INTERNATIONAL STANDARD

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Graphic technology — Displays for colour proofing — Characteristics and viewing conditions

Technologie graphique — Affichages pour la réalisation d'épreuves en couleur — Caractéristiques et conditions d'examen visuel

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

ISO 12646 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This second edition cancels and replaces the first edition (ISO 12646:2004), which has been extensively revised to include the particular requirements of flat panel displays.

Introduction

The ability to match colour images displayed on colour monitors to the images produced when the same digital file is rendered by proofing and printing systems (commonly referred to as “soft” proofing) is increasingly expected in graphic arts. Obtaining such a match is not simple and to be fully accurate requires careful control of many aspects of the process. The primary purpose of this International Standard is to make recommendations with respect to the soft proof viewing conditions. If these are controlled, it is then possible for users to exchange meaningful calibration (3.1.1) and characterization (3.1.2) data such that a consistent and, possibly, accurate colour match to the hard copy proof is achieved. In the case of visual display devices, the RGB device values are related to CIE tristimulus values.

The appearance of a colour image on a colour display is influenced by many physical factors other than controlled ambient viewing conditions. Among the most important of these are uniformity, convergence, size and resolution (in order to permit rendition of the proof at close to its normal size and with the finest detail visible on the hard copy at normal viewing distances), variation of electro-optical properties with viewing direction, freedom from flicker and glare (specular reflections with distinct images), the opto-electronic calibration of the display and the settings of its display driver software. So, to be acceptable as a proofing system which provides a reasonable level of image quality, the display must also exhibit these properties at an acceptable quality. This International Standard is based on the use of the flat panel display (FPD) and cathode ray tube display (CRT) technologies. It specifies the requirements for factors such as uniformity, convergence, refresh rate, size and spatial resolution. However, since these parameters are subject to improvement as display technology changes, this International Standard only defines minimum requirements for these parameters. It is assumed that displays used for this purpose will always conform to accepted industry “standards” for computer-aided design (CAD), and generally provide quality levels considered acceptable for this purpose, where they offer an improvement over the specifications herein.

Note that, even for displays of the highest quality, the appearance of the displayed image will be limited by the accuracy of the colour transformation used for converting the digital file from its encoded colour space to that required for display purposes. This International Standard provides no formal specifications for these transformations, although the issues are discussed in an informative annex (Annex A), together with recommendations for achieving an acceptable colour transformation.

This International Standard only considers the setting up of colour displays as “soft” proofing devices. It primarily focuses on applications where the displayed image will be directly compared to a hard copy. However, in some practical situations, the image on the screen is evaluated in the absence of a hard copy. In this International Standard examples of two practical use cases are described. The first concerns the comparison of a soft proof with a hard copy proof; the second concerns the viewing of displayed images independently of any hard copy image. For the viewing of displayed images independently of any hard copy image, less restrictive requirements are sufficient, and they are stated separately in this International Standard. This viewing is therefore concerned with modifying the “hard” and “soft” controls of the display to enable it to simulate a proof. In this sense, it can be looked on as a “slave” device. However, it is in the interests of a CAD user, where the colour display in a real sense “originates” from the image, to set up the display in a similar way. This will enable simpler optimization of the colour transformation to the selected hard copy system used for rendering the image, in order to produce an accurate reproduction, if this is an important requirement. However, it is possible to undertake image processing to modify the image when rendered to make it look like the displayed image (colour gamuts permitting) whatever the opto-electronic calibration of the display. This is briefly discussed in Annex A.

Users of this International Standard will also benefit from CIE Publication 122[14]. Those unfamiliar with the judgement of displays may also find it helpful to read IEC 61223-2-5[9] which contains much useful detailed information about evaluation and testing of image display devices.

Graphic technology — Displays for colour proofing — Characteristics and viewing conditions

1 Scope

This International Standard specifies the minimum requirements for the characteristics of displays to be used for soft proofing of colour images. Included are requirements for uniformity, convergence, refresh rate, display diagonal size, spatial resolution and glare of the screen surface. The dependence of colorimetric properties on the electrical drive signals and viewing direction, especially for flat panel displays, is also specified.

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.

ISO 3664, *Graphic technology and photography — Viewing conditions*

ISO 13655:—[1)], *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 15790, *Graphic technology and photography — Certified reference materials for reflection and transmission metrology — Documentation and procedures for use, including determination of combined standard uncertainty*

CIE Publication 15, *Colorimetry*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
calibration
operation of establishing that the measured values agree with the values specified by a standard or a characterization process

3.1.2
characterization
process of relating device-dependent colour values to device-independent colour values

1) To be published. (Revision of ISO 13655:1996)

3.1.3
convergence
ability of the three electron beams (R, G and B) to come together at a single spot on the surface of the CRT (see 3.2)

NOTE Not applicable to FPDs (see 3.2).

3.1.4
DVD
design viewing direction
direction for which specific electro-optical characteristics of the display have been optimized

NOTE Examples of important electro-optical characteristics are maximum luminance and maximum contrast.

3.1.5
gamma
γ
best-fit parameter which relates the monitor normalized output luminance to a normalized input digital value presented to the monitor system including its hardware and software components as given in Equation (1):

$$L = S^{\gamma} \tag{1}$$

where

L is the normalized output luminance;

S is the normalized input digital value

NOTE This definition is traditionally used in graphic technology for work with CRTs (see 3.2). It ignores offset and gain and thus differs from that in CIE Publication 122[14]. See also target gamma (3.1.12).

3.1.6
hard copy proofing system
system for simulating a printed image using a printing device which may be different from that used for production

3.1.7
OFF-state
condition in which the display is switched off

3.1.8
ON-state
condition in which the display is switched on

NOTE This definition is important for light-valve-like displays, which might emit a significant light intensity even when displaying the darkest image (R = G = B = 0) in the ON-state.

3.1.9
opto-electronic transfer function
relationship between the input values provided to, and the luminance values produced by, a display device

3.1.10
refresh rate
frequency with which the image on the screen is redrawn

NOTE The refresh rate is expressed in Hertz (Hz).

3.1.11
RGB
additive process colour model where the channels are called Red, Green and Blue

[ISO 15930-7:2008, definition 3.29]

3.1.12
target gamma
gamma value specified by the vendor either as a single number characterizing the total range or piecewise as a look-up table for inputs from 0 to 2^n-1 (n-bit)

NOTE The target gamma characterizes the intended input-output relation. The target gammas of all channels are assumed to be identical.

3.1.13
tracking
channel balance
process of ensuring (by adjustment of the amplifiers) that the relationship between the three channels of a display is balanced, so that for all levels equal values in each channel produce a neutral sensation

3.1.14
viewing cone
VC
conical space, originating at the display surface, that includes all viewing directions with a specified angle of inclination θ

3.1.15
surround
area adjacent to the border of an image, which, upon viewing the image, may affect the local state of adaptation of the eye

3.2 Abbreviated terms

CRT cathode ray tube display

FPD flat panel display

LCD liquid crystal display

4 Requirements

4.1 Resolution

The display resolution shall be sufficient for displaying an image of 1 280 pixels × 1 024 pixels without interpolation. When a test image with dimensions as defined in 5.2 is displayed by a CRT, all specified lines shall be visible at a normal viewing distance (defined as 0,5 m for the purposes of this International Standard).

To avoid issues associated with interpolation, it is important to operate all displays at their intrinsic native resolution.

4.2 Size

The display shall be capable of displaying an image having a diagonal measurement of at least 43 cm and a height of at least 22 cm.

4.3 **Refresh rate** (CRTs only)

The refresh rate, non-interlaced, shall be at least 80 Hz.

4.4 Uniformity of luminance

The display should be visually uniform when displaying flat white, grey and black images. When measured as described in 5.3, all luminance values should be within 5 % of the luminance of the centre and shall be within 10 % of it. There should also be no areas of significant visual non-uniformity between the points marked in Figure 2.

For the entire display, measured at least at the positions stated in 5.3, the chromaticity of every neutral image (defined by equal digital values for R, G, and B) shall be within a radius of 0,01 (in u', v' as defined in ISO 13655) from the chromaticity values measured at the centre of the display.

NOTE 1 The uniformity of chromaticity is specified in 4.8.

NOTE 2 The uniformity tolerance of a radius of 0,01 (in u', v') of CIE 1976[12] corresponds to an average CIELAB difference of 1,7 at a CIE L^* value of 5 and a difference of 8,7 at a CIE L^* value of 95.

4.5 **Geometric accuracy** (CRTs only)

When displaying the grid pattern specified in 5.4, the display should essentially be free of distortion. The length of adjacent lines of the grid pattern shall be within 2 mm of each other and no line length shall deviate by more than 2,5 mm from the mean length.

4.6 **Convergence** (CRTs only)

When displaying the grid pattern specified in 5.4, all lines shall appear wholly free of colour fringing within the central region (defined as the area within half the linear diagonal distance). A small amount of fringing may be accepted outside of this area but is not recommended.

4.7 Ambient illumination, surroundings and environment

4.7.1 General

The luminance of the black level (R = G = B = 0) in the ON-state, measured with a spectroradiometer or a colorimeter in a dark room, as specified in 5.6, shall not be greater than 200 % of the black level reading in the OFF-state.

The reflective properties of the display surface in the OFF-state shall be judged visually in a darkroom using a point source. The reflection of the point source off the screen should appear hazy and should smoothly decrease as one turns away from the direction of specular reflection.

No strongly coloured surfaces (including clothing) should be present in the immediate environment surrounding the monitor.

NOTE Display reflective properties can also be determined as specified in ISO 13406-2 for “unwanted reflections”.

4.7.2 Comparison of monitor and hard copy images

For the comparison of monitor and hard copy images, the following applies.

a) It is necessary that the level of ambient illumination is sufficiently low. The luminance of a perfectly reflecting diffuser, placed at the position of the faceplate of the monitor, with the monitor switched off (OFF-state), shall not be greater than 1/4 of the monitor white point luminance (R = G = B = 255) and should not be greater than 1/8 of the monitor white point luminance. These limits also apply when

measuring in any other plane which might affect the state of adaptation of the observer. The colour temperature of the ambient light, such as room light, should be within ±200 K of the colour temperature of the illumination used in the viewing booth.

b) The luminance of the area surrounding the monitor shall not exceed 1/10 of the luminance of the monitor showing a white screen (R = G = B = 255). The measurement shall be performed as specified in 5.6.

c) The conditions within the viewing booth shall conform to viewing condition P2 of ISO 3664.

d) No light from the viewing booth shall fall directly on the monitor.

e) Extraneous light, whether from light sources or reflected by objects, shall be baffled from view and from illuminating the print or other image being compared.

4.7.3 Viewing of single images

When viewing single images, the following applies.

a) The luminance of the area surrounding the monitor should not exceed 20 %, or preferably even 3 %, of the luminance of the white point of the monitor. The measurement shall be performed as specified in 5.6.

b) It is necessary that the level of ambient illumination is sufficiently low. The luminance of a perfectly reflecting diffuser, placed at the position of the faceplate of the monitor, with the monitor switched off (OFF-state), shall not be greater than 1/4 of the monitor white point luminance (R = G = B = 255) and should not be greater than 1/8 of the monitor white point luminance. These limits also apply when measuring in any other plane which might affect the state of adaptation of the observer.

NOTE By keeping the level of ambient illumination significantly lower than the luminance level of the monitor white point, the full contrast range of the monitor is ensured not to be significantly reduced by the effects of veiling glare. This also enables the observer to adapt reasonably to the monitor. Given the luminance levels currently available with monitors whose white point is set to D65, it is necessary that the level of ambient illumination be less, and preferably much less, than 1/4 of the monitor's white luminance.

c) Extraneous light, whether from light sources or reflected by objects, shall be baffled from view.

4.8 Chromaticity, luminance of the white and black points, and tracking (channel balance)

4.8.1 General

The black point of the display shall have a luminance that is less than 1 % of the maximum luminance (i.e. a luminance ratio of at least 100 to 1).

The luminance of the white displayed on the monitor shall be at least 80 cd/m^2 but preferably 160 cd/m^2.

NOTE 1 In cases where the gradation of the white point cannot be adjusted by hardware means, and the white is therefore achieved by altering look-up tables in the driver software, one of the channels ought to be set to the maximum digital value.

NOTE 2 The display ought to be set at luminance levels lower than or equal to those recommended by the manufacturer.

4.8.2 Comparison of monitor and hard copy images

At the centre of the white image defined in 5.3, the chromaticity of the display should be set to that of D50; namely $u' = 0{,}209\ 2$, $v' = 0{,}488\ 1$ (as specified in CIE Publication 15). The chromaticity obtained, for the white point chosen by the software application vendor, shall be within a circle of radius 0,005 from this point.