IEC 61966-8

Edition 1.0 2001-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Multimedia systems and equipment – Colour measurement and management – Part 8: Multimedia colour scanners

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Systèmes et appareils multimédia – Mesure et gestion de la couleur – Partie 8: Scanners multimédia couleur

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MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 8: Multimedia colour scanners

FOREWORD

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International Standard IEC 61966-8 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

This bilingual version (2013-03) corresponds to the monolingual English version, published in 2001-02.The text of this standard is based on the following documents:

FDIS	Report on voting
100/192/FDIS	100/218/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.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

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

- Part 1: General[1]
- Part 2-0: Colour management in multimedia systems[1]
- Part 2-1: Colour management – Default RGB colour space – sRGB
- Part 2-2: Colour management – Extended RGB colour space – sRGB64[1]
- Part 2-3: Colour management – Default YCC colour space – sYCC[1]
- Part 3: Equipment using cathode ray tubes
- Part 4: Equipment using liquid crystal display panels
- Part 5: Equipment using plasma display panels[1]
- Part 6: Equipment used for digital image projection[1]
- Part 7-1: Colour printers – Reflective prints – RGB inputs[1]
- Part 7-2: Colour printers – Reflective prints – CMYK input[1]
- Part 7-3: Colour printers – Transparent prints[1]
- Part 8: Multimedia colour scanners[1]
- Part 9: Digital cameras
- Part 10: Quality assessment – Colour image in network systems[1]
- Part 11: Quality assessment – Impaired video in network systems[1]

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Annexes A and B form integral parts of this standard.

Annex C is for information only.

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The committee has decided that the contents of this publication will remain unchanged until 2003. At this date, the publication will be

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- withdrawn;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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

1 To be published.

INTRODUCTION

This introduction is intended to distinguish the field of application of ISO 12641 and IEC 61966-8.

In order to standardize the calibration procedure for input scanners used in the printing and prepress industry, ISO 12641 was published in 1997. This part of IEC 61966 targets colour scanners for multimedia applications by providing characterization data necessary for colour management in open multimedia systems. It characterizes any multimedia colour scanners for consumer use, typically being connected to personal computers so as to capture colour images and display the colour information, either locally or distributed worldwide.

In such applications, colour management is important. Any red – green – blue data should have their colorimetric attributes clearly specified. The characterization data reported from this part of IEC 61966 will be used for the calculation of equipment specific colorimetric characterization so that colour management in open systems can be conducted.

The capture of colour information in a prepress input scanner usually assumes that the source is a positive film (transparent) original. The second most common type of original is positive photographic printing paper (reflective). Recently, prepress input scanners can support various types of reflective originals in addition to printing paper and can also capture an image directly from a negative film, although this is not yet very common. Due to these circumstances, ISO 12641 was established for prepress digital data exchange corresponding to transparent and reflective originals. However, a standard colour target for transparent film negative originals has not yet been established.

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Spectral sensitivity characteristics of prepress scanners are not derived from the calculation based on a special colour system or the spectral distribution of printing ink; but are base signals relatively close to the three primary colours (red, green, blue) acquired for calibration purposes. The characteristics of the prepress input scanners are guaranteed by the experience of the operator or the sophistication of the colour processing application so that subtle variations among the colours appear in the printed result. In fact, printing and prepress scanners have many settings that are made available to professional users, and the operator can control the input scanner characteristics in a non-linear fashion to suit their objectives. In older input scanners, these controls were part of the stand-alone scanner system itself. For the scanners of the printing industry, these controls are typically part of the colour processing application software which processes the signals after capture and transfers them to the general purpose computer (workstation or server). In other words, a highly experienced and skilled operator can adjust the settings to freely change scanner characteristics such as tone and colour separation as he desires. Furthermore, scanner characteristics can be changed to correct and compensate for the characteristics of the original image target, such as colour fogging, as well as absorb them, and the operator can even change scanner colour separation conditions (typically cyan, yellow, magenta and black) in anticipation of the later printing process so as to obtain the most feasible printed result. As such, on the site of the prepress scanner, good colour separation (reproduction) is and has been dependent on the skill of the operator.

All prepress input scanners show variation in colour sensitivity characteristics depending on types, manufacturers, manufactured time and condition. Prepress input scanners tend to show less variation than other general-purpose multimedia colour scanners because of their usage in critical colour capturing in a closed system in comparison with the worldwide open system such as the Internet. There has never been an attempt to standardize the colour characteristics of prepress input scanners put on the market by different manufacturers.

However, it is demanded that the printing process should produce essentially the same results from the same original regardless of the input scanner used. This demand has been accomplished by the skill of the operator. For this reason, the process of scanning, including colour processing for the raw data, should involve the human operator, and the total system be considered as one system. In this human-machine interaction system, the characteristics can be understood as unified or standardized.

Under these circumstances, and in consideration of the actual work process, ISO/TC 130 (Graphic technology) has established a method using a colour target as stipulated in ISO 12641 for prepress input scanner calibration that includes functions capable of handling colour changes accompanying local distortions in colour regions. These targets for both positive reflective material (photographic printing paper) and positive transmission material (photographic film) are implemented by the photographic manufacturers on their specific materials of their particular products.

Multimedia colour scanners for general use which are much less expensive in comparison with prepress input scanners, are available for small office/home office personal computers. Targets for scanning are not specified as in prepress input scanners. Images of natural objects such as the petals of violets, green plants or human skin will be most important. As many of the users of multimedia colour scanners are not colour experts, it is preferable to have an automatic system requiring minimal adjustment. The manufacturers of this type of colour scanner do not provide colorimetric specifications of the red – green – blue data obtained from their scanner on one hand. On the other hand, the data obtained from the multimedia colour scanner are easily compressible and compatible to the World Wide Web and anonymous users will use the colour information in colour reproduction without having available the specific features of the original generator.

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Prepress scanners have been used for many years in the printing and prepress industry and an environment has already been created in which only prepress scanners meeting certain critical criteria are selected. This being the case, there is no need for a new evaluation of prepress input scanner performance. In such an environment, however, the maintenance of input scanner quality is important and it is necessary and sufficient to calibrate a scanner using the appropriate target. The internationally standardized target in ISO 12641 exists for this purpose.

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However, open multimedia systems and composing equipment creates a new environment different from the conventional printing industry, and the colour scanners used for multimedia systems have not undergone a similar evaluation process in related industries. In the multimedia environment, it is assumed that multimedia colour scanners will be used for a variety of purposes. This means that the initially assumed environment will vary and the functions required for individual multimedia colour scanners will also vary. In other words, the multimedia colour scanners supplied to the market and bought by general users might be designed for different purposes and will not all assure the same quality and characteristics. This will not be the case if multimedia colour scanner specifications are unified in the future; however, there is currently no movement in this direction.

Therefore, it would be a great advantage to the general user, if he could evaluate the characteristics of the multimedia colour scanner he is about to buy and judge whether it suits his purpose. In other words, knowing the colour reproduction characteristics of each scanner before making a decision, would allow the user to select a multimedia colour scanner having characteristics suited to his purpose.

While there is hope that scanners used in a multimedia environment will undergo critical evaluation in the market over time, the ability to quantitatively evaluate the colour reproduction of such multimedia colour scanners would be of direct benefit to the critical issue of colour management that we now face.

The purpose of IEC 61966-8 is to provide a method for evaluating the colour reproduction of multimedia colour scanners used in a multimedia environment and allows the specification of their colour reproduction characteristics from spectral transmission functions, which can be used for colour management. In an environment such as multimedia that has not yet matured and is constantly developing, the most critical consideration is determining whether or not a multimedia colour scanner is suited to the intended purpose. For this reason, IEC 61966-8 must be viewed separately from strict standards (such as ISO 12641) applicable to the equipment once characteristics have reached a certain level. As such, IEC 61966-8 is presented as a critical, though interim tool, during the undetermined period of evolution of these types of scanners.

Colour control within the equipment is out of the scope of this part. This is because the output data of a multimedia colour scanner depend on the spectral characteristics of the colour pigments or colour inks of the original and a large variety of originals with different pigments or inks has to be considered in office and multimedia applications, for example, photographic colour pigments, offset printing colours, ink jet colours, painting art colours, etc. The output data of the multimedia colour scanner are the result of the spectral reflection of a colour of a document under the in-built light source and the respective selection by the spectral sensitivity curves of the three sensor channels of the multimedia colour scanner. Since the spectral sensitivity curves of multimedia colour scanners do not fit a linear combination of the colour matching functions in ISO/CIE 10527, metameric colours scanned from different colour originals will result in different output data.

Due to this fact, colour control and management requires the restriction to certain classes of colour inks of the originals to be scanned. The multimedia colour scanner characterization of this standard therefore focuses on the characterization of spectral transfer functions of the three channels as multiband sensitivities and achromatic tone characteristics. This enables the user of the standard to optimize colour management for his own class of originals. An example for the use of the spectral characterization defined in this standard to specify sRGB values according to IEC 61966-2-1 is given in annex C.

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MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 8: Multimedia colour scanners

1 Scope and object

This part 8 of IEC 61966 is applicable to the characterization and assessment of multimedia colour scanners used in computer systems, multimedia and similar applications.

The methods of measurement standardized in this part are designed to make possible the characterization and objective performance assessment of multimedia colour scanners which can capture colour images and output colour information such as red, green and blue data from reflective originals. The measured results are intended to be used for the purpose of colour management in multimedia systems. Measurement conditions, possible methods of measurement and characterization are defined to make colour management possible.

Colour control within the equipment is out of the scope of this part. For calibration of prepress input scanners, ISO 12641 will be applied.

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2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61966. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61966 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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IEC 60050(845)/CIE 17.4:1987, *International Electrotechnical Vocabulary (IEV) – Chapter 845: Lighting – International Lighting Vocabulary* (IEC/CIE joint publication)

IEC 61966-2-1:1999, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*

CIE 15.2:1986, *Colorimetry*

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

ISO 9241-8:1997, *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 8: Requirements for displayed colours*

ISO 12641:1997, *Graphic technology – Prepress digital data exchange – Colour targets for input scanners calibration*

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

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

3 Terms and definitions

For the purpose of this part of IEC 61966, the definitions given in IEC 60050(845)/CIE 17.4 and the following apply.

3.1
illuminant E
illuminant of constant spectral power distribution $S_n = 1$ where S_n represents the relative radiant power in the n-th interval per 10 nm bandwidth

3.2
input scanner
equipment capable of converting the light reflected by a photographic paper into electronic signals, where the electronic signals are arranged to have an organized relationship to the spatial areas of the paper evaluated

3.3
multimedia colour scanner
electrotechnical equipment with a light source illuminating a scanning area where an original is placed, which provides means to sense colour signals from the light reflected from specified picture elements within the scanning area in digital form as output data

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3.4
driver software
computational function to control the multimedia colour scanner from internal parameters and parameters specified by the user such as scaling of scan, spatial resolution, etc. comprising a colour control function to convert the colour signals of the multimedia colour scanner into approximate components of a defined colour space such as the sRGB colour space in IEC 61966-2-1 or an equipment independent colour space such as the CIE 1931 XYZ colour space or the CIELAB colour space in CIE 15.2

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3.5
light flux
incident radiant power valued by physical spectral responsivities

3.6
scanning area
dimension of the area to be scanned, given in square centimetres or the number of resolved picture elements along the vertical and the horizontal directions from which digital image data are made readily available at the output

3.7
spatial resolution
number of picture elements used to describe a region of an image of fixed spatial size

3.8
scaling of scan
magnification or reduction of pieces of the scanning area and corresponding image data

3.9
target
image composed of grey patches or colour patches for use in the measurement for characterization of multimedia colour scanners

3.10
original
reflective material, for example, a sheet of paper, a photograph, a hardcopy, etc. to be scanned to obtain corresponding red, green and blue data

4 Letters and symbols

The notations consistently adopted in this part of IEC 61966 are summarized below.

Φ_R: normalized light flux reflected from the target and captured by the red channel. See also 3.5 for the definition of light flux

Φ_G: normalized light flux reflected from the target and captured by the green channel. See also 3.5 for the definition of light flux

Φ_B: normalized light flux reflected from the target and captured by the blue channel. See also 3.5 for the definition of light flux

D_R: integer data obtained from the red channel of the multimedia colour scanner averaged for more than 10 × 10 picture elements corresponding to the centre of a patch of the target

D_G: integer data obtained from the green channel of the multimedia colour scanner averaged for more than 10 × 10 picture elements corresponding to the centre of a patch of the target

D_B: integer data obtained from the blue channel of the multimedia colour scanner averaged for more than 10 × 10 picture elements corresponding to the centre of a patch of the target

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d_R: normalized D_R by $2^N - 1$

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d_G: normalized D_G by $2^N - 1$

d_B: normalized D_B by $2^N - 1$

N: the number of bits per channel

Y: luminance factor. One of the tristimulus values in the CIE 1931 XYZ colour space with the reference illuminant E

λ_n: the n-th wavelength at the centre of 10 nm wavelength band

S_n: spectral power of a built-in light source at the centre wavelength λ_n

p_{R_n}: physical spectral sensitivities at the centre wavelength λ_n of the red channel

p_{G_n}: physical spectral sensitivities at the centre wavelength λ_n of the green channel

p_{B_n}: physical spectral sensitivities at the centre wavelength λ_n of the blue channel

s_{R_n}: effective spectral sensitivities at the centre wavelength λ_n as response of light flux being captured by the red channel; it is a linear combination of p_{R_n}, p_{G_n} and p_{B_n}

s_{G_n}: effective spectral sensitivities at the centre wavelength λ_n as response of light flux being captured by the green channel; it is a linear combination of p_{R_n}, p_{G_n} and p_{B_n}

s_{B_n}: effective spectral sensitivities at the centre wavelength λ_n as response of light flux being captured by the blue channel; it is a linear combination of p_{R_n}, p_{G_n} and p_{B_n}

r_{k_n}: spectral reflectance of the k-th colour patch at the centre wavelength λ_n

K: the number of usable colour patches

5 Conditions

5.1 General conditions

Unless otherwise specified, automatic functions shall be disabled to prevent the multimedia colour scanner from responding automatically to the target and from establishing scanning conditions. This condition shall not be changed during the period of the test.

The scaling of scan shall be set to unity. Resolution of scanning shall be set to the maximum spatial resolution. The multimedia colour scanner shall be powered on 1 h before the measurement, except for the measurement in clause 12.

Environmental conditions such as temperature and relative humidity shall be reported together with the results of measurement. If additional environmental conditions are described in the manufacturer's specifications, these should be taken into account.

Unless otherwise stated in this standard, conditions of measurement shall be set to the conditions recommended by the manufacturer as default conditions.

5.2 Output digital image data

Red – green – blue digital image data, D_R, D_G, D_B, corresponding to the target shall be used as basic data for reporting and further processing of the data. If direct output from the multimedia colour scanner is not available, red – green – blue data shall be calculated using the driver software provided or specified by the manufacturer of the equipment being characterized.

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When a general-purpose software is used for handling the raw data, its name and version number shall be reported together with the results of measurements.

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6 Measurement equipment and target of scan

6.1 Spectrophotometer

A spectrophotometer with the following specifications shall be used for the measurements.

a) Wavelength range and interval: minimum range between 400 nm and 700 nm at 10 nm intervals, measurements beyond the minimum range are permissible.

b) Geometry: 45°/0° or 0°/45° per ISO 5-4.

The guidance in ISO 13655 shall be taken into account as appropriate.

6.2 Spectroradiometer

A one-shot spectroradiometer, which picks up spectral data in parallel at a certain time, with the following specifications shall be used for the measurement of spectral distribution of the built-in light source in clause 7.

a) Wavelength range and interval: minimum range between 400 nm and 700 nm at 10 nm intervals, measurements beyond the minimum range are permissible.

b) Built-in calibrated spectral reference table.

c) Mobile sensor head to be placed on the scanning area.

6.3 Specification of the target

A special reflective target shall be used for the measurements in clauses 8 and 10. The layout of the target is shown in figure 1. The basic format is 12,7 cm × 17,8 cm in accordance with the ISO 12641. There are 12 rows and 22 columns of colour patches with the size of 6,5 mm × 6,5 mm. The patches at the addresses A1 to L22 are filled with selected printing colours of high saturation and strong variation of their spectral reflection.

An achromatic neutral scale lying along the bottom of the target has lightness values according to ISO 12641. The patch located to the left of step one of the grey scale (column zero) has the highest lightness value. The patch to the right of the 24th step (column 23) of the grey scale is of the lowest lightness value.

NOTE It is most important for the application in this standard that the neutral grey scale is printed from a single black colourant to assure that the spectral reflectances of the patches of the grey scale from light to dark just differ by a luminance factor.

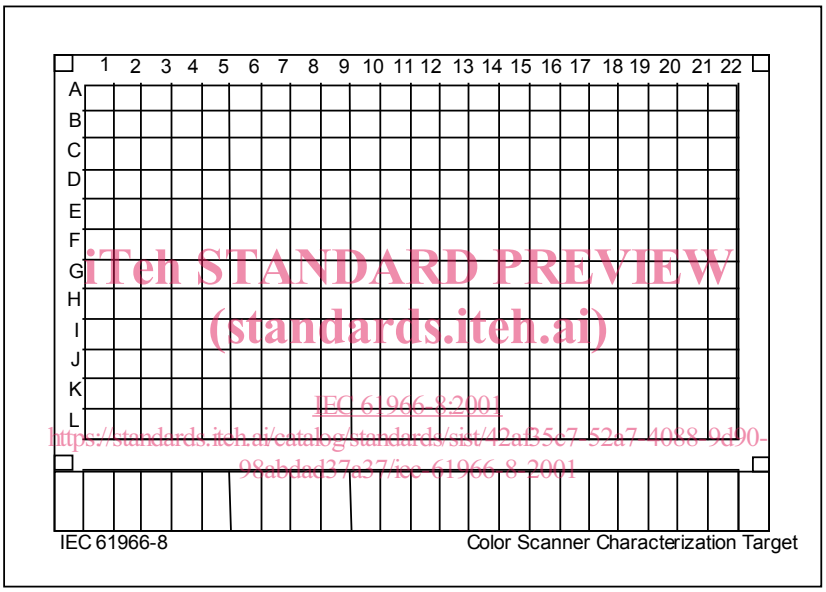

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Figure 1 – Specification of the target for characterization of multimedia colour scanners

Calibrated targets are the targets with measured spectral reflection of each patch on the basis of a calibrated spectrophotometer as specified in 6.1. The luminance factor Y of each patch of the grey scale shall be calculated in reference to the illuminant E. The tristimulus values of each colour patch at addresses from A1 to L22 and the grey scale patches in the CIE 1931 XYZ colour space or the values in the CIELAB colour space calculated in reference to the illuminant E shall be given together with the actual target being used for characterization.

NOTE The illuminant E is the simplest illuminant which provides equally bright spectral radiant power as defined in 3.1. Under the assumption that the grey scale is neutral as specified, it does not matter which illuminant is used. In the algorithm incorporated in IEC 61966-8, the Y values are used as relative factors just describing the relative response of the red, green and blue channels for the patches of the grey scale.

The multiband spectral reflection shall be specified according to the example of table 1 and its graphical representation of figure 2 at 10 nm intervals from 400 nm to 700 nm. The white reference of the spectrophotometer, normally barium sulfate or equivalent, shall be used for normalization.