IEC 62629-12-2

Edition 1.0 2019-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

3D display devices –
Part 12-2: Measuring methods for stereoscopic displays using glasses – Motion blur

Dispositifs d'affichage 3D –
Partie 12-2: Méthodes de mesure pour les écrans stéréoscopiques utilisant des lunettes – Flou de mouvement

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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The text of this International Standard is based on the following documents:

CDV	Report on voting
110/978/CDV	110/1049/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.

A list of all parts in the IEC 62629 series, published under the general title *3D display devices*, can be found on the IEC website.

This document 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- withdrawn,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.

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3D DISPLAY DEVICES –

Part 12-2: Measuring methods for stereoscopic displays using glasses – Motion blur

1 Scope

This part of IEC 62629 specifies the measuring methods of motion artifacts for stereoscopic displays using glasses. This document is applicable to stereoscopic displays using glasses, which consist of transmissive type active matrix liquid crystal display modules (without a post image processing).

NOTE Motion blur measurement methods and analysis methods introduced in this document are not universal tools for all different LCD motion enhancement technologies due to their complexity, and displays with some motion quality enhancement technologies cannot be measured or analysed by the methods introduced in this document. If this is the case, users are made aware of this.

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 61747-30-1, *Liquid crystal display devices – Part 30-1: Measuring methods for liquid crystal display modules – Transmissive type*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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 Terms and definitions

3.1.1
motion picture response curve
curve, representing the convolution of the temporal step response with a moving window function of 1-frame wide

Note 1 to entry: This shows how the luminance is integrated over time during smooth pursuit eye tracking and combines the effects of the display response time and the hold-type characteristics of the device under test.

[SOURCE: IEC 61747-6-3:2011, 3.1, modified – the second part of the definition has been made into a note.]

3.1.2
motion induced edge profile
luminance profile of an intrinsically sharp moving luminance transition when this transition is followed with smooth pursuit eye tracking along its motion trajectory

Note 1 to entry: The profile can be calculated from the motion picture response curve for any given motion speed.

[SOURCE: IEC 61747-6-3:2011, 3.2]

3.1.3
edge blur
blur that becomes visible on an intrinsically sharp transition between two adjacent areas, with a different luminance level, when the transition smoothly moves across the display as a function of time

Note 1 to entry: Preconditions for this type of edge blur are smooth pursuit eye tracking of the object, and no obvious flicker, indicating that luminance integration with a frame period is allowed. This blur phenomenon is mainly caused by a slow response time of the display device in combination with the hold-type characteristics.

[SOURCE: IEC 61747-6-3:2011, 3.3]

3.2 Abbreviated terms

BET	blurred edge time
CCD	charge-coupled device
CIE	Commission Internationale de l'Eclairage (International Commission on Illumination)
CMOS	complimentary metal-oxide semiconductor
DUT	display under test
DVI	digital visual interface
EBET	extended blurred edge time
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LCD	liquid crystal display
LMD	light measuring device
LPF	low-pass filtering
LVDS	low-voltage differential signaling
MCD	motion contrast degradation
MPRC	motion picture response curve

4 Standard measuring conditions

4.1 Temperature, humidity and pressure conditions

The standard environmental conditions for the motion artifact measurement are as follows:

– temperature: (25 ± 3) °C
– relative humidity: 25 % to 85 %
– air pressure: 86 kPa to 106 kPa

4.2 Illumination conditions

The illuminance at the measuring spot of the DUT shall be below 1 lx (standard dark room conditions as defined in IEC 61747-30-1).

5 Standard motion-blur measurement methods

5.1 General

Motion induced object blur is the result of a slow response of the liquid crystal cells and a stationary representation of the temporal image (related to the hold time of the display), in combination with smooth pursuit eye-tracking of an object over the display surface. When an object moves across the display and the eye is tracking this object, a spatiotemporal integration of the object luminance is taking place at the human retina. There are several ways to measure and characterize this spatiotemporal integration, via a direct measurement or via an indirect measurement technique. For direct measurements a pursuit camera system can be used, and the indirect measurement is based on measuring the temporal response curves, and from those curves the motion induced object blur that will occur on the retina can be calculated. Both direct and indirect measurements will be described in this document. In addition to the characteristics of motion blur of two-dimensional (2D) LCD modules, there exist influences from the 3D operation of the display device and the 3D glasses, which result in a change in the perceived hold time. The direction of image motion is another factor to be considered regarding the fact that the 3D image can be perceived to move in a 3D space – not in a 2D plane. See Annex A for an example.

5.2 Direct measurement method

5.2.1 Standard measuring process

5.2.1.1 Test patterns

The test pattern shall be displayed to fill the entire screen to measure the motion blur of stereoscopic 3D display modules. In order to preserve the horizontal resolution in the 3D driving mode, the top/bottom or frame sequential test pattern shall be used. In order to prevent influences from the 3D crosstalk between the left-eye and the right-eye patterns, the test pattern shall be located in the left-eye pattern while the right-eye pattern shall be a black screen (see Figure 1). The details of the test pattern(s) used shall be reported. When using a pursuit system, the width of the test pattern should be sufficiently wide, for example 5 times the advancement (step-width) per frame, to capture the total temporal response of the display. It is recommended that a minimum of seven equally divided gray levels, including black and white, be used for the gray level of each part of a test pattern in Figure 1. The lightness function, specified in CIE 1976 (L*u*v*) and CIE 1976 (L*a*b*) colour spaces, can be used to space the intermediate gray shades equally on the lightness scale. One of the gray level data that are available at the LCD modules input, for example 0 to 255 for an 8-bit LCD module, can also be used as this gray level. See Annex B for the line spreading method.

Figure 1 – Example of edge blur test pattern of top/bottom 3D format

5.2.1.2 Pursuit detection system

Measurement of the edge blur of the LCD module should be done by using a CCD or CMOS camera with the pursuit measurement system shown in Figure 2 and Figure 3. Relevant literature on these systems can be found in the Bibliography, references [1] to [6][1].

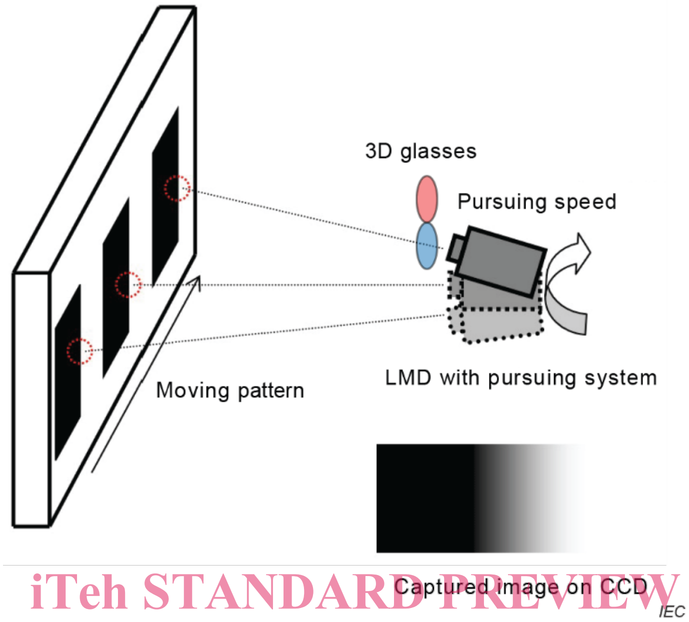

Figure 2 – Example of pivoting pursuit camera system

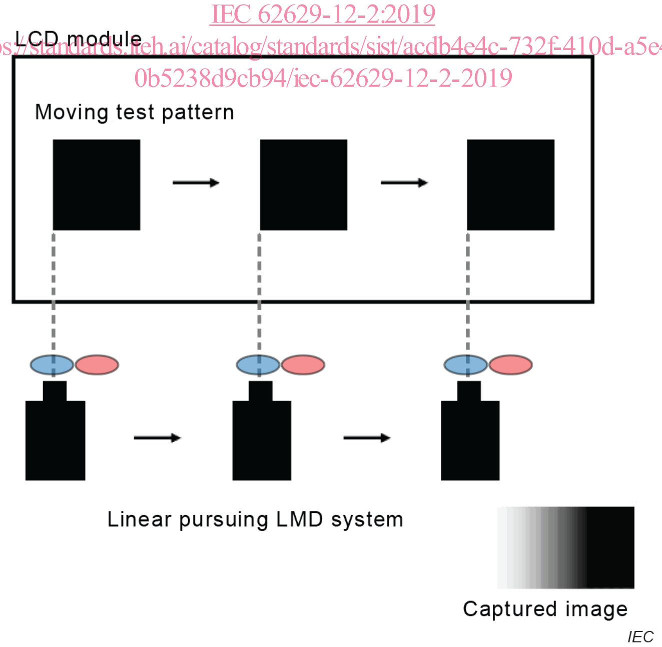

Figure 3 – Example of linear pursuit camera system

The following elements are recommended when implementing the pursuit measuring system:

[1] Numbers in square brackets refer to the Bibliography.

a) LMD: CCD or CMOS type surface measurement devices, with preferably an integrated CIE 1931 photopic luminous sensitivity function (measuring luminance).

b) Scroll speed: the scroll speed of the test pattern and the pursuing speed of the LMD shall be synchronized to prevent integration errors.

c) Pursuing system: either the pivoting or linear pursuit system shown in Figure 2 and Figure 3, respectively. The angular rotation shall be limited to avoid viewing-angle and depth of focus related dependencies (less than ± 5˚).

d) Location of the 3D glasses: if the LMD uses a scanning mirror and a fixed camera, the 3D glasses shall be located between the scanning mirror and the lens.

5.2.1.3 Specified conditions

The specified conditions shall be as follows, and shall be reported:

a) Any deviations from the standard measurement conditions.

b) The signal level (the start level and the end level) for the test pattern is summarized in Table 1.

Table 1 – Step response data for different luminance transitions

Data per colour (e.g. R,G,B,W)		End level					
		L_1	L_2	L_3	..	..	L_N
Start level	L_1		$L_{1\text{-}2}(t)$	$L_{1\text{-}3}(t)$			$L_{1\text{-}N}(t)$
	L_2	$L_{2\text{-}1}(t)$		$L_{2\text{-}3}(t)$			$L_{2\text{-}N}(t)$
	L_3	$L_{3\text{-}1}(t)$	$L_{3\text{-}2}(t)$				$L_{3\text{-}N}(t)$
	..						
	..						
	L_N	$L_{N\text{-}1}(t)$	$L_{N\text{-}2}(t)$	$L_{N\text{-}3}(t)$			
NOTE The gray levels are typically used.							

c) Standard measuring conditions

1) Scroll speed (pixel/frame): 4, 8, 12.

2) Shutter speed of camera (in seconds): multiples of a single frame time, which means a period of $1/R_{\text{vf}}$ (R_{vf}: video refresh rate) for a pair of left-eye patterns and right-eye patterns which are displayed.

d) Requirements for measuring set-up

1) Measuring distance

It is recommended to set a pursuing angle no larger than ±5° (as described in 5.2.1.2 c)) during the shutter speed. The measuring distance shall be set to satisfy the above criterion of pursuing angle. Table 2 shows an example.

Table 2 – Example of measuring conditions

Size of display screen (diagonal, inch)	24
Pixel size (mm)	0,276
Scroll speed (pixel/frame)	8
Shutter speed of camera (frame)	4
Measuring distance (mm)	300
Pursuing angle (degrees)	1,7

2) Measuring positions at screen

   It is recommended to set the measuring positions at the centre of the screen. In addition, the measuring positions can also be horizontally centred at the top and bottom of the screen, provided that is included in the report.

5.2.1.4 Requirements for the measuring system

The measuring system shall have the following conditions:

a) The spectral sensitivity of the camera shall be adjusted to be fitted with a photopic vision function by using an adjusting element such as an optical filter.
b) The camera shall be able to focus at the display screen.
c) The measuring device shall include an iris to adjust the sensitivity.
d) The measuring device shall be able to pursue the scrolled pattern smoothly (consistently uniform pursuing velocity).
e) The measuring system shall be able to provide a cross-section of the luminance profile from the captured images of the scrolled pattern using the pursuing operation.
f) The measuring system shall provide consistent results with the measuring conditions with various scroll speeds of the pattern and various shutter speeds of the camera (various multiples of $1/R_{\mathrm{vf}}$).

5.2.2 Analysis method

5.2.2.1 Blurred edge time

The time between the transitions from 10 % to 90 % in the luminance transition curve (see Figure 4) is used to represent the blurred edge time. Other ranges, such as 40 % to 60 %, can be used, but they shall be reported.

NOTE The relation between the motion blur and the shape of the luminance transition curve (see Figure 4) is still not clear, because the actual curve shape is not so simple (i.e., overshoot, …).

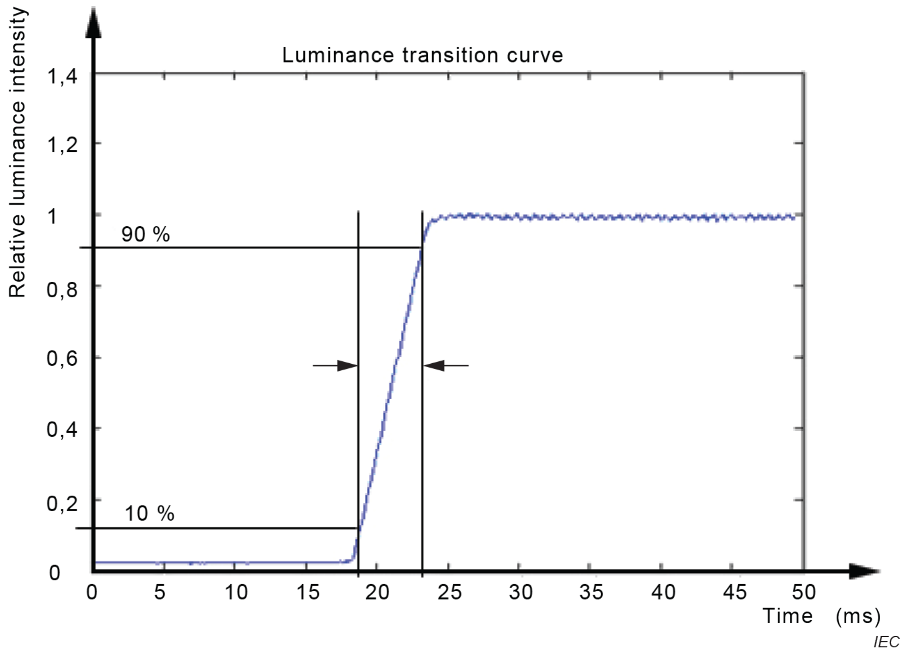

Figure 4 – Example of luminance cross-section profile of a blurred edge with BET

5.2.2.2 Extended blurred edge time

The extended blurred edge time is defined as 80 % of BET, which linearly extends BET to the 0 % to 100 % levels (see Figure 5).

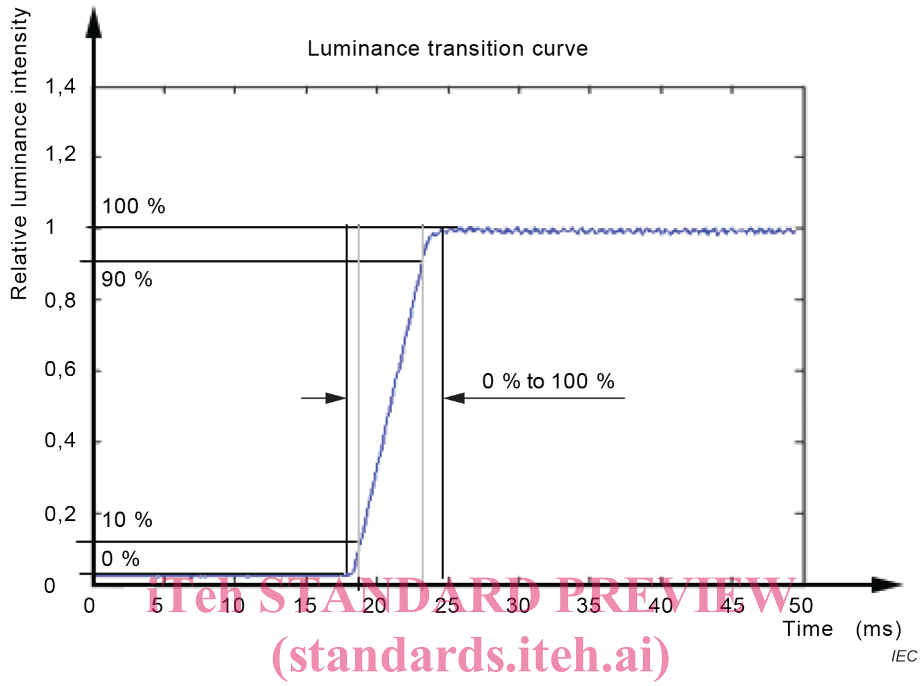

Figure 5 – Example of luminance cross-section profile of a blurred edge with EBET

NOTE The relation that EBET equals 80 % of BET can be used only if a BET from 10 % to 90 % in the luminance transition curve has been used.

5.3 Indirect measurement method

5.3.1 General

The indirect measurement method adopted is the temporal step response measurement method, which is based on the literature, indicated in the Bibliography, i.e., references [10] to [16]. If the display does not have any spatial imaging processing, such as sharpening (spatial high-pass filter), the indirect method can be used.

5.3.2 Measurement system

A schematic representation of the measurement set-up to measure the temporal step response is shown in Figure 6.

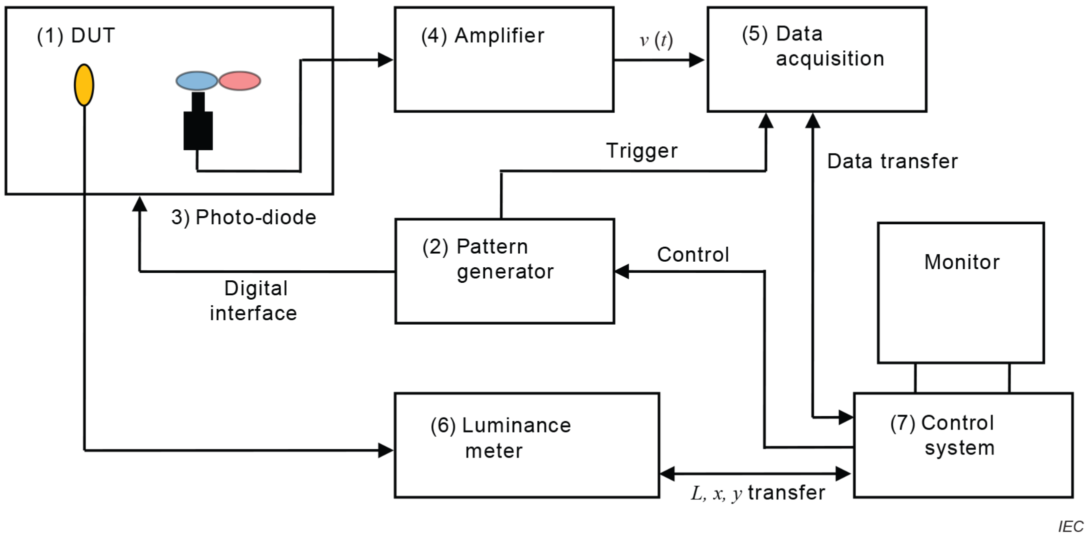

Figure 6 – Set-up to measure the temporal step response

The measurement set-up, presented in Figure 6, comprises the following components:

– The DUT (1), which is the 3D display to be measured.

– A pattern generator (2), which generates the test patterns in the native display resolution and applicable refresh rates. The pattern generator, preferably, has a control terminal or interface, which enables selection of the pattern and start-stop of the measurement procedure. The output of the pattern generator may consist of one or more LVDS, DVI, or other output terminal(s), which can be connected with the display input terminal(s). The pattern generator shall also include a trigger output signal that can be used to start the data acquisition process.

– A fast response (rise time less than 5 µs) photo-diode or other opto-electrical detectors (3), with a spectral sensitivity that is matched to the spectral luminous efficiency function $V(\lambda)$ for photopic vision. The detector is used to capture the temporal luminance, produced by the DUT. As shown in Figure 6, the glasses are placed between the photo-diode and display, the photo-diode with lens shall be used and it shall be able to focus at the display screen to avoid the stray light.

– A signal amplifier (4), which is used for signal amplification to match the input range of the data acquisition device and for low-pass filtering (LPF) to attenuate the signal noise. The low-pass characteristics shall be tuned to the display response speed; the LPF cut-off frequency shall be at least 10 kHz.

– A data acquisition device (5) that records the amplified signal $v(t)$ of the photo-diode. The sampling rate shall be at least 10 kHz to enable the acquisition of temporal luminance data with sufficient temporal resolution, and furthermore the sampling rate should be related to the refresh rate of the display to allow time accurate analysis of the data. The minimum sampling rate per refresh rate shall be no less than 100/1. An oscilloscope or a data-acquisition card can be used to acquire and digitize the time-varying luminance signal.

– A luminance meter (6) that records the luminance of the display for each input code (0 to 255 for an 8-bit input signal). With this information the time varying photo-diode signal $v(t)$ can be translated to a time varying luminance signal $L(t) = f(v(t))$.

– A control system (7), for example a personal computer, which can be used to start the measurement procedure, and to collect and process all data.

5.3.3 Measurement process

In liquid crystal displays the temporal luminance transition from one level to another depends on the selected input codes. The time required for the transition to be completed has an influence on the perceived motion blur, and therefore several luminance transitions need to be