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Introduction

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For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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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.	



110/965A/CD

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SECRETARY:

Mr Yoshi SHIBAHARA

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

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

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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TITLE:

Electronic displays – Part 3-4: Evaluation of optical performances – High dynamic range displays

NOTE FROM TC/SC OFFICERS:

The “A” version is circulated to change the commenting period from 12 weeks to 8 weeks.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC DISPLAYS –

Part 3-4: Evaluation of optical performances – High Dynamic Range displays

FOREWORD

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International Standard IEC 62977-3-4 has been prepared by IEC technical committee 110: Electronic display devices.

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

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.

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

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- withdrawn,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

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

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

INTRODUCTION

This document is intended to describe the measurement and evaluation of colour capabilities of electronic displays as a reference for forthcoming standards to make the work of the involved experts more efficient and to avoid reduplication of efforts.

Introduction of the Optical Measurements of Electronic Displays (OPT) is also related to a structure where each kind of optical measurement finds its unambiguous position for identification of similarities to other methods or for clarification of distinctions. This structural classification together with a general taxonomy is supposed to make the process of standards production easier, faster and thus more effective.

HDR is the ability to display a wider and richer range of colours, much brighter whites, and much deeper, darker blacks. HDR content preserves details in the darkest and brightest areas of a picture that are lost using old standards such as Rec.709. It also allows for more natural, true-to-life colours that are closer to how we see them in real life.

For measurements of HDR displays, many levels of considerations are required in order to do the measurements in a proper manner. For example,

- 1) Very low level of luminance should be measured, which require a careful treatment of stray light from the emission from the display and from the ambient light. Subtle colour change can be problematic especially observing the dark area. The viewing direction dependency should be also measured in addition to the measurement from the normal direction.
- 2) The HDR contents are 10 bits or more. The measurement of resolution of luminance level, especially resolution of luminance of dark black is essential.
- 3) HDR TVs have some very unique modes of operation that we have never seen on displays before. There is also some very unique content/commands/performance information contained in the source material. HDR displays also have limited ways in how they can be driven. All of these are intrinsically tied together. Plus the modes and adjustments in the HDR TVs are really tricky. Getting them correct is an important part of getting the HDR metrology correct and achieving meaningful results from the measurements. For instance, they may have Color Space settings which have to be matched to the expectations of the source material. Or they might have a contrast setting that is really a hidden EOTF setting.
- 4) Measurements generally can be the same between HDR and SDR, but HDR will require some new test patterns and methods that go beyond what is meaningful for SDR. For instance, the EOTF for HDR (which we used to call the gamma curve for SDR) is entirely different for HDR than for SDR and requires assessment in a way that will not work for SDR.
- 5) Actually, for HDR, color and tone mapping are a product of a) the content of the HDR pattern, b) the metadata contained in the HDR signal, c) the color mapping method of the display (mainly the contrast/color mode setup). The color management tends to be a result of b) and c) above. The content, mainly provides the intent of the HDR to be reproduced. In Hollywood terms, that is the Director's artistic intent of the scene.

Proper source content is critical to evaluating HDR performance material. That includes the driver (and interface). In the old days, it was possible to separate these issues with evaluation of “panels”, but for HDR, we cannot easily separate them, nor avoid new areas.

ELECTRONIC DISPLAYS –

Part 3-4: Evaluation of optical performances – High Dynamic Range displays

1 Scope

This part of IEC 62977 specifies the standard measurements of optical characteristics of electronic display system including drivers or controllers for HDR contents in dark room and bright room conditions. Display panels for HDR by themselves are excluded from the scope of this document. This document is applicable to displays to render HDR images effectively. The measuring methods stipulated in this document are in order to evaluate HDR display systems comply with the HDR standards such as ITU-R BT.2100.

2 Normative references

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

Recommendation ITU-R BT.2020: *Parameter values for the ultra-high definition television systems for production and international programme exchange*, 2012

Recommendation ITU-R BT.2100-0: *Image parameter values for high dynamic range television for use in production and international programme exchange*, July, 2016

Report ITU-R BT.2390-0: *High dynamic range television for production and international programme exchange*, 2016

IEC 62341-6-2:2015, *Organic Light Emitting Diode (OLED) Displays – Part 6-2: Measuring methods of visual quality and ambient performance*

IEC 62341-6-3 Ed.2, *Organic Light Emitting Diode (OLED) Displays – Part 6-3: Measuring methods of image quality (FDIS)*

IEC 62977-2-1, *Electronic displays – Part 2-1: Measurement of optical characteristics – Fundamental measurements (CDV)*

IEC 62977-2-1, *Electronic displays – Part 2-2: Measurement of optical characteristics – Ambient performance (NP)*

IEC 62977-3-1, *Electronic displays – Part 3-1: Evaluation of Optical performances – Colour difference based viewing direction dependence (CD)*

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 015:2004, *Colorimetry*, 3rd Edition

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 (International Electrotechnical Vocabulary, <http://www.electropedia.org>) as well as following apply.

3.1.1**peak luminance**

maximum rendered display luminance for a specific input signal condition

Note 1 to entry: The peak luminance should be measured among the maximum luminance at white input of a specific APL.

Note 2 to entry: When measuring the peak luminance of HDR property, it can be independent from colour signal white in non-RGB displays which may not make white colour by mixture of other colours where the peaked performance of luminance such as highlighted area in HDR mode of display products can be treated as a specified function for distinguishable brightness and more realistic image of highlighted area such as lighting objects as long as the chromaticity is maintained.

3.1.2**dynamic range**

luminance range or span expressed as a ratio of peak luminance to the lowest luminance that the display can render in a single scene

Note to entry: The unit of dynamic range can be expressed in terms of the number of stops using the formula $\text{Log}_2[\text{dynamic range}]$.

3.1.3**high dynamic range**

span of image luminance that is larger than normally possible for standard, high definition, and ultra HD video or larger ratio of dynamic range than the standard dynamic range

Note 1 to entry: In this document, high dynamic range is used as a proper noun HDR such as HDR display that is capable to render HDR content.

Note 2 to entry: In case of Recommendation ITU-R BT.2100, the dynamic range of HDR display is recommended from $\leq 0,005$ to $\geq 1\,000\text{ cd/m}^2$ for reference viewing environment.

3.1.4**standard dynamic range**

span of image luminance that is normally possible for standard and high definition video for the conventional video display against high dynamic range video

Note 1 to entry: Standard definition, high definition, and ultra HD video systems are normally capable of producing luminance of 10 times that of an average mid-tone at the top (white) end of the range, and of 0,01 times that of an average mid-tone at the bottom (black) end of the range.

Note 2 to entry: SDR is defined and constrained by ITU-R BT.601 or ITU-R BT.709 or ITU-R BT.2020.

3.1.5**average picture level**

average level percentage of input signal pixels or average level percentage of displayed signal pixels after EOTF of input signals

Note 1 to entry: Pre-gamma APL is calculated by averaging of signal pixels (non-linear code values) which is equal or greater than post-gamma APL.

Note 2 to entry: Post-gamma APL is calculated by averaging of post-gamma signal pixels (linear code values), but APL loading depends on the power consumption logic of the display according as pixel configuration.

Note 3 to entry: APL loading means the percentage of average power loading to display subpixels in self-emitting displays when signal inputs.

3.1.6**code value**

digital representation of an image signal element

3.1.7**opto-electrical transfer function**

mathematical function usually used for image acquisition devices such as digital cameras that maps scene luminance (light from a scene) to digital code value that can be transmitted or compressed

Note to entry: If OETF and EOTF function is described by a specific exponential value, it can be called gamma.

3.1.8**electro-optical transfer function**

mathematical function usually used for display devices such as TV and monitors that maps digital code values to displayed luminance

3.1.9**optical-to-optical transfer function**

mathematical function that maps captured luminance by a camera to displayed luminance by a display device according to rendering intent or peak luminance of the display

Note to entry: OOTF for PQ HDR adopts BT.1886 and BT.709 gamma for conventional SDR display gamma, whereas OOTF for HLG HDR adopts the system gamma defined in BT.2100.

3.1.10**wide colour gamut**

wider range of colours in xy and $u'v'$ colour space than conventional colour gamut such as ITU-R BT.709 or sRGB colour gamut

Note 1 to entry: BT.709 shows 52,89% coverage of BT.2020 in xy colour coordinate, and 58,03% coverage of BT.2020 in $u'v'$ colour coordinate. The gamut rendering over 52,89% of BT.2020 in xy and 58,03% of BT.2020 in $u'v'$ can be called the wide colour gamut.

Note 2 to entry: Adobe RGB and DCI-P3 are also called wide colour gamut which render 134,90% and 135,65% of BT.709 respectively in xy , and 116,7% and 125,6% of BT.709 respectively in $u'v'$ colour coordinate.

3.1.11**colour reproduction accuracy**

capability to render target colours to within a certain level of accuracy

Note to entry: In order to reproduce target colours to within the third or fourth decimal place in chromaticity, the display would need enough colour gamut coverage and may need a 10 to 14 display bit depth.

3.1.12**white boosting**

luminance boosting for low saturated colour or achromatic signal inputs by power distribution management for target blocks of the screen with maintaining its chromaticity

3.1.13**colour saturation gamma**

luminance transfer function based on boosting ratio by colour saturation between primary colours and white

3.1.14**HDR display**

display which accommodate to HDR content

Note to entry: HDR display can also display SDR content by changing EOTF and its related functions such as tone mapping and system gamma.

3.1.15**HDR content**

content which is described in Rec. ITU-R BT.2100

Note to entry: The colour reproduction of HDR content should comply with BT.2020.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

APL	average picture level
CCT	correlated colour temperature
CIELAB	CIE 1976 ($L^*a^*b^*$) colour space
DUT	device under test
HDR	high dynamic range
SDR	standard dynamic range
OETF	opto-electrical transfer function
EOTF	electro-optical transfer function
OOTF	optical-to-optical transfer function
PQ	perceptual quantizer
HLG	hybrid log-gamma
OLED	organic light emitting diode

WCG wide colour gamut

WRGB white, red, green and blue (pixel configuration within a pixel)

RGBW red, green, blue and white (subpixel layout with subpixel rendering)

4 Standard measuring equipment

4.1 Video signal generator

A digital video signal generator is used. The DUT should support 10 bit or over 10 bit signal and colour range signal input of ITU-R BT.2020. It shall be reported by “Supported” or “Not supported” in the test report of chapter 7. The signal characteristics shall match with HDR signal. Input signal or input data, in this document, means the transferred code values by the OETF of PQ HDR or HLG HDR (refer to Rec. ITU-R BT.2100 and Rep. ITU-R BT.2390).

Note: In case of HDR, the video signal is special for HDR, 10 bit or over 10 bit with high dynamic range.

4.2 Measuring equipment

Optical properties of displays shall generally be expressed in photometric or colorimetric units using the CIE 1931 standard colorimetric 2-degree observer (see ISO 11664-1). Luminance can be measured by a photometer, and CIE tristimulus values (X , Y , Z) or CIE chromaticity coordinates by a colorimeter. A spectroradiometer may also obtain photometric and colorimetric values through a numerical conversion of the measured spectral radiance data. The following requirements are given for these instruments:

The LMD shall be a luminance meter, colorimeter, or a spectroradiometer. For DUTs that have sharp spectral peak full-width-at-half-maximums (FWHMs) smaller than 20 nm, such as laser displays, LCDs with fluorescent lamp backlights or LED with narrow-peak phosphors, quantum-dot phosphors, or narrow-spectrum OLEDs, a spectroradiometer should be used. A filter colorimeter should generally not be used for light sources with sharp spectral peaks. If they are used, the colorimeter must be calibrated with a narrow bandwidth spectroradiometer to give the same results for the specific spectrum. Report the spectroradiometer characteristics of spectroradiometer which is used for calibration. For light sources with sharp spectral peaks, the maximum bandwidth of the spectroradiometer shall be ≤ 5 nm. The higher resolution spectrometer produces a more accurate colour measurement, especially for lasers sources. The spectroradiometer shall be capable of measuring spectral radiance over at least the 380 nm to 780 nm wavelength range, with a maximum bandwidth of 10 nm for smooth broadband spectra (i.e. broad spectrum with no sharp spikes).

The following additional best practices shall be followed:

- 1) The LMD shall be focused on the image plane of the display and generally aligned perpendicular to the display surface at the centre of the active display area, unless stated otherwise.
- 2) The relative uncertainty and repeatability of all the measuring devices shall be maintained by following the instrument supplier's recommended calibration schedule
- 3) If the light level of the display is temporally modulated, then the LMD integration time shall be synchronized with the modulation frequency. If the LMD is not capable of synchronizing, then the LMD integration time shall be at least 200 cycles of the fundamental Fourier Transform frequency light of the modulated light in order to measure the luminance to better than 5 %.
- 4) If LMD measurements are taken for displays with temporal light modulation (including LCD backlights), the temporal high peak luminance of these displays can cause detector saturation errors. The accuracy of these measurements can be checked by attenuating the light with a neutral density filter with known characteristics. If the change in signal amplitude of the detector is proportional to the transmittance of the neutral density filter, then there are no detector saturation errors. This method can be used for measuring the time-averaged screen luminance.
- 5) If the LMD is to measure a dim measurement area, the LMD field of view should avoid containing a bright background. If this is not possible, then a frustum or stray light elimination tube shall be used (see ISO 9241-305).