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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



110/1176/CD

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SECRETARIAT:

Japan

SECRETARY:

Mr Yoshi SHIBAHARA

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 100

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

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TITLE:

Electronic displays – Part 3-7: Evaluation of optical performances - Tone characteristics

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC DISPLAYS –

Part 3-7: Evaluation of optical performance – Tone characteristics

FOREWORD

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

CDV	Report on voting
XX/XX/CDV	XX/XX/RVC

Full information on the voting for the approval of this International 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.

127 The committee has decided that the contents of this document will remain unchanged until the
128 stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to
129 the specific document. At this date, the document will be

- 130 • reconfirmed,
- 131 • withdrawn,
- 132 • replaced by a revised edition, or
- 133 • amended.

134

135

136 The National Committees are requested to note that for this publication the stability date
137 is 2024.

138 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED
139 AT THE PUBLICATION STAGE.

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INTRODUCTION

Displays render the required gradation of an image through tone reproduction. Tone means the variation of brightness while maintaining a consistent hue. It also includes the variation of brightness while varying of colour saturation ($= 1 - \min(R, G, B) / \max(R, G, B)$) as shown in Figure 1. Differently from the tone reproduction with full saturated colour, the tone reproduction according to colour saturation also varies the chromaticity as well as luminance. The reproduction of grey tone and colour tone is one of the fundamental optical properties of flat panel displays since it is the native function of electronic displays to render appropriate luminance corresponding to each input code values.

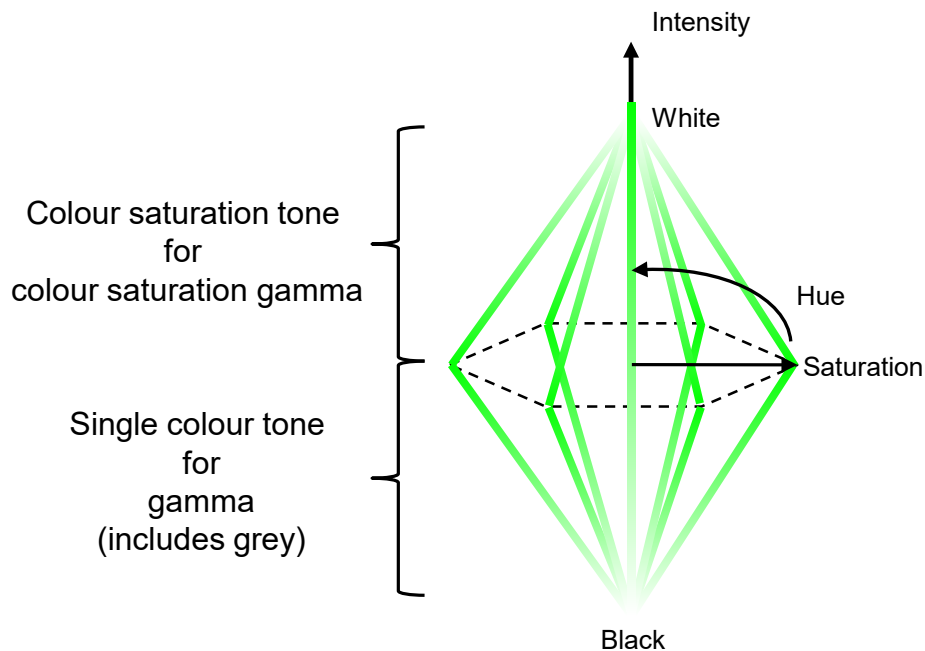


Figure 1 – Hue Saturation Intensity (HSI) colour space model

There are several kinds of device types for flat panel display. When calling the flat panel display products by the device name, the name of device is generally called based on the stuff to manage the tone reproduction by controlling the luminous intensity like LCD and OLED and so on. That means the tone reproduction is the main characteristics of display, and it can determine the colour reproduction capability for the displayed image.

In contemporary display systems, the gamma correction has been still adopted for the compatibility with historical CRT displays as well as the coding efficiency with the limited code words in digital video signal. Generally, it calls gamma correction to convert optical quantity to electric code in encoding system. In the decoding side, display gamma is used to express tone characteristics by inverse gamma correction that converts electric code to the linear value proportional to luminosity.

Also, the directional image quality is directly relevant to the directional tone reproduction, where the directional display gamma shall affect the directional colour reproduction as much as it is distorted.

This document is intended to identify these methods and to describe them, together with suitable precautions and diagnostics, as a reference for forthcoming standards to make the work of the involved experts more efficient and to avoid reduplication of efforts.

In this document, the methods are available for the verification or test purpose in R&D of display system products such as TV and monitor. Methods that require long test times may not be appropriate for production line testing of displays products, but can be sampled for quality assessment.

ELECTRONIC DISPLAYS –

Part 3-7: Evaluation of optical performance – Tone characteristics

1 Scope

This part of IEC 62977 specifies the standard measurement and evaluation of optical performances for grey and colour tone reproduction of electronic display systems under darkroom condition. This document describes measuring methods and evaluation of tone rendering of neutral grey, primary and secondary input colours. This document is applied to flat panel display systems with standard dynamic range (SDR).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62341-6-3 Ed.2, *Organic Light Emitting Diode (OLED) Displays – Part 6-3: Measuring methods of image quality*

IEC 62341-6-4:2017, *Organic Light Emitting Diode (OLED) Displays – Part 6-4: Measuring methods of transparent properties*

IEC 62977-2-1, *Electronic display devices – Part 2-1: Measurement of optical characteristics – Fundamental measurements (5CD)*

IEC 62977-3-1, *Electronic display devices – Part 3-1: Evaluation of optical performances – Colour difference based viewing direction dependence*

IEC 62977-3-5, *Electronic display devices – Part 3-5: Evaluation of optical performance – Colour capabilities (3CD)*

IEC 61966-4:2000, *Multimedia systems and equipment – Colour measurement and management – Part 4: Equipment using liquid crystal display panels*

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

ISO 11664-1:2007, *Colorimetry – Part 1: CIE Standard Colorimetric Observers*

CIE 015, *Colorimetry*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1**display gamma**

exponent value with single exponent of power function as electro-optical transfer function of display to express tone characteristics of the corresponding video signal, over the useful range of the curve

Note 1 to entry Generally, display gamma value is considered as black level offset of the display is excluded, and the ideal display renders constant chromaticity for the inputs of display gamma measurement, and identical gamma value regardless of R , G , B , C , M , Y and grey tone.

Note 2 to entry Colour gamut volume is hardly changed by display gamma value because the volume calculation is done with the volume surface just like the boundary for gamut area.

Note 3 to entry Display gamma for inverse gamma correction is also called decoding gamma, and the gamma for gamma correction of image signal is called encoding gamma as the inverse of decoding gamma^[4]. The name of gamma comes from the Greek character gamma (γ) which resembles the merged shape of encoding and decoding gamma curves.

3.1.2**gamma correction** ^[4], ^[7]

signal transform expressed in a power function with single exponent as an opto-electrical transfer function ^[4] usually used for image acquisition devices such as digital camera that maps scene luminance to digital code value prior to transmission or compression

Note 1 to entry In conventional non-constant luminance system, the gamma correction is done in RGB domain, whereas the gamma correction is done in YC_bC_r domain for the constant luminance system.

Note 2 to entry The gamma correction of image signal might be done with linear conversion for the near black range to save the signal bit depth.

3.1.3**inverse gamma correction**

inverse transform of gamma correction expressed in a power function with single exponent as an electro-optical transfer function ^[4] usually used for display devices such as TV and monitors that maps digital code values to display luminance

Note 1 to entry Generally, the inverse gamma correction might be the inverse function of gamma correction or conventional 2,2 display gamma.

3.1.4**colour saturation tone curve**

luminance curve as a function of input colour saturation of R , G , B , C , M , and Y

Note 1 to entry The ideal display renders constant colorimetric hue for the inputs.

Note 2 to entry When the colour saturation tone curve minus the luminance at maximum saturation (bias correction) is evaluated by a power function, its exponent is called colour saturation gamma.

Note 3 to entry Colour gamut volume would be changed when the colour saturation bias-corrected tone curve differs from that of the bias-corrected display EOTF (see IEC 62977-3-5 (2CD) and [18]).

3.1.5**display bit depth**

number of display bits or $\log_2$ [number of addressable shades] available levels in the tone rendering

Note 1 to entry Display bit depth for colour tone can be reduced for each primary due to White Balance gain control in display system (see IEC 62977-3-5 (2CD) Annex B) ^[4], ^[7]. The colour bit depth shall be evaluated with the native white point without any white balance gain control.

Note 2 to entry Display colour depth is the sum of the bit depths of the rendered primary colours (RGB). Primary colours can have different bit depths, e.g. 5-, 6- and 5-bit RGB depth for 16-bit colour depth.

3.2 Abbreviated terms

ABC	automatic brightness control
ALL	average light level
APL	average picture level
CIELAB	CIE 1976 (L*a*b*) colour space
DUT	device under test
EOTF	electro-optical transfer function
HSI	hue saturation intensity (device dependent colour space, also called HSL(lightness))
OETF	opto-electrical transfer function
OOTF	Opto-optical transfer function
RGBCMY	red, green, blue, cyan, magenta, and yellow
SDR	standard dynamic range
sRGB	a standard RGB colour space as defined in IEC 61966-2-1 (same colorimetry with BT.709)

4 Standard measuring equipment

4.1 Video signal generator

A digital video signal generator or a computer with digital RGB outputs, each of which with at least 8 bits depth, shall be used. The signal bit depth supported by the DUT shall be reported according to Clause 7. In this document, it is assumed that the input signal is appropriately encoded by the OETF for SDR displays such as BT.709 ^{[11], [12]}.

4.2 Measuring equipment and conditions

Refer to 5.3.4 in IEC 62977-2-1.

4.3 Test equipment block diagram

The block diagram of non-contact LMD is shown in Figure 2. Optical axis of the optical test equipment shall be centered on the screen and perpendicular to the plane of the display screen. The general conditions of measuring equipment such as measurement angle and angular aperture should be referred to IEC 62977-2-1. Generally, the measuring distance should be set up if the manufacturer of the display specifies such as the design viewing distance for TV application ^[8]. Otherwise, the minimum measurement distance shall correspond to a minimum of 500 pixels in the measurement field.

Non-contact LMDs are preferred with avoiding the stray light for example by using a stray-light elimination tube (SLET) ^[1]. In case of close-up type LMD to avoid stray light, it shall be as close as possible to the display screen in normal direction as shown in Figure 3. The close-up type LMD can be used also when avoiding the leakage illumination to disable automatic brightness control in 5.3, or to save room space. An angular extension tube such as shown in Figure 4 (a) can be used as Figure 4 (b) for the viewing directional measurement when it satisfies the accuracy explained in IEC 62977-2-1 5.3.4. Inside surface of the extension tube shall be anti-reflective or negligible not to affect the accuracy of the LMD.