INTERNATIONAL STANDARD

IEC 61966-7-1

Second edition
2006-05

Multimedia systems and equipment –
Colour measurement and management –

Part 7-1:
Colour printers – Reflective prints – RGB inputs

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CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 7
4 Letters and symbols 9
5 Conditions 9
5.1 Environmental conditions 9
5.2 Sampling conditions 10
5.3 Measurement conditions 11
5.4 Method of calculation 12
6 Spectral characteristics 14
6.1 Attributes to be measured 14
6.2 Method of measurement 14
6.3 Presentation of the result 14
7 Basic colorimetric characteristics 15
7.1 Attribute to be measured 15
7.2 Method of measurement 15
7.3 Presentation of the results 15
8 Tone reproduction characteristics 16
8.1 Attribute to be measured 16
8.2 Method of measurement 16
8.3 Presentation of the results 17
9 Spatial non-uniformity characteristics 18
9.1 Attribute to be measured 18
9.2 Method of measurement 18
9.3 Presentation of the result 18
10 Temporal instability characteristics 19
10.1 Short-term instability 19
10.2 Long-term instability 20
11 Dependency on illuminant characteristics 23

Annex A (normative) Values in the colour test-chart file 26
Annex B (normative) Specification of the measurement positions in the spatial non-uniformity test-chart file and the reporting form 32
Annex C (normative) Specification for the measurement of short-term instability characteristics 37
Annex D (informative) Estimation of effect for backing material change 38
Annex E (informative) Layout of the colour test-chart file reproduced as a reflective print 39
Annex F (informative) Layout of the spatial non-uniformity test-chart file reproduced as a reflective print 40
Annex G (informative) Layout of the short-term instability test-chart file reproduced as a reflective print 41

Bibliography 42

Figure 1 – Spectral reflectance of the primary and secondary saturated colours, and white, grey and black 15

Figure 2 – Example plots for gamut of colours in the CIE 1976 $L^*a^*b^*$ colour space 16

Figure 3 – An example of reporting tone reproduction characteristics 17

Table 1 – Reference to Table A.1 14

Table 2 – Reference to Table A.3 17

Table 3 – Conditions for sampling and measurements 19

Table 4 – Specification of data in the colour test chart file and the form for reporting the result in the long-term instability measurement 22

Table 5 – Specification of colour patches 23

Table 6 – Specification of data in the colour test chart file and the form of reporting the result of dependency on illuminants measurement – 24

Table 7 – Specification of data in the colour test chart file and the form of reporting the result of dependency on illuminants measurement – 25

Table A.1 – Specification of the colour test chart file and the form for reporting – Primary colours 26

Table A.2 – Specification of the colour test-chart file and the form for reporting – 6-by-6-by-6 cubic data 26

Table A.3 – Specification of the colour test-chart file and the form for reporting – Data and form for gradation 30

Table B.1 – Form of reporting with measurement positions 32

Table C.1 – Short-term instability characteristics 37

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 7-1: Colour printers – Reflective prints – RGB inputs

FOREWORD

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International Standard IEC 61966-7-1 has been prepared by Task Area 2: Colour measurement and management, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition.

a) In addition to the default illuminant, D50, D65, F11 and illuminant A were added as optional illuminants.
b) The numbering of the colour patches in the test-chart file was changed for easy understanding of the measurement location.

c) Two test-chart files: short-term instability test chart and spatial non-uniformity test chart were added.

The text of this standard is based on the following documents:

FDIS	Report on voting
100/1061FDIS	100/1082/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61966 consists of the following parts, under the general title *Multimedia systems and equipment – Colour measurement and management:*

Part 1: General (proposed work item)

Part 2-1: Colour management – Default RGB colour space – sRGB

Part 2-2: Colour management – Extended RGB colour space – scRGB

Part 2-4: Colour management – Extended-gamut YCC colour space for video applications – xvYC (to be published)

Part 2-5: Colour management – Optional RGB colour space – opRGB (under consideration)

Part 3: Equipment using cathode ray tubes

Part 4: Equipment using liquid crystal display panels

Part 5: Equipment using plasma display panels

Part 6: Front projection displays

Part 7-1: Colour printers – Reflective prints – RGB inputs

Part 7-2: Colour printers – Reflective prints – CMYK inputs (proposed work item)

Part 8: Multimedia colour scanners

Part 9: Digital cameras

Part 10: Quality assessment – Colour image in network systems (proposed work item)

Part 11: Quality assessment – Impaired video in network systems (proposed work item)

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

INTRODUCTION

This part of IEC 61966 is applicable to characterization of colour printers that produce colour on opaque substrate corresponding to digital data files in which colour image information is expressed in a red–green–blue colour space. The characterization will be realized by objective measurements to be utilized for colour management in open systems. The measured and reported results are used to relate the equipment-dependent and undefined red –green–blue colour space to the default RGB colour space defined as the sRGB by IEC 61966-2-1. This standard is also applicable to assessment of colour image attributes on reflective prints reproduced from colour digital image files.

The recommended usage of the standard is for evaluation of the output of home and office RGB printers.

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 7-1: Colour printers – Reflective prints – RGB inputs

1 Scope

This part of IEC 61966 specifies a set of data in colour test chart files for measurements, sampling of successive prints, measurement conditions and forms of reporting the results so as to make possible the characterization of the colour printer and comparison of the results of measurements. The sets of data for measurements are in colour test chart files expressed in a red–green–blue colour space, to which corresponding colour images are reproduced on reflective substrate. The methods of measurement in this standard are designed to be applicable to reflective colour prints for consumer use. The reflective colour prints may be produced by non-impact colour printers, incorporating such technologies as ink-jet, sublimation transfer, thermal transfer, electro-photography and other similar technologies.

This standard does not specify limiting values for various attributes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(845):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 845: Lighting*

ISO 216:1975, *Writing paper and certain classes of printed matter – Trimmed sizes – A and B series*

ISO/CIE 10526:1999, *CIE standard illuminants for colorimetry*

ISO/CIE 10527:1991, *CIE standard colorimetric observers*

CIE 15, *Colorimetry*

3 Terms and definitions

For the purposes of this document, terms and definitions which relate to lighting in IEC 60050(845), as well as the following, apply.

3.1
colour printer
system composed of an application programme to handle colour digital image files, a driver for equipment that produces colour images on a substrate, and the equipment itself which accepts equipment specific data for each input channel and is able to process by such technologies as ink jet, sublimation transfer, thermal transfer, or electro-photography and other similar technologies

NOTE The colour printer includes a system whereby the equipment that reproduces prints is connected direct to another piece of equipment in which a set of colour digital image data is contained.

3.2
driver
software code which converts output data from an application programme to feed a series of digital signals to the equipment which produces reflective prints

3.3
application programme
any software which has access to the colour digital image file and output colour image information to the driver, and possibly renders the colour image on displays

3.4
consumable
any material necessary to run colour printers; for example, sheets of paper, toners, ink, fuser oil, etc.

3.5
half-tone screen
set of rules for two-dimensional pixel layouts to render a tone

3.6
image
visible two-dimensional representation of electronic signals intended to form a picture

3.7
substrate
opaque substance providing support for a medium

3.8
reflective print
colour image reproduced on a piece of substrate

3.9
gamut of colours
three-dimensional maximum range of reproducible colours expressed in the CIE 1976 $L^*a^*b^*$ colour space defined in CIE15

3.10
primary colours
colours used to define a colour space incorporated in the colour digital image file

NOTE Red, green and blue are the primary colours for this standard.

3.11
secondary colours
colours to be defined by a mixture of two primary colours except black

NOTE Cyan, magenta and yellow are the secondary colours for this standard.

3.12
saturated colours
primary colours and secondary colours intended to be reproduced corresponding to their maximum excitation of electronic signals

NOTE Saturation means the maximum excitation purity (chromaticity) limited by each specific system.

3.13
reproduced colours
colorimetric information measured from the reflective print, expressed in the CIE 1976 colour space defined in CIE 15

3.14
tone reproduction
relationship between data in the colour digital image file which are intended to reproduce the images of primary, secondary and achromatic colours and the CIE 1976 lightness values of reflective prints actually reproduced

3.15
characterization
process of obtaining the spectral characteristics, basic colorimetric characteristics, tone reproduction characteristics, spatial non-uniformity characteristics, temporal instability characteristics or dependency on illuminant characteristics. In general, these characteristics relate the input RGB signal to some measured CIE colour values

3.16
electronic signal
data prepared as a colour digital image file intended to form a picture

4 Letters and symbols

The letters and symbols consistently adopted in this part of IEC 61966 are summarized below.

N_{s}	Number of samples of reflective prints for measurements
N_{u}	Metric in colour difference ΔE^*_{ab} for spatial non-uniformity within a page
N_{t}	Metric in colour difference ΔE^*_{ab} for short-term instability among successive reflective prints
p	Printing speed of the colour printer
$S(\lambda)$	Spectral power distribution of the illuminant D50 as default, D65, F11 and illuminant A optional
$\rho(\lambda)$	Spectral reflectance of a printed image
D_{R}, D_{G}, D_{B}	Digital data in integers fed to colour printers
R, G, B	Data normalized by $2^{\mathrm{N}} - 1$, where N is the number of bits per channel
$\widetilde{L}^*$, $\widetilde{a}^*$, $\widetilde{b}^*$	Colour in CIE 1976 UCS in reference to printed colour white (see also equation (4))

NOTE Special attention should be given to the illuminant and illumination used. Future work is hoped for in this area for consumer situations.

5 Conditions

5.1 Environmental conditions

Sampling and measurements shall be carried out within the environmental conditions specified by the manufacturer of the equipment that produces reflective prints, unless otherwise specified by this standard. The environmental conditions, at least the room temperature and the relative humidity, during sampling and measurement shall be reported, together with the presentation of the results of measurements.

NOTE Recommended environmental conditions are a temperature of 20 °C ± 5 °C, a relative humidity of 65 % ± 10 % and atmospheric pressure from 86 kPa to 106 kPa, unless otherwise specified.

5.2 Sampling conditions

5.2.1 Substrate

The substrate shall be opaque as specified by the manufacturer of the equipment that produces reflective prints as either recommended or default. The substrate shall be exposed for at least one day in order to be accustomed to the environmental conditions.

5.2.2 Settings and operation

5.2.2.1 Half-tone screen

All sampling shall be carried out in the half-tone screen mode whenever applicable. This shall be as specified by the manufacturer of the equipment that produces reflective prints as either recommended or default. When multiple options such as half-tone screen for texts, graphics, and natural pictures are available, the choices shall be reported together with the presentation of the results of measurements.

If the half-tone screen is not applicable, this shall be reported together with the presentation of the results.

5.2.2.2 Resolution

All sampling shall be carried out with the resolution setting specified by the manufacturer of the equipment that produces reflective prints as either recommended or default. When multiple options such as resolution for texts, graphics, natural pictures are available, the choices shall be reported together with the presentation of the results of measurements.

5.2.2.3 Miscellaneous settings

Colour rendering, digital filtering and tone reproduction characteristics shall be set as specified by the manufacturer of the printing equipment that produces reflective prints as either recommended or default.

The application programme used should provide no extra colour processing or enhancement. Otherwise, a type of colour processing or enhancement shall be reported.

5.2.3 Number of samples

To minimize an error due to short-term variation and non-uniformity within a page, the number of samples of reflective prints N_s should be decided by equation (1), except for Clause 9, and 10.1 and 10.2.

$$N_s = \sqrt{N_u^2 + N_t^2} \tag{1}$$

where N_u is the metric in colour difference ΔE^*_{ab} for spatial non-uniformity within a page as defined in equation (7) and N_t is the metric in colour difference ΔE^*_{ab} for short-term instability among successive reflective prints as defined in equation (8).

The number of samples less than N_s shall be reported together with the presentation of the results of measurements.

NOTE For simplicity of the characterization procedure, $N_s = 1$ may be allowed.

5.2.4 Operation of colour printers

All sampling shall be carried out in line with the conditions specified in the operation manuals of the colour printer, unless otherwise specified in this standard.

5.2.5 Electric power source

All sampling shall be carried out with an a.c. power source with nominal voltage ±10 % of stable frequency.

5.2.6 Consumables

All sampling shall be carried out with the consumables for the equipment that produces reflective prints as specified by the manufacturer of the equipment.

5.2.7 Other conditions

All sampling shall be carried out after the warm-up time specified by the manufacturer of the equipment that produces reflective prints, unless otherwise specified in this standard.

NOTE If the equipment that produces reflective prints has multiple paper trays, any paper tray can be used for sampling.

5.3 Measurement conditions

5.3.1 General

To minimize an error due to instability of the instruments for colorimetric measurement, the reflective prints shall be measured at least three times and the measured data shall be averaged. The number of average times less than three shall be reported together with the presentation of the results of measurements.

5.3.2 Spectrophotometric and colorimetric measurements

Reflective prints shall be measured successively without any time interval, unless otherwise specified.

For spectrophotometric measurement, spectral reflectance of the reflective prints shall be measured over the wavelengths at least from 400 nm to 700 nm every 10 nm for the reflective print illuminated by incandescent lamps and every 5 nm for the reflective print illuminated by fluorescent lamps.

NOTE 1 The measurement over the wavelengths from 380 nm to 780 nm is recommended.

NOTE 2 The spectral reflectance should be measured using a spectrophotometer with either 0°/45° or 45°/0° geometry as specified in ISO 5-4, in order to remove the specular component of the reflected light.

NOTE 3 With some media and colorants, fluorescence may affect the colorimetry measured.

For colorimetric measurement, the spectral radiance of the illumination shall be approximated to the illuminant D50, as default, defined in Table 1.1 of CIE 15.

The name of the manufacturer of the measuring instrument, the model number and the manufactured date shall be reported together with the measured results.

5.3.3 Backing material

White backing material, such as five pieces or more of the same substrate on which the colour image is printed, shall be used. When other backing materials are used, the specification of the material shall be reported together with the presentation of the results of measurements.

NOTE For estimation of the effect of backing material changes, refer to Annex D.

5.4 Method of calculation

5.4.1 Illuminants and colorimetric observers

The illuminant D50, as default, defined in Table 1.1 of CIE 15 and the CIE 1931 Standard Colorimetric Observer defined in ISO/CIE 10527 shall be used for calculation of the tristimulus values from the measured spectral data. D65, F11 and illuminant A can be used for the calculation as optional. If any other illuminants are used, this shall be reported.

NOTE For some measurements, optical reflective density may be used but it should be noted that the measured values depend on the instruments used for the measurement.

5.4.2 Tristimulus values

The tristimulus values X, Y and Z in the CIE 1931 XYZ colour space for object colours and illuminant colours shall be calculated by the summations of the products of the spectral power distribution $S(\lambda)$ of the illuminant D50 as default, D65, F11 and illuminant A as optional, the spectral reflectance $\rho(\lambda)$ of the printed image, and the colour matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, $\bar{z}(\lambda)$, in accordance with equation (2).

$$\begin{aligned} X &= \frac{1}{K}\int_{\text{vis}} S(\lambda)\rho(\lambda)\bar{x}(\lambda)d\lambda \\ Y &= \frac{1}{K}\int_{\text{vis}} S(\lambda)\rho(\lambda)\bar{y}(\lambda)d\lambda \\ Z &= \frac{1}{K}\int_{\text{vis}} S(\lambda)\rho(\lambda)\bar{z}(\lambda)d\lambda \end{aligned} \tag{2}$$

where $K = \int_{\text{vis}} S(\lambda)\bar{y}(\lambda)d\lambda$.

5.4.3 CIELAB colour space

The CIELAB values L^*, a^* and b^* in the CIE 1976 $L^*a^*b^*$ colour space shall be calculated as in equation (3) in accordance with CIE 15.

$$\begin{aligned} L^* &= 116\left(\frac{Y}{Y_{\text{n}}}\right)^{\frac{1}{3}} - 16 \\ a^* &= 500\left\{\left(\frac{X}{X_{\text{n}}}\right)^{\frac{1}{3}} - \left(\frac{Y}{Y_{\text{n}}}\right)^{\frac{1}{3}}\right\} \\ b^* &= 200\left\{\left(\frac{Y}{Y_{\text{n}}}\right)^{\frac{1}{3}} - \left(\frac{Z}{Z_{\text{n}}}\right)^{\frac{1}{3}}\right\} \end{aligned} \tag{3}$$

where the tristimulus values $X_{\text{n}}, Y_{\text{n}}$ and Z_{n} correspond to the default illuminant D50; $X_{\text{n}} = 96{,}42$, $Y_{\text{n}} = 100{,}00$ and $Z_{\text{n}} = 82{,}49$ to optional illuminant D65; $X_{\text{n}} = 95{,}04$, $Y_n = 100{,}00$ and $Z_{\text{n}} = 108{,}89$ to optional illuminant F11; $X_{\text{n}} = 100{,}95$, $Y_{\text{n}} = 100{,}00$ and $Z_{\text{n}} = 64{,}37$ to optional illuminant A; $X_{\text{n}} = 109{,}85$, $Y_{\text{n}} = 100{,}00$ and $Z_{\text{n}} = 35{,}58$.

Relative values to the colour white shall also be calculated when it is required in accordance with equation (4).

$$\begin{aligned}
\tilde{L}^* &= 116\left(\frac{Y}{Y_W}\right)^{\frac{1}{3}} - 16 \\
\tilde{a}^* &= 500\left\{\left(\frac{X}{X_W}\right)^{\frac{1}{3}} - \left(\frac{Y}{Y_W}\right)^{\frac{1}{3}}\right\} \\
\tilde{b}^* &= 200\left\{\left(\frac{Y}{Y_W}\right)^{\frac{1}{3}} - \left(\frac{Z}{Z_W}\right)^{\frac{1}{3}}\right\}
\end{aligned} \tag{4}$$

where the tristimulus values X_W, Y_W and Z_W correspond to the printed colour white resulting from $D_R = D_G = D_B = 2^N - 1$ under the illuminant D50 as default, D65, F11 and illuminant A optional.

5.4.4 Averaging CIELAB values

The colorimetric values in the CIELAB colour space for reproduced colour chips obtained by multiple printing jobs shall be averaged over all the measured and calculated values as in equation (5).

$$\begin{aligned}
\bar{L}^* &= \frac{1}{N_s}\sum_{n=1}^{N_s} L_n^* \\
\bar{a}^* &= \frac{1}{N_s}\sum_{n=1}^{N_s} a_n^* \\
\bar{b}^* &= \frac{1}{N_s}\sum_{n=1}^{N_s} b_n^*
\end{aligned} \tag{5}$$

for Clauses 6, 7 and 8, where N_s is the number of printing jobs defined in equation (1); and

$$\begin{aligned}
\bar{L}^* &= \frac{1}{M}\sum_{m=1}^{M} L_m^* \\
\bar{a}^* &= \frac{1}{M}\sum_{m=1}^{M} a_m^* \\
\bar{b}^* &= \frac{1}{M}\sum_{m=1}^{M} b_m^*
\end{aligned} \tag{6}$$

for 10.1, where M is the number of printing jobs defined in 10.1.2. For simplicity, $\bar{L}^*$, $\bar{a}^*$ and $\bar{b}^*$ are written without the bars in the following clauses.

6 Spectral characteristics

6.1 Attributes to be measured

Spectral reflectance of reflective prints for primary colours, secondary colours, black and white.

6.2 Method of measurement

The colour test chart file containing data for red–green–blue as the primary colours, cyan–magenta–yellow as the secondary colours, and black, grey and white shall be prepared. The names of the colours and the identification numbers in Table A.1 are shown in Table 1 below.

Table 1 – Reference to Table A.1

Colour	Identification number	Colour	Identification number
Red	13B	Yellow	15C
Green	14B	Black	13A
Blue	15B	Grey	14A
Cyan	13C	White	15A
Magenta	14C		

NOTE Actual data in a red-green-blue colour space in Table A.1 provide examples for the case of 8-bit quantization for each channel.

All colours shall be reproduced as a piece of reflective print on one sheet of substrate, as shown in Annex E. Annex E shows alphanumeric characters, such as "01 to 16" vertically and "A to U" horizontally. The first two digits of the identification number indicate the vertical position, and the last one digit indicates the horizontal position. It shall be repeated for N_s times as specified in equation (1). Spectral reflectance $\rho(\lambda)$ of each reproduced colour patch shall be measured by the spectrophotometer in accordance with the specification in 5.3.2.

6.3 Presentation of the result

The spectral reflectance, $\overline{\rho}(\lambda)$, averaged at each wavelength, for the primary saturated colours, the secondary saturated colours, and black and white shall be plotted as in Figure 1.

The measured spectral reflectance of each colour shall be converted to the CIE 1931 XYZ values using equation (2), and the CIELAB values in the CIE 1976 $L^*a^*b^*$ colour space shall be calculated from the tristimulus values in the CIE 1931 XYZ colour space in accordance with equation (3). The CIELAB values shall be averaged as in equation (5) and entered in the form shown in Table A.1 at the column positions specified in Table 1.

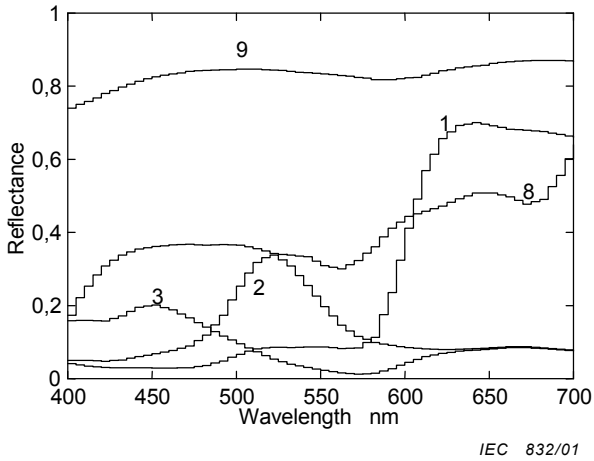

Figure 1a – Spectral reflectance of the primary saturated colours, grey and white

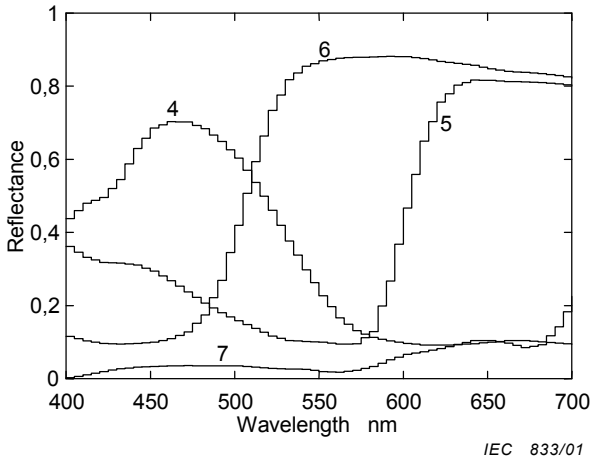

Figure 1b – Spectral reflectance of the secondary saturated colours and black

NOTE Identification numbers of the plots are the same as in Table 1.

Figure 1 – Spectral reflectance of the primary and secondary saturated colours, and white, grey and black

7 Basic colorimetric characteristics

7.1 Attribute to be measured

Relationship between the data in red–green–blue in the colour test chart file and reproduced corresponding colours as reflective prints.

7.2 Method of measurement

The colour test chart file containing data for the 6-by-6-by-6 cubic data points specified by the data identification numbers in Table A.2 shall be used. The file shall be processed to obtain a piece of reflective print on one sheet of substrate as an arrangement of colour patches, as shown in Annex E, for N_s times, as specified in equation (1).

NOTE The number of the cubic data points may be increased, for example, to account for discontinuities or non-monotonic artefacts indicated in Figure 3.

The spectral reflectance of each colour patch of the reflective print should be measured. The measured data shall be calculated according to equation (2). The tristimulus values X, Y and Z shall be converted to the CIELAB colour space, L^*, a^* and b^* in accordance with equation (3), which shall be averaged as in equation (5).

NOTE For simplicity of the measurement procedure, colorimeters may be used to acquire the tristimulus values X, Y and Z directly in accordance with the specification in 5.3.2.

7.3 Presentation of the results

Results of the measurement followed by the calculation shall be entered in the corresponding column positions of Table A.2. The reported CIELAB values shall also be plotted as in Figure 2.

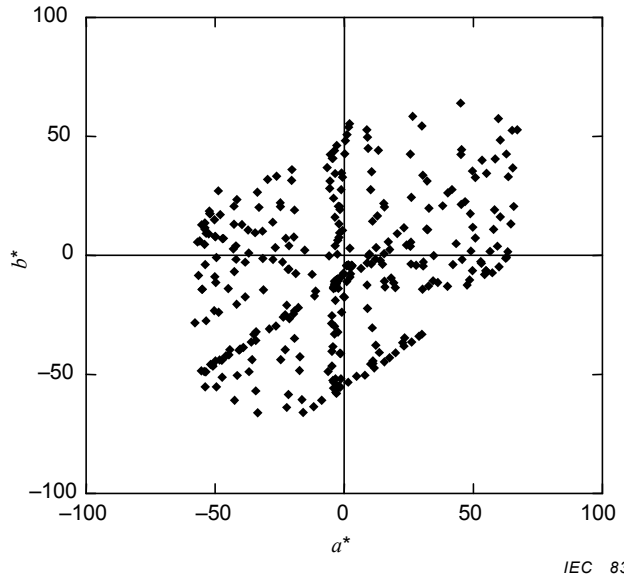

Figure 2a – Gamut of colours in b^* versus a^* plane

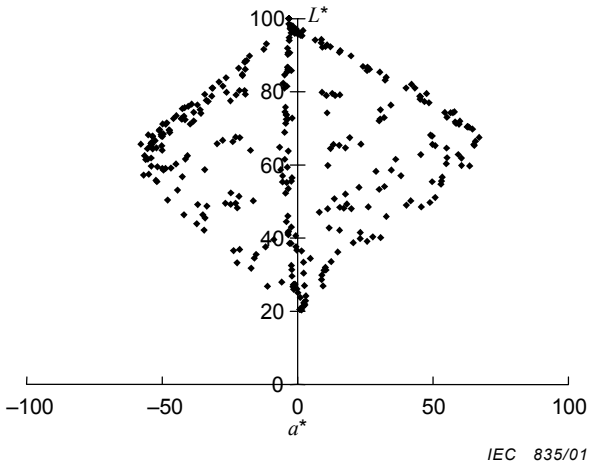

Figure 2b – Gamut of colours in L^* versus a^* plane

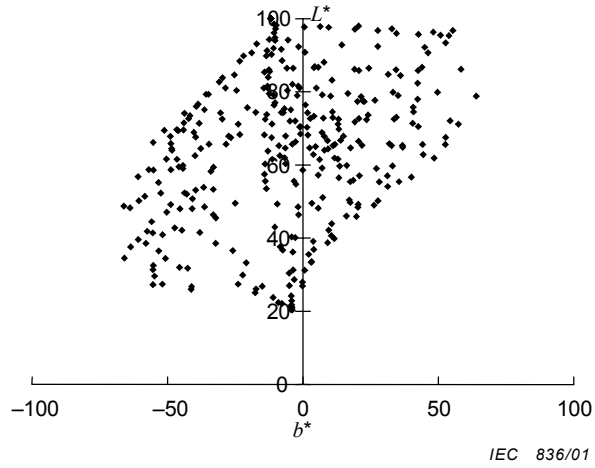

Figure 2c – Gamut of colours in L^* versus b^* plane

Figure 2 – Example plots for gamut of colours in the CIE 1976 $L^*a^*b^*$ colour space

8 Tone reproduction characteristics

8.1 Attribute to be measured

Relationship between the input data for the primary and secondary colours and black, and the CIE 1976 lightness of the reproduced colours.

8.2 Method of measurement

The colour test-chart file containing data specified by Table 2 for the input full-scale ranges shall be prepared for the primary colours, the secondary colours, and black. Table 2 shows the identification numbers corresponding to Table A.3 for each set of colours for reproduction and measurements.

Table 2 – Reference to Table A.3

Colour	Identification numbers	Colour	Identification numbers
Red	From 01S to 15S	Magenta	From 14D to 14R
Green	From 01T to 15T	Yellow	From 15D to 15R
Blue	From 01U to 15U	Black	From 16A to 16U
Cyan	From 13D to 13R		

The file shall be processed to obtain a piece of reflective print on one sheet of substrate as an arrangement of colour patches, as shown in Annex E, for N_S times, as specified in equation (1).

NOTE The number of cubic data points may be increased, for example, to account for discontinuities or non-monotonic artefacts indicated in Figure 3.

The spectral reflectance of each colour patch of the reflective print shall be measured and the measured data shall be calculated according to equation (2). One of the tristimulus values, Y, shall be converted to the lightness L^* in the CIELAB colour space in accordance with equation (3). The lightness L^* shall be averaged as in equation (5).

NOTE For simplicity of the measurement procedure, colorimeters may be used to acquire one of the tristimulus values Y directly in accordance with the specification in 5.3.2.

8.3 Presentation of the results

The measured and calculated results, including the rest of the CIELAB values shall be reported in the columns specified in Table 2 to Table A.1. The averaged lightness L^* versus normalized input data shall also be reported as the plots shown in Figure 3, where normalized input data for red and cyan is $(2R+G+B)/4$, for green and magenta is $(R+2G+B)/4$ and for black is $(R+G+B)/3$.

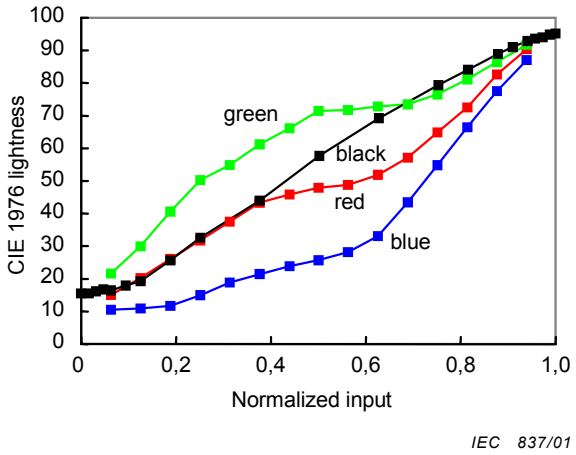

Figure 3a – Tone reproduction for red, green, blue and black

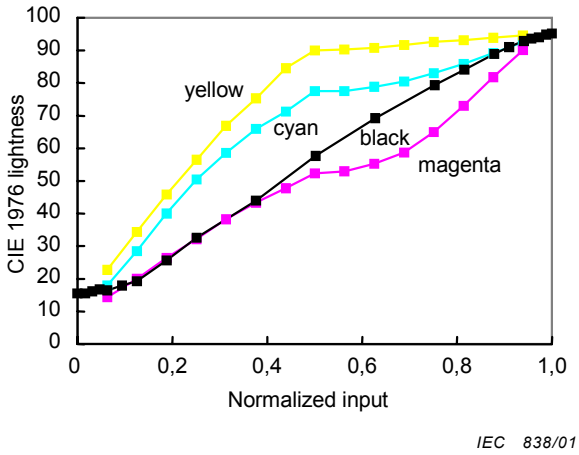

Figure 3b – Tone reproduction for cyan, magenta, yellow and black

NOTE Output characteristics such as lightness versus chroma may be reported to show gradations.

Figure 3 – An example of reporting tone reproduction characteristics

9 Spatial non-uniformity characteristics

9.1 Attribute to be measured

Non-uniformity of achromatic image reproduced within one sheet of substrate.

9.2 Method of measurement

The data in the spatial non-uniformity test chart file for this measurement shall be 80 % of the full scale for red–green–blue.

The size of the substrate shall be either A4 defined by ISO 216 or letter size[1]. If another size is recommended by the manufacturer of the equipment that reproduces the reflective print, it shall be reported together with the presentation of the results of measurements.

The location of the measurement points should be defined from top-left of the substrate in landscape and 15 mm ± 2 mm distance to the bottom-right repeatedly, until the next data point is outside of the substrate. An example of the points is shown in Table B.1. If the location of data points is different from the recommendation, it shall be reported together with the presentation of the results of measurements.

The spectral reflectance of the reproduced achromatic image should be measured and the acquired data shall be calculated according to equation (2). The tristimulus values X, Y and Z shall be converted to the CIE 1976 $L^*a^*b^*$ colour space in accordance with equation (3).

The spatial non-uniformity test chart file shall be reproduced as a piece of reflective print on one sheet of substrate, as shown in Annex F. Annex F shows alphanumeric characters, such as "01 to 14" vertically, and "A to S" horizontally. The first two digits of the identification number indicate the vertical position, and the last one digit indicates the horizontal position.

NOTE 1 For simplicity of the measurement procedure, colorimeters may be used to acquire the tristimulus values X, Y and Z directly in accordance with the specification in 5.3.2.

NOTE 2 The spatial non-uniformity test-chart file should be modified according to the paper size used. For A4 size paper, 210 mm or more should be cut off from the left. For letter size paper, 279,4 mm or more should be cut off from the bottom.

9.3 Presentation of the result

Results of the measurement followed by the calculation shall be filled in to the corresponding columns of Table B.1. The colour differences from the average of the CIELAB values $\Delta E^*_{\mathrm{ab}_i}$ at the position i shall also be calculated and reported in Table B.1, where the colour difference shall be

$$\Delta E^*_{\mathrm{ab_i}} = \sqrt{\left(L^*_{\mathrm{i}} - \overline{L^*}\right)^2 + \left(a^*_{\mathrm{i}} - \overline{a^*}\right)^2 + \left(b^*_{\mathrm{i}} - \overline{b^*}\right)^2}$$

The metric N_{u} for use in equation (1) shall also be calculated by the following equation (7):

$$N_{\mathrm{u}} = \sqrt{\frac{1}{n}\sum_{\mathrm{i}=1}^{n} \Delta E^{*2}_{\mathrm{ab_i}}} \qquad (7)$$

where n is the number of positions of the measurement.

NOTE The other colour difference based on CIE 116 may also be reported.

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1 A paper size used only in North America.

10 Temporal instability characteristics

10.1 Short-term instability

10.1.1 Attribute to be measured

Colour variation amongst successive reflective prints.

10.1.2 Method of measurement

A colour digital image data as combinations of data 0 %– 50 %–100 % for each of red, green and blue shall be prepared as specified in Table C.1 for $1 \le j \le 27$. The short-term instability test chart file containing 27 colour images in a single page shall be processed to obtain printed samples in accordance with a basic sampling sequence. The basic sampling sequence shall consist of seven printing jobs corresponding to the sequence number $1 \le i \le 7$ in Table C.1. The basic sampling sequence shall be conducted under each of the environmental conditions $1 \le k \le 4$ as specified in Table 3.

Table 3 – Conditions for sampling and measurements

Conditions k	Ambient temperature	Relative humidity
1	20 °C ± 5 °C	65 % ± 10 %
2	30 °C ± 5 °C	85 % ± 10 %
3	10 °C ± 5 °C	15 % ± 10 %
4	20 °C ± 5 °C	65 % ± 10 %

NOTE It should be noted that atmospheric pressure remains in the range from 86 kPa to 106 kPa during the four environmental conditions in Table 3.

The number of reflective prints M for each sampling sequence for the first and the seventh printing jobs should be $M = \text{round}(10p)$, where p is the printing speed of the colour printer under measurement in terms of the number of reflective prints per minute, and should be $M = \text{round}(3p)$ for the rest of the printing jobs (from the second to the sixth printing job).

NOTE Only the first and the last prints under each environmental condition may be allowed to be used in order to simplify the measurement procedure.

In order to initiate the basic sampling sequence, the colour printer under measurement shall be powered off for at least one day to acclimate the colour printer to each of the environmental conditions in Table 3. The first printing job in the sequence shall be started after the colour printer has been powered on and warmed up in accordance with the manufacturer's specifications. The rest of the printing jobs shall be conducted within the time interval of four to five minutes.

NOTE In the case where the colour printer shuts down at the i-th printing job in the basic sampling sequence due to any trouble, the sampling sequence should be resumed from the beginning of the i-th printing job after fixing the trouble.

The spectral reflectance of each of the reproduced colour images should be measured by the spectrophotometer. The measured spectral data shall be calculated in accordance with equation (2). The tristimulus values X, Y and Z shall be converted to the CIE 1976 L^*, a^*, b^* colour space in accordance with equation (3) which shall further be averaged over the number of reproduced colour images under the same colour (j) and the same environmental condition (k).

All reproduced colour images, except the set of colour prints obtained in the seventh printing job under the environmental condition $k = 4$, shall be discarded. The spectral reflectance of the colour patches for $1 \leq j \leq 27$ of the number of prints M_7 for $k = 4$ and $i = 7$ should be measured by the spectrophotometer. The measured spectral data shall be calculated in accordance with equation (2).

The short-term instability test-chart file shall be reproduced as a piece of reflective print on one sheet of substrate, as shown in Annex G. Annex G shows alphanumeric characters, such as "01 to 03" vertically, and "A to I" horizontally. The first two digits of the identification number indicate the vertical position, and the last one digit indicates the horizontal position.

NOTE For simplicity of the measurement procedure, colorimeters may be used to acquire the tristimulus values X, Y and Z directly in accordance with the specification in 5.3.2.

10.1.3 Presentation of the result

The averaged CIELAB values, L^*, a^* and b^* shall be filled in to the corresponding columns of Table C.1 together with the environmental condition k. The colour difference $\Delta E^*_{\mathrm{ab_{ij}}}$ for the ith sampling sequence and for the jth image shall be calculated as follows and reported in Table C.1.

$$\Delta E^*_{\mathrm{ab_{ij}}} = \sqrt{\left(L^*_{\mathrm{ij}} - \overline{L^*_{\mathrm{j}}}\right)^2 + \left(a^*_{\mathrm{ij}} - \overline{a^*_{\mathrm{j}}}\right)^2 + \left(b^*_{\mathrm{ij}} - \overline{b^*_{j}}\right)^2}$$

where $\overline{L^*_{\mathrm{j}}}$, $\overline{a^*_{\mathrm{j}}}$ and $\overline{b^*_{\mathrm{j}}}$ are the averages calculated as follows:

$$\overline{L^*_{\mathrm{j}}} = \frac{1}{7}\sum_{\mathrm{i}=1}^{7} L^*_{\mathrm{ij}}$$

$$\overline{a^*_{\mathrm{j}}} = \frac{1}{7}\sum_{\mathrm{i}=1}^{7} a^*_{\mathrm{ij}}$$

$$\overline{b^*_{\mathrm{j}}} = \frac{1}{7}\sum_{\mathrm{i}=1}^{7} b^*_{\mathrm{ij}}$$

Based on the reported results in Table C.1 under the environmental condition for $k = 4$, the metric N_t for use in equation (1) shall also be calculated by the following equation (8).

$$N_{\mathrm{t}} = \sqrt{\frac{1}{27}\sum_{\mathrm{j}=1}^{27} \Delta E^{*2}_{\mathrm{ab_{7j}}}} \qquad (8)$$

NOTE The other colour difference based on CIE 116 may also be reported.

10.2 Long-term instability

10.2.1 Attribute to be measured

Colour image instability of the reflective prints under light exposure or light fastness.

10.2.2 Method of measurement

The colour test-chart file containing data for the saturated primary colours, the secondary colours, the peak white and the peak black shall be prepared as shown in Table 4. The file shall be processed to obtain each colour image printed on one sheet of the substance.

Each of the printed colour images shall be cut in half at the beginning to have two sets of the samples. The first set shall be kept in a dark environment at a temperature of 20 °C ± 5 °C, a relative humidity of 65 % ± 10 %, and at atmospheric pressure from 86 kPa to 106 kPa. The second set shall be placed underneath a sodium glass plate of thickness 6 mm and shall be kept exposed under a xenon lamp giving an irradiance of 0,22 W/m^2 at the wavelength 340 nm, for a duration of seven days, at a temperature of 20 °C ± 5 °C, a relative humidity of 65 % ± 10 %, and at atmospheric pressure from 86 kPa to 106 kPa.

NOTE When any of the values do not match the specification, the actual values of irradiance of the light source and exposing time should be reported together with the presentation of the results of measurements.

The spectral reflectance of each colour image should be measured by the spectrophotometer at the beginning and after seven days. The values in the CIELAB colour space for each colour images in the first set shall be calculated in accordance with equations (2) and (3).

The values in the CIELAB colour space for each colour image in the second set should also be calculated on the basis of spectral reflectance, in accordance with equations (2) and (3), every 24 h for seven days. If the time interval is not equal to the specification, it shall be reported together with the presentation of the results.

NOTE For simplicity of the measurement procedure, colorimeters may be used to acquire the tristimulus values X, Y and Z directly in accordance with the specification in 5.3.2.

10.2.3 Presentation of the result

The data in the CIE 1976 $L^*a^*b^*$ colour space, together with the colour difference from the initial data in CIELAB colour space shall be reported in Table 4 as functions of time (or days).

The environmental conditions during measurement and sampling shall be reported together with the presentation of the results of measurements.

Table 4 – Specification of data in the colour test chart file and the form for reporting the result in the long-term instability measurement

Identification numbers			13C	14C	15C	13A	13B	14B	15B	15A
Set	Lap-time (days)	R	0 %	100 %	100 %	0 %	100 %	0 %	0 %	100 %
		G	100 %	0 %	100 %	0 %	0 %	100 %	0 %	100 %
		B	100 %	100 %	0 %	0 %	0 %	0 %	100 %	100 %
1st	0	L^*								
		a^*								
		b^*								
	7	L^*								
		a^*								
		b^*								
2nd	0	L^*								
		a^*								
		b^*								
	1	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	2	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	3	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	4	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	5	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	6	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								
	7	L^*								
		a^*								
		b^*								
		ΔE^*_{ab}								

11 Dependency on illuminant characteristics

11.1 Attribute to be measured

Colour fidelity against the change of illuminants.

11.2 Method of measurement

The colour test-chart file containing data for the saturated primary colours, the secondary colours, the peak white and the peak black shall be prepared. The reference to the identification numbers in the colour test chart file specified in Table A.1 is shown in Table 5.

Table 5 – Specification of colour patches

Peak colours	Index j	Identification number in Table A.1
Cyan	1	13C
Magenta	2	14C
Yellow	3	15C
Black	4	13A
Red	5	13B
Green	6	14B
Blue	7	15B
White	8	15A

The file shall be processed to obtain all colour images printed on one sheet of the substrate for N_s times as specified in equation (1). The spectral reflectance of each colour image shall be measured by the spectrophotometer. The tristimulus values shall be calculated in accordance with equation (2) for such illuminants $S(\lambda)$ as

a) illuminant D50 defined by Table 1.1 of CIE 15,

b) illuminant A defined by ISO/CIE 10526,

c) illuminant D65 defined by ISO/CIE 10526,

d) illuminant F11 defined by Table 3.1 of CIE 15.

NOTE Additional illuminants may be allowed for calculation and report.

The corresponding CIELAB values in accordance with equation (3) shall be calculated and averaged as in equation (5).

The relative CIELAB values $\widetilde{L}^*$, $\widetilde{a}^*$ and $\widetilde{b}^*$ in reference to X_W, Y_W and Z_W under the illuminant D50 shall also be calculated in accordance with equation (4) and averaged as in equation (5).

NOTE If any other illuminants are used for the reference, they shall be reported together with the calculated values.

11.3 Presentation of the results

The calculated values in the CIE 1976 $L^*a^*b^*$ colour space, together with the colour differences as in equation (7) shall be reported in Table 6 as the measures for colour fidelity under different illuminations.

$$\Delta E^*_{ab_{ij}} = \sqrt{\left(L^*_{ij} - L^*_{D50j}\right)^2 + \left(a^*_{ij} - a^*_{D50j}\right)^2 + \left(b^*_{ij} - b^*_{D50j}\right)^2}$$
$$\Delta \tilde{E}^*_{ab_{ij}} = \sqrt{\left(\tilde{L}^*_{ij} - \tilde{L}^*_{D50j}\right)^2 + \left(\tilde{a}^*_{ij} - \tilde{a}^*_{D50j}\right)^2 + \left(\tilde{b}^*_{ij} - \tilde{b}^*_{D50j}\right)^2} \quad (7)$$

where the index i is for the illuminants A, D65 and F11, the index $1 \leq j \leq 8$ is for the colours in Tables 5 and 6.

NOTE The other colour difference based on CIE 116 may also be used in reporting.

Table 6 – Specification of data in the colour test chart file and the form of reporting the result of dependency on illuminants measurement –

CIELAB values

	No. j	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Identification numbers		**13C**	**14C**	**15C**	**13A**	**13B**	**14B**	**15B**	**15A**
Illuminant	R	0 %	100 %	100 %	0 %	100 %	0 %	0 %	100 %
or	G	100 %	0 %	100 %	0 %	0 %	100 %	0 %	100 %
light source	B	100 %	100 %	0 %	0 %	0 %	0 %	100 %	100 %
D50	L^*								
	a^*								
	b^*								
A	L^*								
	a^*								
	b^*								
	ΔE^*_{ab}								
D65	L^*								
	a^*								
	b^*								
	ΔE^*_{ab}								
F11	L^*								
	a^*								
	b^*								
	ΔE^*_{ab}								

Table 7 – Specification of data in the colour test chart file and the form of reporting the result of dependency on illuminants measurement –

Relative CIELAB values

	No. j	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Identification numbers		**13C**	**14C**	**15C**	**13A**	**13B**	**14B**	**15B**
Illuminant	R	0 %	100 %	100 %	0 %	100 %	0 %	0 %
or	G	100 %	0 %	100 %	0 %	0 %	100 %	0 %
light source	B	100 %	100 %	0 %	0 %	0 %	0 %	100 %
D50	$\tilde{L}^*$							
	$\tilde{a}^*$							
	$\tilde{b}^*$							
A	$\tilde{L}^*$							
	$\tilde{a}^*$							
	$\tilde{b}^*$							
	$\Delta\tilde{E}^*_{ab}$							
D65	$\tilde{L}^*$							
	$\tilde{a}^*$							
	$\tilde{b}^*$							
	$\Delta\tilde{E}^*_{ab}$							
F11	$\tilde{L}^*$							
	$\tilde{a}^*$							
	$\tilde{b}^*$							
	$\Delta\tilde{E}^*_{ab}$							

Annex A
(normative)

Values in the colour test-chart file

Table A.1 specifies the identification numbers for each set of red(R)–green(G)–blue(B) data and the form to be used to report the measured results. The table shall be applicable for measurements in Clauses 6, 7 and 8. Reproduced reflective print as an array of colour images is shown in Annex E.

NOTE The actual data are shown just for information in the case of 8-bit quantization for each of the R, G, and B channels.

Table A.1 – Specification of the colour test chart file and the form for reporting – Primary colours

No.	D_R	D_G	D_B	L^*	a^*	b^*
13B	255	0	0			
14B	0	255	0			
15B	0	0	255			
13C	0	255	255			
14C	255	0	255			
15C	255	255	0			
13A	0	0	0			
14A	128	128	128			
15A	255	255	255			

Table A.2 – Specification of the colour test-chart file and the form for reporting – 6-by-6-by-6 cubic data

No.	D_R	D_G	D_B	L^*	a^*	b^*
01A	0	0	0			
01B	0	0	51			
01C	0	0	102			
01D	0	0	153			
01E	0	0	204			
01F	0	0	255			
02A	0	51	0			
02B	0	51	51			
02C	0	51	102			
02D	0	51	153			
02E	0	51	204			
02F	0	51	255			
03A	0	102	0			
03B	0	102	51			
03C	0	102	102			
03D	0	102	153			
03E	0	102	204			
03F	0	102	255			
04A	0	153	0			
04B	0	153	51			
04C	0	153	102			
04D	0	153	153			
04E	0	153	204			
04F	0	153	255			
05A	0	204	0			
05B	0	204	51			
05C	0	204	102			
05D	0	204	153			
05E	0	204	204			
05F	0	204	255			

Table A.2 *(continued)*

No.	D_R	D_G	D_B	L^*	a^*	b^*
06A	0	255	0			
06B	0	255	51			
06C	0	255	102			
06D	0	255	153			
06E	0	255	204			
06F	0	255	255			
01G	51	0	0			
01H	51	0	51			
01I	51	0	102			
01J	51	0	153			
01K	51	0	204			
01L	51	0	255			
02G	51	51	0			
02H	51	51	51			
02I	51	51	102			
02J	51	51	153			
02K	51	51	204			
02L	51	51	255			
03G	51	102	0			
03H	51	102	51			
03I	51	102	102			
03J	51	102	153			
03K	51	102	204			
03L	51	102	255			
04G	51	153	0			
04H	51	153	51			
04I	51	153	102			
04J	51	153	153			
04K	51	153	204			
04L	51	153	255			
05G	51	204	0			
05H	51	204	51			
05I	51	204	102			
05J	51	204	153			
05K	51	204	204			
05L	51	204	255			
06G	51	255	0			
06H	51	255	51			
06I	51	255	102			
06J	51	255	153			
06K	51	255	204			
06L	51	255	255			
01M	102	0	0			
01N	102	0	51			
01O	102	0	102			
01P	102	0	153			
01Q	102	0	204			
01R	102	0	255			
02M	102	51	0			
02N	102	51	51			
02O	102	51	102			
02P	102	51	153			
02Q	102	51	204			
02R	102	51	255			
03M	102	102	0			
03N	102	102	51			
03O	102	102	102			
03P	102	102	153			
03Q	102	102	204			
03R	102	102	255			
04M	102	153	0			
04N	102	153	51			
04O	102	153	102			
04P	102	153	153			
04Q	102	153	204			
04R	102	153	255			

Table A.2 (*continued*)

No.	D_R	D_G	D_B	L^*	a^*	b^*
05M	102	204	0			
05N	102	204	51			
05O	102	204	102			
05P	102	204	153			
05Q	102	204	204			
05R	102	204	255			
06M	102	255	0			
06N	102	255	51			
06O	102	255	102			
06P	102	255	153			
06Q	102	255	204			
06R	102	255	255			
07A	153	0	0			
07B	153	0	51			
07C	153	0	102			
07D	153	0	153			
07E	153	0	204			
07F	153	0	255			
08A	153	51	0			
08B	153	51	51			
08C	153	51	102			
08D	153	51	153			
08E	153	51	204			
08F	153	51	255			
09A	153	102	0			
09B	153	102	51			
09C	153	102	102			
09D	153	102	153			
09E	153	102	204			
09F	153	102	255			
10A	153	153	0			
10B	153	153	51			
10C	153	153	102			
10D	153	153	153			
10E	153	153	204			
10F	153	153	255			
11A	153	204	0			
11B	153	204	51			
11C	153	204	102			
11D	153	204	153			
11E	153	204	204			
11F	153	204	255			
12A	153	255	0			
12B	153	255	51			
12C	153	255	102			
12D	153	255	153			
12E	153	255	204			
12F	153	255	255			
07G	204	0	0			
07H	204	0	51			
07I	204	0	102			
07J	204	0	153			
07K	204	0	204			
07L	204	0	255			
08G	204	51	0			
08H	204	51	51			
08I	204	51	102			
08J	204	51	153			
08K	204	51	204			
08L	204	51	255			
09G	204	102	0			
09H	204	102	51			
09I	204	102	102			
09J	204	102	153			
09K	204	102	204			
09L	204	102	255			

Table A.2 (*continued*)

No.	D_R	D_G	D_B	L^*	a^*	b^*
10G	204	153	0			
10H	204	153	51			
10I	204	153	102			
10J	204	153	153			
10K	204	153	204			
10L	204	153	255			
11G	204	204	0			
11H	204	204	51			
11I	204	204	102			
11J	204	204	153			
11K	204	204	204			
11L	204	204	255			
12G	204	255	0			
12H	204	255	51			
12I	204	255	102			
12J	204	255	153			
12K	204	255	204			
12L	204	255	255			
07M	255	0	0			
07N	255	0	51			
07O	255	0	102			
07P	255	0	153			
07Q	255	0	204			
07R	255	0	255			
08M	255	51	0			
08N	255	51	51			
08O	255	51	102			
08P	255	51	153			
08Q	255	51	204			
08R	255	51	255			
09M	255	102	0			
09N	255	102	51			
09O	255	102	102			
09P	255	102	153			
09Q	255	102	204			
09R	255	102	255			
10M	255	153	0			
10N	255	153	51			
10O	255	153	102			
10P	255	153	153			
10Q	255	153	204			
10R	255	153	255			
11M	255	204	0			
11N	255	204	51			
11O	255	204	102			
11P	255	204	153			
11Q	255	204	204			
11R	255	204	255			
12M	255	255	0			
12N	255	255	51			
12O	255	255	102			
12P	255	255	153			
12Q	255	255	204			
12R	255	255	255			

Table A.3 – Specification of the colour test-chart file and the form for reporting – Data and form for gradation

No.	D_R	D_G	D_B	L^*	a^*	b^*
01S	32	0	0			
02S	64	0	0			
03S	96	0	0			
04S	128	0	0			
05S	160	0	0			
06S	192	0	0			
07S	224	0	0			
08S	255	0	0			
09S	255	32	32			
10S	255	64	64			
11S	255	96	96			
12S	255	128	128			
13S	255	160	160			
14S	255	192	192			
15S	255	224	224			
01T	0	32	0			
02T	0	64	0			
03T	0	96	0			
04T	0	128	0			
05T	0	160	0			
06T	0	192	0			
07T	0	224	0			
08T	0	255	0			
09T	32	255	32			
10T	64	255	64			
11T	96	255	96			
12T	128	255	128			
13T	160	255	160			
14T	192	255	192			
15T	224	255	224			
01U	0	0	32			
02U	0	0	64			
03U	0	0	96			
04U	0	0	128			
05U	0	0	160			
06U	0	0	192			
07U	0	0	224			
08U	0	0	255			
09U	32	32	255			
10U	64	64	255			
11U	96	96	255			
12U	128	128	255			
13U	160	160	255			
14U	192	192	255			
15U	224	224	255			
13D	0	32	32			
13E	0	64	64			
13F	0	96	96			
13G	0	128	128			
13H	0	160	160			
13I	0	192	192			
13J	0	224	224			
13K	0	255	255			
13L	32	255	255			
13M	64	255	255			
13N	96	255	255			
13O	128	255	255			
13P	160	255	255			
13Q	192	255	255			
13R	224	255	255			
14D	32	0	32			
14E	64	0	64			
14F	96	0	96			
14G	128	0	128			
14H	160	0	160			
14I	192	0	192			
14J	224	0	224			

Table A.3(*continued*)

No.	D_R	D_G	D_B	L^*	a^*	b^*
14K	255	0	255			
14L	255	32	255			
14M	255	64	255			
14N	255	96	255			
14O	255	128	255			
14P	255	160	255			
14Q	255	192	255			
14R	255	224	255			
15D	32	32	0			
15E	64	64	0			
15F	96	96	0			
15G	128	128	0			
15H	160	160	0			
15I	192	192	0			
15J	224	224	0			
15K	255	255	0			
15L	255	255	32			
15M	255	255	64			
15N	255	255	96			
15O	255	255	128			
15P	255	255	160			
15Q	255	255	192			
15R	255	255	224			
16A	0	0	0			
16B	4	4	4			
16C	8	8	8			
16D	12	12	12			
16E	16	16	16			
16F	24	24	24			
16G	32	32	32			
16H	48	48	48			
16I	64	64	64			
16J	96	96	96			
16K	128	128	128			
16L	160	160	160			
16M	192	192	192			
16N	208	208	208			
16O	224	224	224			
16P	232	232	232			
16Q	240	240	240			
16R	244	244	244			
16S	248	248	248			
16T	252	252	252			
16U	255	255	255			

Annex B
(normative)

Specification of the measurement positions in the spatial non-uniformity test-chart file and the reporting form

Table B.1 specifies the positions in millimetres to be measured for spatial non-uniformity in Clause 9. This table also specifies the form to be used to report the measured results. The colour difference is from total averages of the CIELAB values in Table B.1.

Table B.1 – Form of reporting with measurement positions

i	**Left** mm	**Top** mm	L^*	a^*	b^*	ΔE^*_{ab}
01A	15	15				
01B	30	15				
01C	45	15				
01D	60	15				
01E	75	15				
01F	90	15				
01G	105	15				
01H	120	15				
01I	135	15				
01J	150	15				
01K	165	15				
01L	180	15				
01M	195	15				
01N	210	15				
01O	225	15				
01P	240	15				
01Q	255	15				
01R	270	15				
01S	285	15				
02A	15	30				
02B	30	30				
02C	45	30				
02D	60	30				
02E	75	30				
02F	90	30				
02G	105	30				
02H	120	30				
02I	135	30				
02J	150	30				
02K	165	30				
02L	180	30				
02M	195	30				
02N	210	30				
02O	225	30				
02P	240	30				
02Q	255	30				
02R	270	30				
02S	285	30				
03A	15	45				
03B	30	45				
03C	45	45				
03D	60	45				
03E	75	45				
03F	90	45				
03G	105	45				
03H	120	45				
03I	135	45				
03J	150	45				
03K	165	45				
03L	180	45				
03M	195	45				

Table B.1 (*continued*)

i	**Left** mm	**Top** mm	L^*	a^*	b^*	ΔE^*_{ab}
03N	210	45				
03O	225	45				
03P	240	45				
03Q	255	45				
03R	270	45				
03S	285	45				
04A	15	60				
04B	30	60				
04C	45	60				
04D	60	60				
04E	75	60				
04F	90	60				
04G	105	60				
04H	120	60				
04I	135	60				
04J	150	60				
04K	165	60				
04L	180	60				
04M	195	60				
04N	210	60				
04O	225	60				
04P	240	60				
04Q	255	60				
04R	270	60				
04S	285	60				
05A	15	75				
05B	30	75				
05C	45	75				
05D	60	75				
05E	75	75				
05F	90	75				
05G	105	75				
05H	120	75				
05I	135	75				
05J	150	75				
05K	165	75				
05L	180	75				
05M	195	75				
05N	210	75				
05O	225	75				
05P	240	75				
05Q	255	75				
05R	270	75				
05S	285	75				
06A	15	90				
06B	30	90				
06C	45	90				
06D	60	90				
06E	75	90				
06F	90	90				
06G	105	90				
06H	120	90				
06I	135	90				
06J	150	90				
06K	165	90				
06L	180	90				
06M	195	90				
06N	210	90				
06O	225	90				
06P	240	90				
06Q	255	90				
06R	270	90				
06S	285	90				

Table B.1 (*continued*)

i	**Left** mm	**Top** mm	L^*	a^*	b^*	ΔE^*_{ab}
07A	15	105				
07B	30	105				
07C	45	105				
07D	60	105				
07E	75	105				
07F	90	105				
07G	105	105				
07H	120	105				
07I	135	105				
07J	150	105				
07K	165	105				
07L	180	105				
07M	195	105				
07N	210	105				
07O	225	105				
07P	240	105				
07Q	255	105				
07R	270	105				
07S	285	105				
08A	15	120				
08B	30	120				
08C	45	120				
08D	60	120				
08E	75	120				
08F	90	120				
08G	105	120				
08H	120	120				
08I	135	120				
08J	150	120				
08K	165	120				
08L	180	120				
08M	195	120				
08N	210	120				
08O	225	120				
08P	240	120				
08Q	255	120				
08R	270	120				
08S	285	120				
09A	15	135				
09B	30	135				
09C	45	135				
09D	60	135				
09E	75	135				
09F	90	135				
09G	105	135				
09H	120	135				
09I	135	135				
09J	150	135				
09K	165	135				
09L	180	135				
09M	195	135				
09N	210	135				
09O	225	135				
09P	240	135				
09Q	255	135				
09R	270	135				
09S	285	135				
10A	15	150				
10B	30	150				
10C	45	150				
10D	60	150				
10E	75	150				
10F	90	150				

Table B.1 (*continued*)

i	**Left** mm	**Top** mm	L^*	a^*	b^*	ΔE^*_{ab}
10G	105	150				
10H	120	150				
10I	135	150				
10J	150	150				
10K	165	150				
10L	180	150				
10M	195	150				
10N	210	150				
10O	225	150				
10P	240	150				
10Q	255	150				
10R	270	150				
10S	285	150				
11A	15	165				
11B	30	165				
11C	45	165				
11D	60	165				
11E	75	165				
11F	90	165				
11G	105	165				
11H	120	165				
11I	135	165				
11J	150	165				
11K	165	165				
11L	180	165				
11M	195	165				
11N	210	165				
11O	225	165				
11P	240	165				
11Q	255	165				
11R	270	165				
11S	285	165				
12A	15	180				
12B	30	180				
12C	45	180				
12D	60	180				
12E	75	180				
12F	90	180				
12G	105	180				
12H	120	180				
12I	135	180				
12J	150	180				
12K	165	180				
12L	180	180				
12M	195	180				
12N	210	180				
12O	225	180				
12P	240	180				
12Q	255	180				
12R	270	180				
12S	285	180				
13A	15	195				
13B	30	195				
13C	45	195				
13D	60	195				
13E	75	195				
13F	90	195				
13G	105	195				
13H	120	195				
13I	135	195				
13J	150	195				
13K	165	195				

Table B.1 (*continued*)

i	**Left** mm	**Top** mm	L^*	a^*	b^*	ΔE^*_{ab}
13L	180	195				
13M	195	195				
13N	210	195				
13O	225	195				
13P	240	195				
13Q	255	195				
13R	270	195				
13S	285	195				
14A	15	210				
14B	30	210				
14C	45	210				
14D	60	210				
14E	75	210				
14F	90	210				
14G	105	210				
14H	120	210				
14I	135	210				
14J	150	210				
14K	165	210				
14L	180	210				
14M	195	210				
14N	210	210				
14O	225	210				
14P	240	210				
14Q	255	210				
14R	270	210				
14S	285	210				

Annex C
(normative)
Specification for the measurement of short-term instability characteristics

Table C.1 – Short-term instability characteristics

Colour (j)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Identification numbers		01 A	01 B	01 C	01 D	01 E	01 F	01 G	01 H	01 I	02 A	02 B	02 C	02 D	02 E	02 F	02 G	02 H	02 I	03 A	03 B	03 C	03 D	03 E	03 F	03 G	03 H	03 I
i	R (%)	0	50	0	0	50	0	50	50	100	0	0	100	0	50	50	0	100	100	50	50	100	0	100	50	100	100	100
	G (%)	0	0	50	0	50	50	0	50	0	100	0	50	100	0	100	50	0	50	100	50	100	100	0	100	50	100	100
	B (%)	0	0	0	50	0	50	50	50	0	0	100	0	50	100	0	100	50	50	50	100	0	100	100	100	100	50	100
1	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{1j}}$																											
2	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{2j}}$																											
3	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{3j}}$																											
4	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{4j}}$																											
5	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{5j}}$																											
6	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{6j}}$																											
7	L^*																											
	a^*																											
	b^*																											
	$\Delta E^*_{ab_{7j}}$																											

Environmental condition: ambient temperature =___°C, relative humidity =___ %.

Annex D
(informative)

Estimation of effect for backing material change

The way to estimate spectrophotometric characteristics caused by backing material change is as follows.

$$D_{X_i}(\lambda) = D_{W_i}(\lambda) + \Delta D(\lambda),$$

where

λ is the wavelength in nanometers;

$D_{X_i}(\lambda)$ is the "X" backing spectral density of i th image;

$D_{W_i}(\lambda)$ is the white backing spectral density of i th image, and

ΔD is a measured value of density. Cubic spline functions are used to fit the ΔD curve.

When $|\lambda| \le \omega$,

$$C(\lambda) = \frac{\left(\omega^3 + 3\omega^2(\omega - |\lambda|) + 3\omega(\omega - |\lambda|)^2 - 3(\omega - |\lambda|)^3\right)}{6\omega^3}$$

when $\omega \le |\lambda| \le 2\omega$,

$$C(\lambda) = \frac{(2\omega - |\lambda|)^3}{6\omega^3}$$

when $2\omega \le |\lambda|$,

$$C(\lambda) = 0$$

where

$C(\lambda)$ is a spline function and ω (no dimension) is a constant which defines a width of $C(\lambda)$.
$\Delta D(\lambda)$ is described as a linear combination of a series of $C(\lambda)$ as in

$$\Delta D(\lambda) = \sum_{j=1}^{m} x_j C_j(\lambda)$$

where

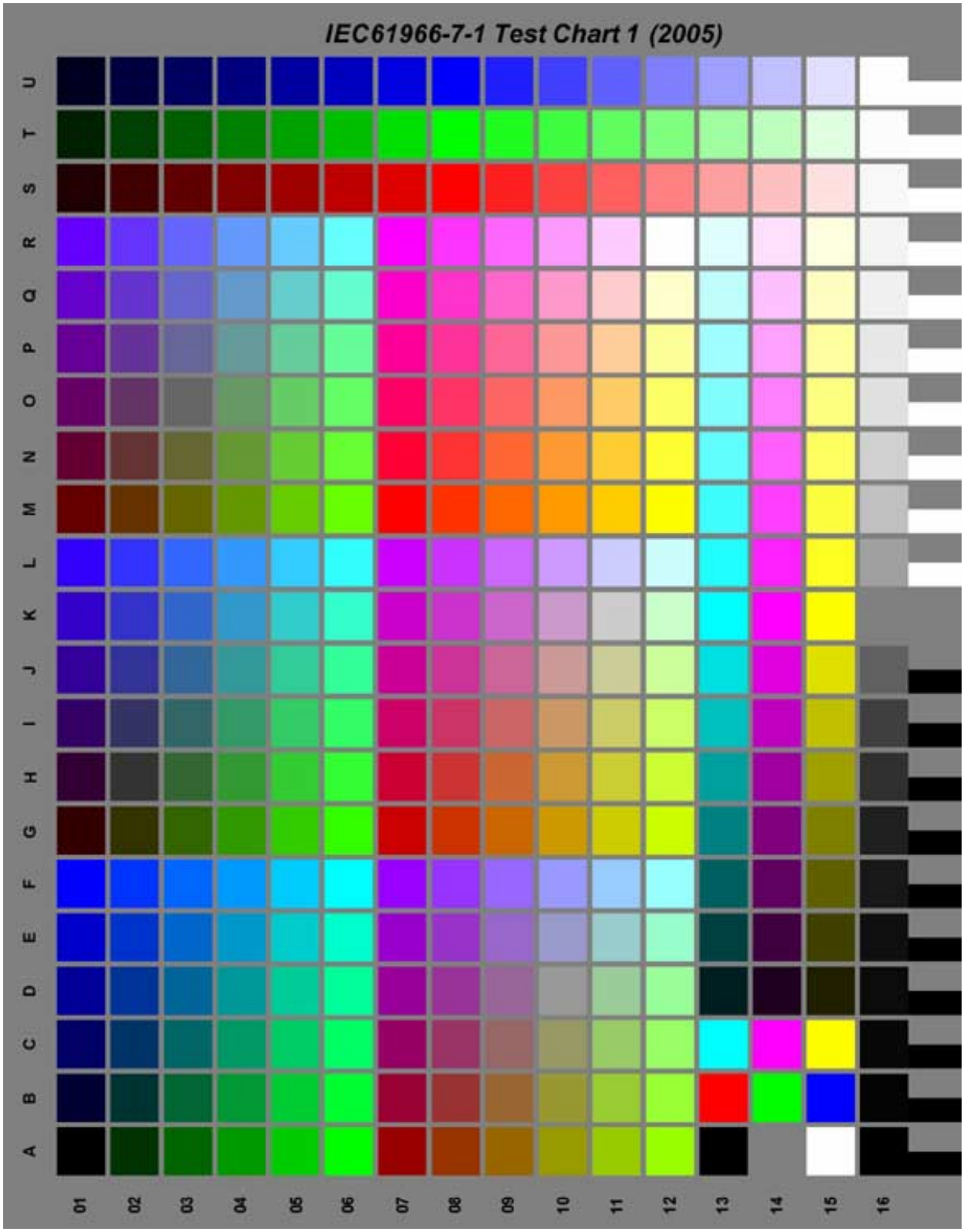
m is a number of spline functions laid out along with the wavelength equally distanced; $C_j(\lambda)$ is the j th spline function;

x_j is a weighting factor for it.

Recommended values are $m = 18$ and $\omega = 20$.

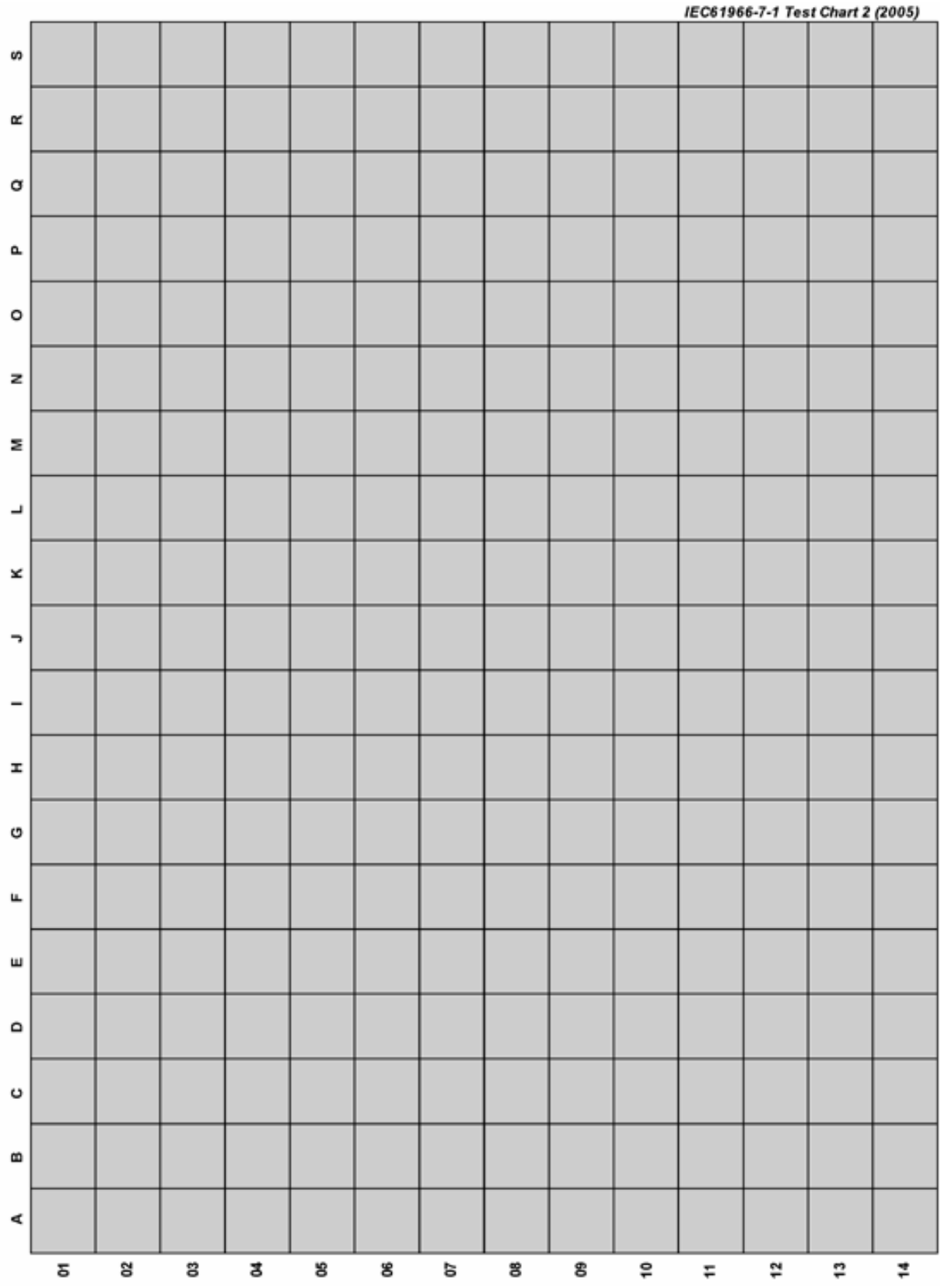
Annex E
(informative)

Layout of the colour test chart file reproduced as a reflective print



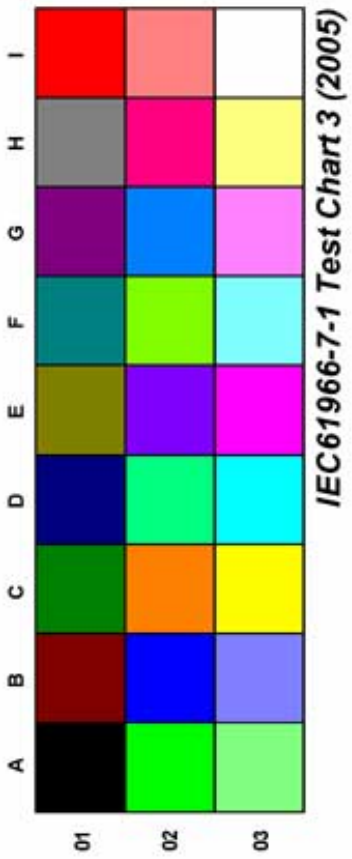
Annex F
(informative)

Layout of the spatial non-uniformity test-chart file reproduced as a reflective print



Annex G
(informative)

Layout of the short-term instability test chart file reproduced as a reflective print



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