IEC 61747-30-3

Edition 1.0 2019-08

INTERNATIONAL STANDARD

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Liquid crystal display devices – Part 30-3: Measuring methods for liquid crystal display modules – Motion artefact measurement of active matrix liquid crystal display modules

IEC 61747-30-3:2019-08(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 31.120

ISBN 978-2-8322-7262-6

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LIQUID CRYSTAL DISPLAY DEVICES –

Part 30-3: Measuring methods for liquid crystal display modules – Motion artefact measurement of active matrix liquid crystal display modules

FOREWORD

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International Standard IEC 61747-30-3 has been prepared by IEC technical committee 110: Electronic displays.

This first edition cancels and replaces the first edition of IEC 61747-6-3 published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) added test positions and areas;
b) revised standard measuring conditions;
c) added calculation of the standard deviation of the line-spread function of the eye;
d) added requirements for high speed camera;

e) changed “LCDs” to “transmissive TFT LCDs” in Clause 1.

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

FDIS	Report on voting
110/1103/FDIS	110/1130/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.

A list of all parts in the IEC 61747 series, published under the general title *Liquid crystal 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- withdrawn,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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LIQUID CRYSTAL DISPLAY DEVICES –

Part 30-3: Measuring methods for liquid crystal display modules – Motion artefact measurement of active matrix liquid crystal display modules

1 Scope

This part of IEC 61747 applies to transmissive type active matrix liquid crystal displays.

This document defines general procedures for quality evaluation related to the motion performance of transmissive thin film transistor (TFT) LCDs. It defines artefacts in the moving image and methods for motion artefact measurement.

NOTE Motion blur measurement methods and analysis methods introduced in this document are not universal tools for all the different LCD motion enhancement technologies due to their complexity. Users' attention is drawn to this fact.

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*

ISO 11664-4, *Colourimetry – Part 4: CIE 1976 L*a*b* Colour space*

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

NOTE In this document, the term "pixel" is adopted as the unit of the signal resolution. That is, the horizontal and vertical pixel pitch (size) of the DUT is determined based on the spatial distance displayed (scrolled) on the screen corresponding to the inputted signal pixel regardless of the display pixel types.

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

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

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.

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 liquid crystal cell in combination with the hold-type characteristics.

3.1.4
perceived blurred edge time
time-related equivalent of the perceived blurred edge width

Note 1 to entry: The perceived blurred edge width is derived from the motion induced edge profile by means of filtering the edge profile with the contrast sensitivity function of the human eye.

3.2 Abbreviated terms

BET	blurred edge time
BEW	blurred edge width
CCD	charge-coupled device
CIE	Commission Internationale de l'Eclairage (International Commission on Illumination)
CMOS	complimentary metal-oxide semiconductor
CSF	contrast sensitivity function
DMTF	dynamic modulation transfer function
DUT	display under test
DVI	digital visual interface
EBET	extended blurred edge time
FFT	fast Fourier transform
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JND	just-noticeable difference
LCD	liquid crystal display
LMD	light measuring device
LVDS	low-voltage differential signaling
MCD	motion contrast degradation
MPRC	motion picture response curve
MPRT	moving picture response time
MTF	modulation transfer function
PBET	perceived blurred edge time
PBEW	perceived blurred edge width
TFT	thin film transistor
TN-LCD	twisted nematic liquid crystal display
VA-LCD	vertically-aligned liquid crystal display

4 Standard measuring conditions

Measurements shall be carried out under standard environmental conditions:

– temperature: 25 °C ± 3 °C;
– relative humidity: 25 % RH to 85 % RH;
– atmospheric pressure: 86 kPa to 106 kPa.

All visual inspection tests shall be tested at 25 °C ± 3 °C.

When different environmental conditions are used, they shall be noted in the measurement report.

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 measuring methods

5.1 General

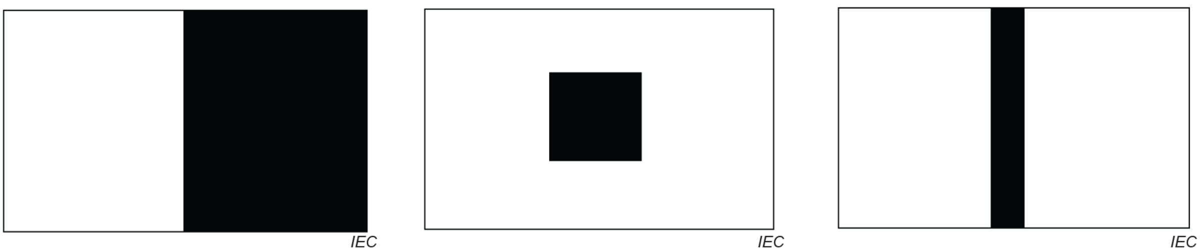
Motion induced object blur is the result of a slow response of the liquid crystal cells and a stationary representation of the temporal image (related to the hold time of the display), in combination with smooth pursuit eye tracking of an object over the display surface. When an object moves across the 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 measurement, a pursuit camera system can be used; 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. Possible alternatives to direct measurement are described in Annex A, Annex B and Annex C.

5.2 Direct measurement method

5.2.1 Standard measuring process

5.2.1.1 Test patterns

There are several patterns that can be used to measure motion induced object blur, such as a full test pattern, box test pattern, and line bar test pattern (see Figure 1). The details of the used test pattern(s) shall be reported. When using a pursuit system, the width of the test pattern should be sufficiently wide, for example five times the advancement (step-width) per frame, to capture the total temporal response of the display. It is recommended that a minimum of seven gray shades, including black and white, be used for the gray level of each part of a test pattern in Figure 1. The lightness function L^*, specified in ISO 11664-4, shall be used to space the intermediate gray shades equally on the lightness scale.



a) Full test pattern **b) Box test pattern** **c) Line bar test pattern**

Figure 1 – Examples of edge blur test pattern

NOTE LCD input data for gray levels can be obtained by first measuring luminance as a function of input level, i.e. a gray tone-rendering curve, and selecting the input values corresponding most closely to equidistant L^* values.

5.2.1.2 Pursuit detection system

Measuring 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 [1] to [5], [17], [22] [1].

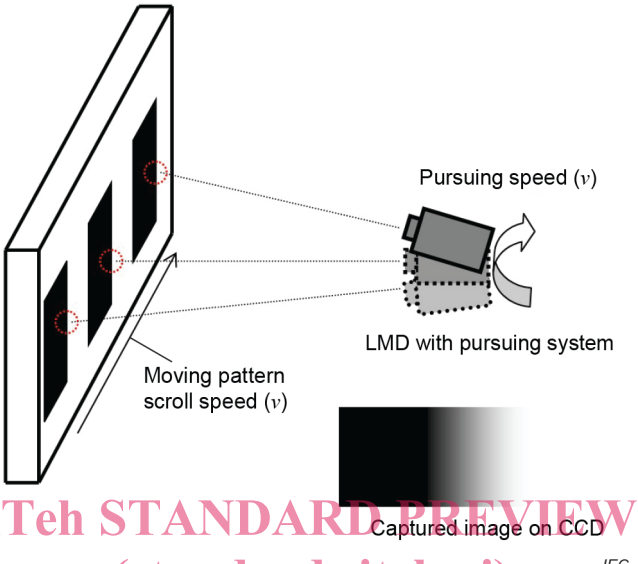


Figure 2 – Example of a pivoting pursuit camera system

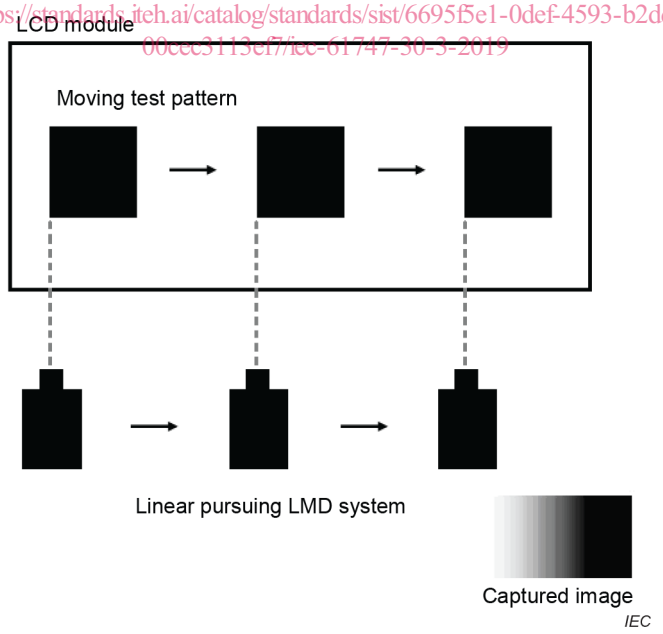


Figure 3 – Example of a linear pursuit camera system

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

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

a) LMD: CCD or CMOS type surface measurement devices (CCD camera), 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 are synchronized accurately to prevent integration errors. Pursuit speed error can be verified by the method in [22]

c) Pursuing system: a pivoting or linear pursuit system as shown in Figure 2 and Figure 3, respectively. The angular rotation is limited to avoid viewing angle–related dependencies (less than ± 5˚).

5.2.1.3 Test position

Since the measurement results of motion blur can be dependent on the measurement position on the display depending on the scanning direction as well as the use of backlight behaviour (scanning backlight/modulation), measurements shall be taken on multiple positions according to Figure 4.

The measurements are taken inside boxes centred on the measurement positions, with a length of $H/5$ and a height of $V/20$.

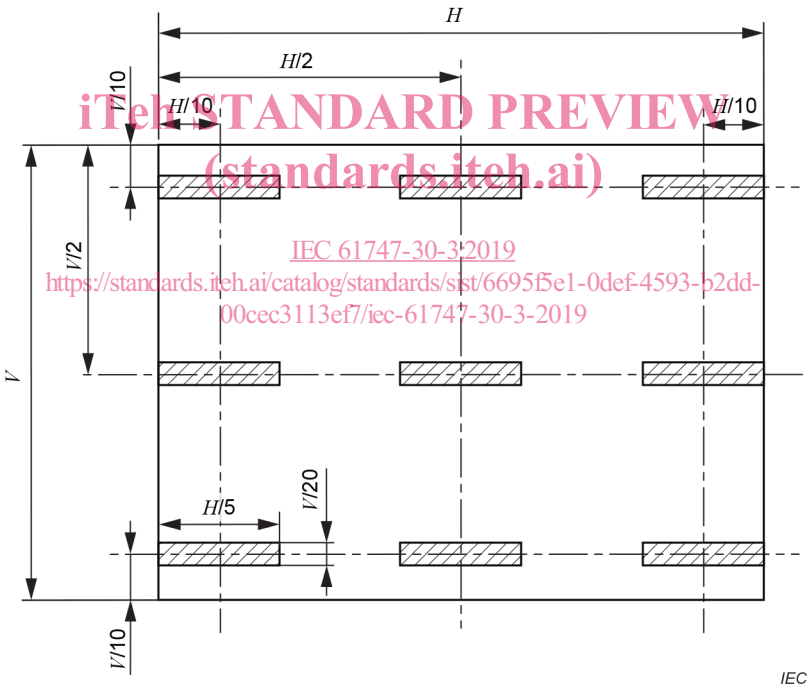


Figure 4 – Measurement regions for landscape orientation

On displays where the (line) scan direction does not coincide with the vertical axis, or displays where the (line) scan direction is unknown, the measurement shall be repeated with the display and measurement positions rotated by 90°, as shown in Figure 5.