3.31 reflection densitometer: Instrument which measures reflection density.

3.32 reflectometer: Photometer for measuring quantities pertaining to reflection. [CIE 17.4, 845-05-26]

3.33 relative density: Density from which the density of a reference, such as the film base or the unprinted print substrate, has been subtracted. Unit: 1.

3.34 sampling aperture size: Dimensions of the surface area of a specimen that contributes to the measurement of the reflectance or transmittance factor density, governed by the design of the instrument.

3.35 screen angle: For oblong-shaped half-tone dots, the angle which the principal axis of the screen makes with the reference direction. For circular and square dot shapes, the smallest angle which an axis of the screen makes with the reference direction. Unit: Degree.

1) ISO 5-4.

2) CIE 17.4.

3.36 screen ruling; screen frequency: Number of image elements, such as dots or lines, per unit of length in the direction which produces the highest value. Unit: cm^{-1}.

3.37 screen width: Reciprocal of screen ruling. Unit: µm.

3.38 surface finishing: Process by which a print is either covered by varnish (lacquer) or laminated with a transparent polymeric film.

3.39 tone value; dot area (on a print), A: Percentage of the surface which appears to be covered by colorant of a single colour (if light scattering in the print substrate and other optical phenomena are ignored), calculated from the formula:

$$A\,(\%) = 100 * \left[1 - 10^{-(D_t - D_0)}\right] / \left[1 - 10^{-(D_s - D_0)}\right]$$

where

D_0 is the reflection density of the unprinted print substrate, or the non-printing parts of the printing forme;

D_s is the reflection density of the solid;

D_t is the reflection density of the half-tone.

NOTES

13 Also known as apparent, equivalent or total dot area.

14 The synonym, dot area, may be applied only to half-tones produced by dot patterns.

15 This definition may be used to provide an approximation of the tone value on certain printing formes.

16 In general it is assumed that the tone value [termed "ink value" in ISO 12642] of the data is reproduced identically on the film produced by an image setter. Final films should reproduce those tone values.

3.40 tone value; dot area (on a half-tone film of positive polarity), A: Percentage calculated from the formula:

$$A\,(\%) = 100 * \left[1 - 10^{-(D_t - D_0)}\right] / \left[1 - 10^{-(D_s - D_0)}\right]$$

where

D_0 is the transmission density of the clear half-tone film;

D_s is the transmission density of the solid;

D_t is the transmission density of the half-tone.

NOTE 17 Also known as the film printing dot area.

3.41 tone value; dot area (on a half-tone film of negative polarity), A: Percentage calculated from the formula:

$$A\,(\%) = 100 - 100 * \left[1 - 10^{-(D_t - D_0)}\right] / \left[1 - 10^{-(D_s - D_0)}\right]$$

where

D_0 is the transmission density of the clear half-tone film;

D_s is the transmission density of the solid;

D_t is the transmission density of the half-tone.

NOTE 18 Also known as the film printing dot area.

3.42 tone value increase; dot gain: Difference between a tone value on the print and the corresponding tone value on the half-tone film. Unit: percent.

NOTE 19 The synonym, dot gain, may be applied only to half-tones produced by dot patterns.

3.43 tone value sum: Sum of the tone values on all colour separation films of a set. Unit: percent.

NOTES

20 Also known as the total dot area (TDA).

21 For most sets of colour separation films, the maximum of the tone value sum occurs at the position of the darkest achromatic tone of the image.

3.44 transmission densitometer: Device which measures transmission density.

3.45 transmission density[1]**; transmittance (optical) density**[2]**:** Logarithm to base ten of the reciprocal of the transmittance factor. Unit: 1.

3.46 transmittance factor, T: Ratio of the luminous flux transmitted through an aperture covered by a specimen to the luminous flux through the aperture without the specimen in place. [ISO 5-2] Unit: 1.

3.47 variation tolerance: Permissible difference between the OK print and that of a sample print taken at random from the production.

1) ISO 5-2.

2) CIE 17.4.

4 Requirements

The following subclauses provide a number of properties and primary parameters that uniquely define the visual characteristics and other technical properties of a half-tone print product. Where appropriate, test methods and specific values are provided. The general layout and content of clause 4 will be repeated in the other parts of ISO 12647.

NOTE 22 Information about properties and primary parameters is important to communication about the half-tone colour printing process. In practice, many of these parameters can be assumed to have standard values so that explicit specification of each is unnecessary. Such values are specified in other parts of ISO 12647.

4.1 Colour separation films

4.1.1 Quality

The minimum core density and the maximum fringe width shall be specified.

NOTE 23 Refer to annex B for assessment or measurement methods.

4.1.2 Screen ruling

For every set of colour separation films, the screen ruling shall be specified in reciprocal centimetres (cm^{-1}). If the set includes more than one screen ruling, each colour separation film shall be specified individually or the exception to the screen ruling specified for the set shall be reported explicity.

NOTES

24 Rough print substrates require coarser screens than smoothly coated ones. Otherwise the tone value limits become too restricted and the tone value increase becomes excessive.

25 For the black process colour image, the screen ruling may be substantially finer than that of the chromatic colours. For example, 80 cm^{-1} for K and 60 cm^{-1} for CMY.

26 See also note 28 in 4.1.3.

4.1.3 Screen angle

For every colour, the screen angle shall be specified. The test method shall be as specified in 5.1; the reporting shall be as specified in A.1.

NOTES

27 Conventionally, the nominal screen separation between black, cyan and magenta is 30°, with yellow separated by 15° from cyan or black. The screen angle of the principal axis of the dominant process colour is 45°, which refers to measurement on the films.

28 With computer-generated screening, the parameters "screen ruling" and "screen angle" may be varied slightly from one process colour to another.

4.1.4 Dot shape and its relationship to tone value

For a complete description, the shape of the half-tone dot structure and its dependence on tone value should be specified over the complete tone value range.

Alternatively, the mid-tone dot shape (e.g. circular, square, elliptic) shall be specified and, in the case of screens with a principal axis, the tone values shall be specified where the half-tone dots show the first and second link-ups. The tone value test method shall be as specified in 5.2; the reporting shall be as specified in clause A.2.

4.1.5 Image size tolerance

The maximum size difference between any two colour separation films of one set shall be specified as a percentage of the diagonal of the image. This percentage is obtained by first aligning corresponding images on all four colour separation films along the upper edge and the left-hand upper corner. Secondly, the maximum size difference at the lower right-hand corner is measured and expressed as a percentage of the diagonal.

4.1.6 Tone value sum

The tone value sum at the position of the darkest achromatic tone in the image shall be specified. Where useful, the tone value of the black process colour image should be specified separately. The tone value test method shall be as specified in 5.2; the reporting shall be as specified in clause A.2.

4.1.7 Grey balance

The tone values of magenta and yellow leading to a neutral grey together with a certain cyan tone value (usually 50 %) should be specified. Additional triplets of such tone values may also be specified. The tone value test method shall be as specified in 5.2; the reporting shall be as specified in clause A.2.

NOTE 29 The grey balance is determined by the tone values of the cyan, magenta and yellow images, their colours and the colours of their overprints. Since these parameters are to be specified according to this part of ISO 12647, a separate specification for grey balance is not strictly necessary and can overdetermine the process specification. For practical reasons, however, this specification is useful and appreciated by the colour separator, particularly if his proofing process is not an exact match to that of the production press.

4.2 Print

4.2.1 Visual characteristics of image components

4.2.1.1 Print substrate colour

For the unprinted print substrate, the CIELAB colour coordinates (L^*, a^*, b^*) and colour difference tolerances (ΔE^*_{ab}) shall be specified. Where the print is to be surface finished the coordinates L^*, a^*, b^* of the surface-finished, but unprinted, print substrate shall be specified as well. The test method shall be as specified in 5.6; the reporting shall be as specified in clause A.6.

4.2.1.2 Print substrate gloss

The gloss of the unprinted print substrate and a tolerance shall be specified. Where the print is to be surface finished, the gloss of the surface-finished, but unprinted, print substrate shall be specified as well. The test method shall be as specified in 5.5; the reporting shall be as specified in clause A.5.

4.2.1.3 Ink set colours

The CIELAB colour coordinates L^*, a^*, b^* and colour difference (deviation and variation) tolerances ΔE^*_{ab} shall be specified for a solid print of each of the four process colours. In addition, either the colour coordinates of the overprints cyan-magenta, cyan-yellow, magenta-yellow, black-yellow or the preferred colour sequence together with some measure of the transfer efficiency of the overprint ink relative to its value on the unprinted print substrate shall be specified. Where the print is to be surface finished, the L^*, a^*, b^* values of the surface-finished print product shall be specified as well.

For a precise definition of ink set colours, the following eight additional colours may be specified:

3 two-colour overprints: black with cyan, magenta, yellow (C-K, M-K, Y-K);

4 three-colour overprints of process colours (C-M-Y, M-Y-K, C-M-K, C-Y-K);

1 four-colour overprint of all process colours (C-M-Y-K).

The test method shall be as specified in 5.6; the reporting shall be as specified in clause A.6.

NOTES

30 Overprint combinations with black are less important for colour definition, but are particularly useful for transparency testing.

31 As an informative reference, reflection densities may be specified for the process colours. The measurement should be carried out using a black backing in accordance with ISO 5-4. Reporting should then be as specified in clause A.7.

32 Though density values may be practical, it should be recognized that there may be cases where densitometric and colorimetric matchings to a specification lead to different results.

33 Specifying the colour sequence rather than the two-colour overprints is only adequate if ink trapping and transparency values are known to conform to agreed-upon values.

4.2.1.4 Ink set gloss

The gloss, together with a tolerance, of the printed process inks should be specified. The test method shall be as specified in 5.5; the reporting shall be as specified in clause A.5.

4.2.2 Tone value reproduction limits

For every process colour the lowest tone value of the colour separation film that transfers on to the print in a uniform and consistent manner shall be specified. Likewise, the highest tone value that is useful for carrying image information shall be specified. The tone value test method shall be as specified in 5.2; the reporting shall be as specified in clause A.2.

4.2.3 Tolerance for image positioning

The maximum deviation between the image centres of any two process colour images shall be specified, to be expressed as a fraction of the nominal screen width of the cyan, magenta and yellow process colour images.

4.2.4 Tone value increase

For every process colour, the tone value increase values that best represent production printing shall be reported for at least two tone values on the film other than 0 % or 100 %. Alternatively, the tone value increase function may be specified using a table or a graph. Figure 1 gives a schematic example.

In addition, deviation and variation tolerances shall be specified. All tone values shall be relative to a multicolour control strip. It shall be printed along with the subject during proof printing and should be printed with the subject in production printing. A control strip colour separation film shall contain well-defined control patches with tone value designations accurate to plus or minus one percent. The shape of the half-tone dot structure shall be circular.

The test method for the tone value increase shall be as specified in 5.4; reporting shall be as specified in clause A.3.

NOTE 34 For press prints on paper, a unique correspondence exists between tone value increase values determined at various screen rulings. Therefore, for those prints the screen ruling of the control strip need not be identical to those of the subject films, but should be within one sixth of the average nominal value of the subject colour separation films.

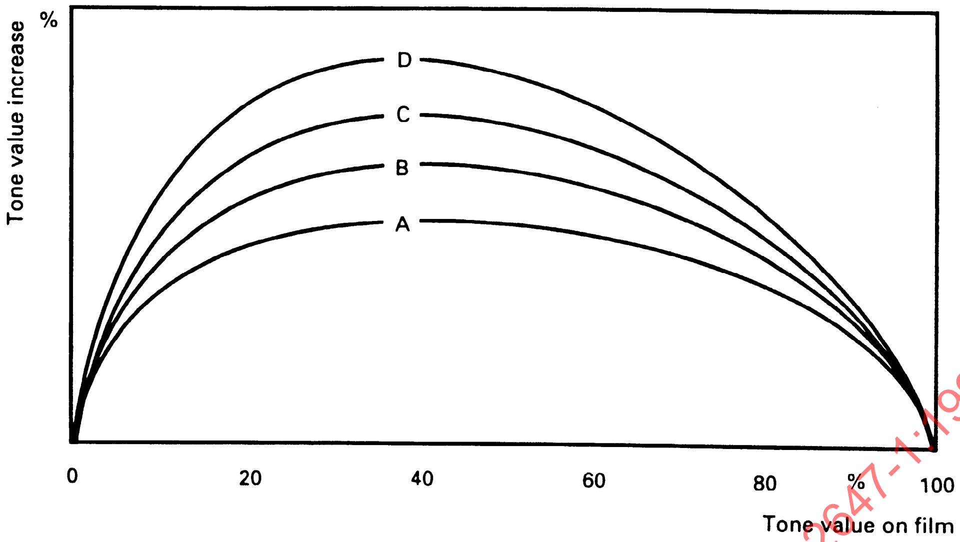


Figure 1 — Schematic diagram of a family of tone value increase curves

5 Test methods

5.1 Screen angles

Lay each colour separation film to be measured on a light table and orient it as viewed by the end-user; it will then be right-reading. Determine the principal axis of the screen. Measure the smallest positive angle between the principal axis and the reference direction, with an anticlockwise-ascending scale protractor, as shown in figure 2. If there is no principal axis, use the axis which produces the smallest angle.

Alternatively, measure the angles of each process colour on the print using the same angle definition.

Report results as specified in clause A.1.

NOTE 35 In the absence of a generally accepted method, this angle definition was selected because it yields identical values irrespective of film generation or substrate.

5.2 Tone value on a colour separation film

Using a transmission densitometer conforming to ISO 5-2, with 0°/d or d/0° geometry, determine the transmittance densities of the film base material, D_0, the solid tone, D_s, and a well-defined half-tone area, D_t. Calculate the tone value from the pertinent definition, that is 3.40 for positive polarity and 3.41 for negative polarity colour separation films.

In order to assure sufficient accuracy, the sampling aperture of the instrument should have a diameter not less than 15 times the screen width and it shall be not less than 10 times the screen width. This requirement applies also by analogy to the area of non-circular sampling apertures.

Report results as specified in clause A.2.

5.3 Tone value on the print

5.3.1 Reflection densitometer

Place the print on a black backing in accordance with ISO 5-4. For chromatic process colours, select the densitometer channel which gives the highest reading for the solid and use this channel to measure the reflection densities of the unprinted print substrate. D_0, a well-defined half-tone area, D_t, and a nearby solid, D_s. Measure the black process colour with the "ISO visual" spectral products (see ISO 5-3). Calculate the tone value on the print from the definition 3.39.

In order to assure sufficient accuracy, the sampling aperture of the instrument should have a diameter not less than 15 times the screen width and it shall be not less than 10 times the screen width. This requirement applies also by analogy to the area of non-circular sampling apertures.

Report results as specified in clause A.3.

NOTE 36 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.

5.3.2 Colorimeter

Use a 45/0 or 0/45 geometry colorimeter for measuring the tristimulus values X, Y and Z, relative to the perfect diffuser, using the CIE 1931 2° standard observer function and illuminant D_{50} or D_{65}. Measure the tristimulus values X, Y, Z of the unprinted print substrate, a well-defined half-tone area, and a nearby solid. Calculate the tone value from

A (%) = 100 %*$(X_0 - X_t)/(X_0 - X_s)$ for cyan

A (%) = 100 %*$(Y_0 - Y_t)/(Y_0 - Y_s)$ for magenta and black

A (%) = 100 %*$(Z_0 - Z_t)/(Z_0 - Z_s)$ for yellow

where

subscript 0 denotes the unprinted print substrate;

subscript t denotes the half-tone;

subscript s denotes the solid.

In order to assure sufficient accuracy, the sampling aperture of the instrument should have a diameter not less than 15 times the screen width and it shall be not less than 10 times the screen width. This requirement applies also by analogy to the area of non-circular sampling apertures.

Report results as specified in clause A.3.

5.4 Tone value increase on the print

Calculate the quantity by deducting the tone value on the colour separation film (see 5.2) from the corresponding tone value on the print (see 5.3). Report values as specified in clause A.3.

5.5 Gloss

Measure the specular gloss of the print substrate or a solid printed area of a process ink with light incident at an angle appropriate to the gloss level of the print substrate of the particular printing process in question. Details of the appropriate test methods will be specified in the other parts of ISO 12647. Report results as specified in clause A.5.

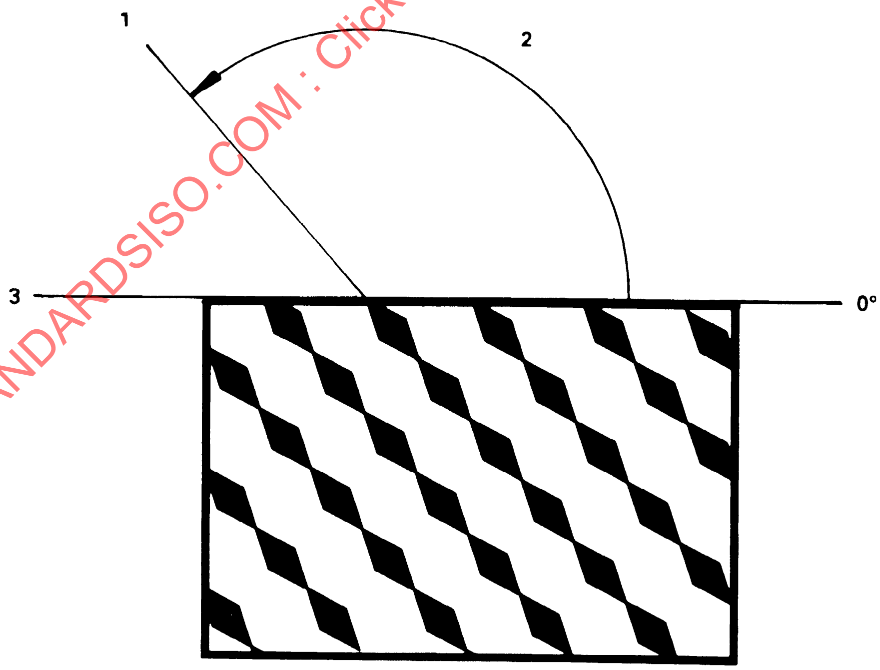
5.6 Spectral measurement, computation of CIELAB colour coordinates and CIELAB colour differences

Carry out the measurement in accordance with ISO 13655, i.e. using a 45/0 or 0/45 geometry spectrophotometer, with a black backing according to ISO 5-4. Use illuminant D_{50} and the CIE 1931 2° standard observer function for computation of the tristimulus values. From the tristimulus values X, Y, Z, compute the CIELAB colour coordinates L^*, a^*, b^* as detailed in ISO 13655.

From two sets of colour coordinates (L_1^*, a_1^*, b_1^*) and (L_2^*, a_2^*, b_2^*) calculate the CIELAB colour difference ΔE_{ab}^* as detailed in ISO 13655.

Any colorimeter which reports the same values within the tolerances given in the relevant part of ISO 12647 may be used instead of a spectrophotometer.

Report results as specified in clause A.6.



Key

1 Principal axis

2 Screen angle

3 Reference direction

Figure 2 — Measurement of screen angles

Annex A
(normative)

Reporting

A.1 Screen angles

For the colour separation films, report angles in degrees for C, M, Y and K. EXAMPLES — C 15°, M 45°, K 75°, Y 0°.

If the angle cannot be expressed by a whole number, use two decimal places or report the angle in degrees and minutes.

A.2 Tone value on the colour separation film or on a control strip film

Report tone values in percent.

EXAMPLE — "The tone value of the shadow-tone patch of the control strip is 75 %."

A.3 Tone value on the print

Together with the tone value in percent, report the spectral response of the instrument used, the sampling aperture size and whether polarization was used.

EXAMPLES

1 (densitometer) "The tone value in the cyan 75 % patch of the control strip is 87 % as measured with a densitometer with ISO Status T spectral products (ISO 5-3), 3 mm diameter sampling aperture, without polarization"; "... with DIN narrow band, 9 mm^2 sampling aperture, without polarization"; or "... with ISO visual spectral products, 5 mm diameter sampling aperture, with polarization."

2 (colorimeter) "The tone value in the cyan 40 % patch of the control strip is 56 % as calculated from the tristimulus value X, measured with a colorimeter of 4 mm diameter sampling aperture and D_{50} illuminant."

A.4 Tone value increase on the print

Report the tone value increase in the same manner as tone values on the print, see clause A.3.

A.5 Gloss

Report the gloss value and the test method.

EXAMPLE — "The gloss of the unprinted paper was 45 % as measured with 75°/75° geometry following TAPPI official test method T 480 om-85."

A.6 Colour coordinates and ΔE^*_{ab}-differences

Report the L^*, a^*, b^* values or ΔE^*_{ab}-differences and state that they refer to the spectral measurement and calculation conditions specified in ISO 13655. In addition, report the brand and model of the instrument used and the sampling aperture size.

For additional information, state if conditions other than those specified in ISO 13655 have been used, such as illuminant D_{65} or white backing.

NOTE 37 Colour coordinates are so-called dimensionless quantities, for which the unit is 1.

A.7 Reflectance factor densities and relative densities

Report densities to 2 decimal places and include the following:

— the spectral characteristics, preferably by quoting ISO 5-3 Status E, I or T;

— the density of the unprinted print substrate;

— the sampling aperture size;

— the backing material, if not in accordance with ISO 5-4;

— whether polarization was used.

EXAMPLES

1 "The density of the cyan solid was 1,45; that of the substrate was 0,15; both measured on a black backing in accordance with ISO 5-4, with an ISO Status T spectral response, 10 mm^2 sampling aperture, without polarization."

2 "The relative visual density of the black solid was 1,85 with regard to the substrate (visual density 0,07), both measured with the XYZ model of ZYX Company, on a black backing in accordance with ISO 5-4, 3 mm diameter sampling aperture, with polarization.

NOTE 38 Optical densities are so-called dimensionless quantities, for which the unit is 1.

Annex B
(informative)

Determination of quality parameters of half-tone dots on a colour separation film

B.1 A simple qualitative method for half-tone films with a base plus fog transmittance density of less than 0,1 is to place a control strip film with a microline target, emulsion oriented up, on a light table and to cover it with the film to be evaluated, emulsion oriented down. With a hand-held microscope of between × 60 and × 100 magnification, observe the isolated opaque half-tone dots which are found in those parts of the half-tone film, of positive or negative polarity, that appears lighter. If the microlines are distinctly visible below the half-tone dots, then the core density is too low. The fringe width can be estimated by comparing it to the width of the microlines which is stated on the microline target. The colour separation film should be illuminated from below by light oblique angles of incidence, a condition known as dark field illumination. With some experience, the compliance of half-tone dots to a specified maximum fringe width can be predicted with near certainty.

B.2 A quantitative method may be obtained using a scanning microdensitometer. This is an instrument in which, for instance, the illumination stage of a transmission microscope is equipped such that an aperture, with an adjustable diameter of 3 µm or less, is formed in the centre of the object plane. The film is movable, in a controlled way, in both x and y directions of the object plane. As the film is moved, the radiation transmitted by the film is measured with a photodetector which has been calibrated in terms of transmittance density. The wavelength range of the radiation source should be selected in view of the spectral requirement of the process steps where the film is to be used. The data may be presented graphically either as a transmittance density profile across a half-tone dot (see figure B.1) or by drawing contour lines that connect points of equal transmittance density (see figure B.2).

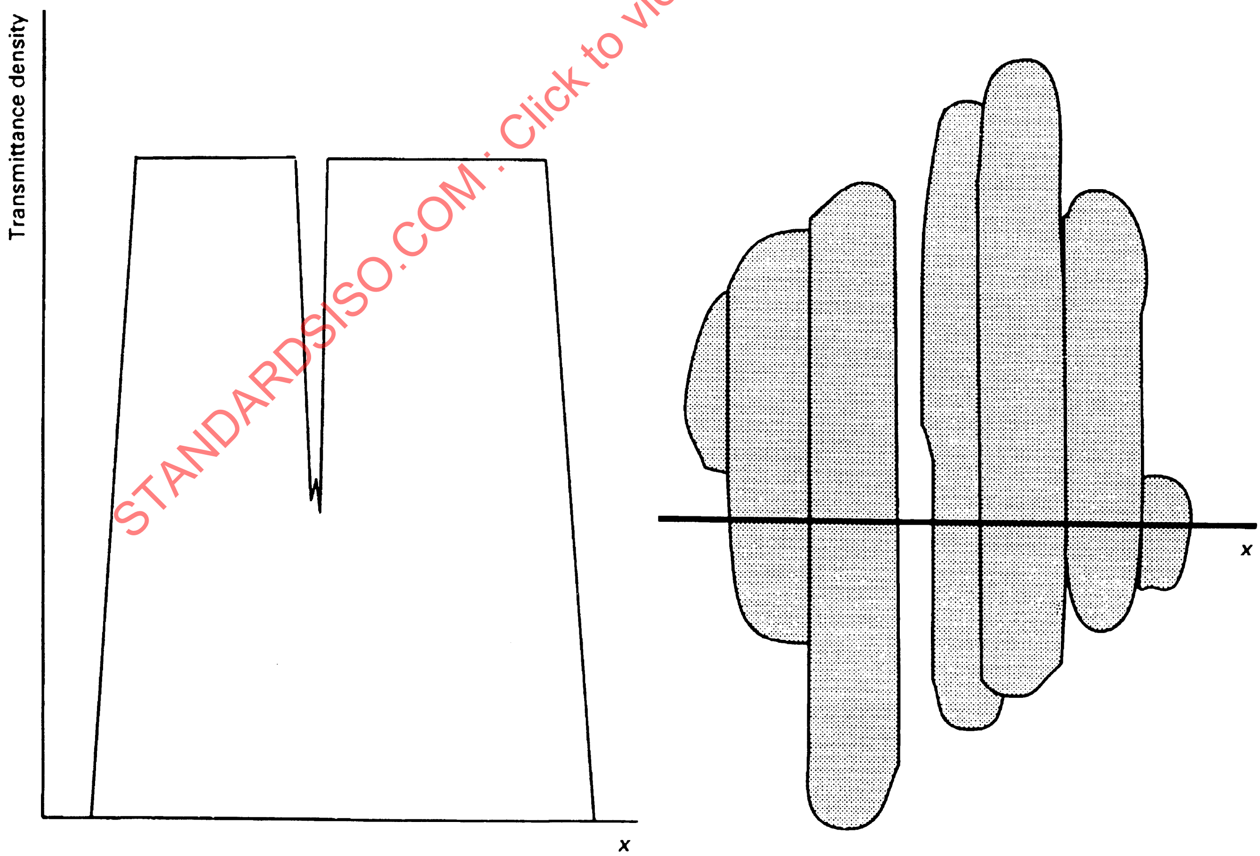


Figure B.1 — Transmittance density profile of a split half-tone dot on a colour separation film (left), microscopic image of the same dot (right)

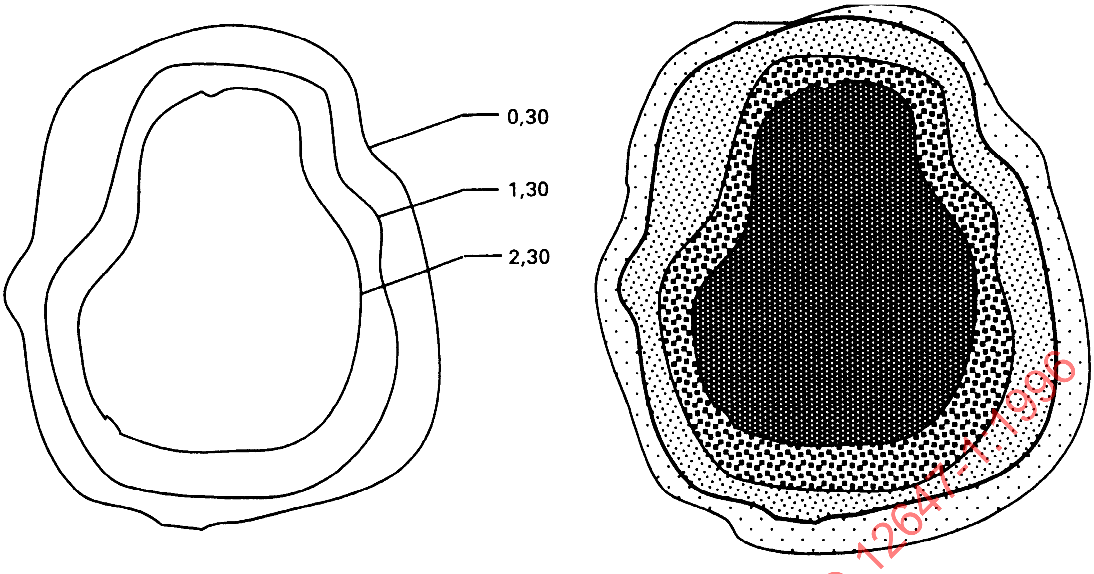


Figure B.2 — Example for the transmittance density contour lines of a soft half-tone dot on a colour separation film (left), microscopic image of the same dot (right)

Annex C
(informative)

Bibliography

[1] ISO 5-1:1984, *Photography — Density measurements — Part 1: Terms, symbols and notations.*

[2] ISO 12642:1996, *Graphic technology — Prepress digital data exchange — Input data for characterization of 4-colour process printing.*