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INTERNATIONAL STANDARD

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Organic light emitting diode (OLED) displays – Part 5-2: Mechanical endurance testing methods

Afficheurs à diodes électroluminescentes organiques (OLED) – Partie 5-2: Méthodes d'essais d'endurance mécanique

IEC 62341-5-2:2013

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

FDIS	Report on voting
110/472/FDIS	110/486/RVD

Full information on the voting for the approval of this 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.

A list of all parts in the IEC 62341 series, published under the general title *Organic light emitting diode (OLED) displays*, can be found on the IEC website.

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

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- withdrawn,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

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ORGANIC LIGHT EMITTING DIODE (OLED) DISPLAYS –

Part 5-2: Mechanical endurance testing methods

1 Scope

This part of IEC 62341 defines testing methods for evaluating mechanical endurance quality of Organic Light Emitting Diode (OLED) display panels and modules or their packaged form for transportation. It takes into account, wherever possible, the environmental testing methods outlined in specific parts of IEC 60068. The object of this standard is to establish uniform preferred test methods for judging the mechanical endurance properties of OLED display devices.

There are generally two categories of mechanical endurance tests: those relating to the product usage environment and those relating to the transportation environment in packaged form. Vibration, shock, quasistatic strength, four-point bending test and peel strength test are introduced here for usage environment, while transportation drop test is applicable to the transportation environment. Mechanical endurance tests may also be categorized into mobile application, notebook computer or monitor application and large size TV application. Special considerations or limitations of test methods according to the size or application of the specimen will be noted.

NOTE This standard is established separately from IEC 61747-5-3, because the technology of organic light emitting diodes is considerably different from that of liquid crystal devices in such matters as:

– used materials and structure;
– operation principles;
– measuring methods.

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.

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests–Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests–Test Ea and guidance: Shock*

IEC 61747-5:1998, *Liquid crystal and solid-state display devices – Part 5: Environmental, endurance and mechanical test methods*

IEC 61747-5-3:2009, *Liquid crystal display devices – Part 5-3: Environmental, endurance and mechanical test methods – Glass strength and reliability*

IEC 62341-1-2:2007, *Organic light emitting diode displays – Part 1-2: Terminology and letter symbols*

IEC 62341-5:2009, *Organic light emitting diode (OLED) displays – Part 5: Environmental testing methods*

IEC 62341-6-1:2009, *Organic light emitting diode (OLED) displays – Part 6-1: Measuring methods of optical and electro-optical parameters*

IEC 62341-6-2:2012, *Organic light emitting diode (OLED) displays – Part 6-2: Measuring methods of visual quality and ambient performance*

ISO 2206:1987, *Packaging – Complete, filled transport packages – Identification of parts when testing*

ISO 2248:1985, *Packaging – Complete, filled transport packages – Vertical impact test by dropping*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62341-1-2 and the following apply.

3.1
strength
stress at which a sample fails for a given loading condition

3.2
glass edge strength
measured stress at failure where the failure origin is known to have occurred at an edge

4 Abbreviations

FEA	finite element analysis
FPCB	flexible printed circuit board
B_{10}	the value at lower 10 % position in the Weibull distribution [1][1]
TSP	touch screen panel

5 Standard atmospheric conditions

The standard atmospheric conditions in IEC 62341-5:2009, 5.3, shall apply unless otherwise specifically agreed between customer and supplier.

6 Evaluations

6.1 Visual examination and verification of dimensions

The specimen shall be submitted to the visual, dimensional checks in non-operation condition and functional checks in operational condition prescribed by the following specification.

a) Visual checks of damage to exterior body of the specimen including marking, encapsulation and terminals shall be examined as specified in IEC 61747-5:1998, 1.5.

b) Dimensions given in the customer's specification shall be verified.

c) Visual and optical performance shall be checked as specified in IEC 62341-6-1.

Unless otherwise specified, visual inspection shall be performed under the conditions and methods as specified in IEC 62341-6-2:2012, 6.2.

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

6.2 Reporting

For the main results in each test, generally the minimum and averaged values or B_{10} value instead of minimum value shall be reported over the number of specimens depending on the test purposes. The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

7 Mechanical endurance test methods

7.1 General

Choice of the appropriate tests depends on the type of devices. The relevant specification shall state which tests are applicable.

7.2 Vibration (sinusoidal)

7.2.1 General

Test Fc, specified in IEC 60068-2-6 and IEC 61747-5:1998, 2.3, are applicable with the following specific conditions. In case of contradiction between these standards, IEC 61747-5:1998, 2.3, shall govern.

7.2.2 Purpose

The purpose of this test is to investigate the behaviour of the specimen in a vibration environment such as transportation or in actual use.

7.2.3 Test apparatus

The equipment shall be capable of maintaining the test conditions specified in 7.2.4. The vibration testing table should not resonate within the test condition vibration frequency range. The required characteristics apply to the complete vibration system, which includes the power amplifier, vibrator, test fixture, specimen and control system when loaded for testing. The body of the device shall be securely clamped during the test. If the device has a specified method of installation, it shall be used to clamp the device. The specimen shall be tested under the non-operational condition.

7.2.4 Test procedure

7.2.4.1 Test conditions

7.2.4.1.1 Basic motion

The basic motion shall be a sinusoidal function of time and such that the fixing points of the specimen move substantially in phase and in straight parallel lines.

7.2.4.1.2 Spurious motion

The maximum amplitude of spurious transverse motion at the check points in any perpendicular to the specified axis shall not exceed 25 %. In the case of large size or high mass specimens, the occurrence of spurious rotational motion of the vibration table may be important. If so, the relevant specification shall prescribe a tolerance level.

7.2.4.1.3 Signal tolerance

Unless otherwise stated in the relevant specification, acceleration signal tolerance measurements shall be performed and signal tolerance shall not exceed 5 %.

7.2.4.1.4 Vibration amplitude tolerance

Reference point: ± 15 %;

Check point: ± 25 %.

7.2.4.1.5 Frequency tolerances

7.2.4.1.5.1 Endurance by sweeping

± 1 Hz from 5 Hz to 50 Hz;

± 2 % above 50 Hz.

7.2.4.1.5.2 Endurance at critical frequencies

± 2 %.

7.2.4.2 Severities

7.2.4.2.1 General

A vibration severity is defined by the combination of the three parameters: frequency range, vibration amplitude and duration of endurance (in sweep cycles or time).

7.2.4.2.2 Frequency range

The frequency range shall be given in the relevant specification by selecting a lower frequency from Table 1 and an upper frequency from Table 2.

Table 1 – Frequency range – Lower end

Lower frequency f_1 Hz
5
10
20

Table 2 – Frequency range – Upper end

Upper frequency f_2 Hz
55
100
200
300
500

The recommended ranges are shown in Table 3.

Table 3 – Recommended frequency ranges

Recommended frequency ranges, from f_1 to f_2 Hz
5 to 100
5 to 200
5 to 500
10 to 55
10 to 200
10 to 300
10 to 500

7.2.4.2.3 Vibration Amplitude

The vibration amplitude shall be stated in the relevant specification. Recommended vibration amplitudes with cross-over frequency are shown in Table 4.

Table 4 – Recommended vibration amplitudes

Displacement amplitude below the cross-over frequency	Acceleration amplitude above the cross-over frequency	
mm	m/s^2	g_n
0,035	4,9	0,5
0,075	9,8	1,0
0,10	14,7	1,5
0,15	19,6	2,0
0,20	2,4	3,0
NOTE The values listed apply in Table 4 for cross-over frequencies between 57 Hz and 62 Hz.		

7.2.4.2.4 Duration of endurance

7.2.4.2.4.1 Endurance by sweeping

The duration of the endurance test in each axis shall be given as a number of sweep cycles chosen from the list given below.

1, 5, 10, 20, 30, 45, 60, 120

The sweeping shall be continuous and the frequency shall change exponentially with time. The endurance time associated with number of sweep cycles or sweep rate in octaves/minute shall be specified. During the vibration response investigation, the specimen and the vibration response data shall be examined in order to determine critical frequencies.

7.2.4.2.4.2 Endurance at critical frequencies

The duration of the endurance test in each axis at the critical frequencies found during the vibration response investigation shall be chosen from the list given below. This test shall be repeated for the number of critical frequencies as specified by the relevant specification.

10 min, 15 min, 30 min, 90 min.

7.2.5 Evaluation

After the test, visual, dimensional and functional checks shall be performed and compared as described in 6.1.

7.3 Shock

7.3.1 General

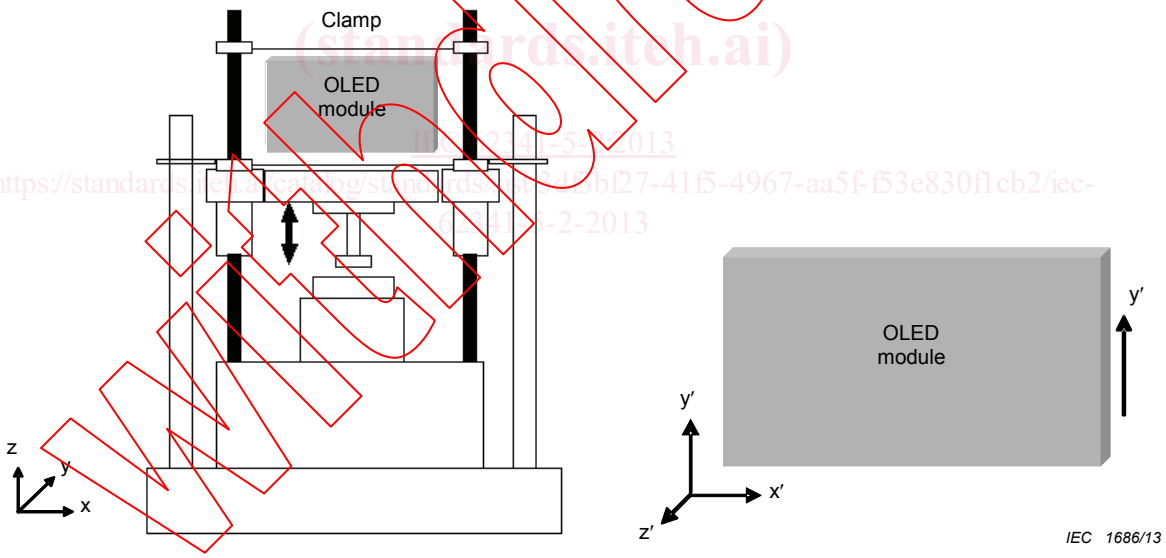
IEC 60068-2-27 and 61747-5:1998, 2.4, shall be applied with the following specific conditions. In case of contradiction between these standards, IEC 61747-5:1998, 2.4, shall govern.

7.3.2 Purpose

This test is to provide a standard procedure for determining the ability of an OLED panel or module to withstand specified severities of shock. During transportation or in use, an OLED panel or module may be subjected to conditions involving relatively non-repetitive shocks.

7.3.3 Test apparatus

The body of the specimen shall be securely clamped during the test in the test direction aligning with the z-axis of the test machine; for example, Figure 1 depicts shock test along the y'-direction of the specimen. If the device has a specified method of installation, it shall be used to clamp the device.



a) Example of a shock test machine

b) Test direction of a specimen

Figure 1 – Configuration of OLED shock test set-up

7.3.4 Test procedure

Test Ea, specified in IEC 60068-2-27, is applicable, with the following specific requirements. The conditions shall be selected from Table 5, taking into consideration the mass of the device and its internal construction.

Table 5 – Conditions for shock test

Peak amplitude A	Corresponding duration D of the nominal pulse	Corresponding velocity change ΔV	
		Half-sine	Trapezoidal
m/s^2 (g_n)	ms	m/s	m/s
50 (5)	30	1,0	-
150 (15)	11	1,0	1,5
300 (30)	18	3,4	4,8
300 (30)	11	2,1	2,9
300 (30)	6	1,1	1,6
500 (50)	11	3,4	4,9
500 (50)	3	0,9	1,3
1 000 (100)	11	6,9	9,7
1 000 (100)	6	3,7	5,3
2 000 (200)	6	7,5	10,6
2 000 (200)	3	3,7	5,3
5 000 (500)	1	3,1	-
10 000 (1 000)	1	6,2	-

NOTE Preferred values are underlined.

The choice of waveform to be used depends on a number of factors, and difficulties inherent in making such a choice preclude a preferred order being given in the standard (see IEC 60068-2-27:2008, Clause A.3). The relevant specification shall state the waveform utilized.

Unless otherwise prescribed by the relevant specification, three successive shocks shall be applied in each direction of three mutually perpendicular axes of the specimen, for a total of 18 shocks. Depending on the number of identical devices available and the mounting arrangements, particularly in the case of components, they may be oriented such that the multiple axis/direction requirements of the relevant specification can be met by the application of three shocks in one direction only (see IEC 60068-2-27:2008, Clause A.7).

7.3.5 Evaluation

Visual, dimensional and functional checks shall be performed and compared as described in 6.1 to the relevant specification.

7.4 Quasistatic strength

7.4.1 General

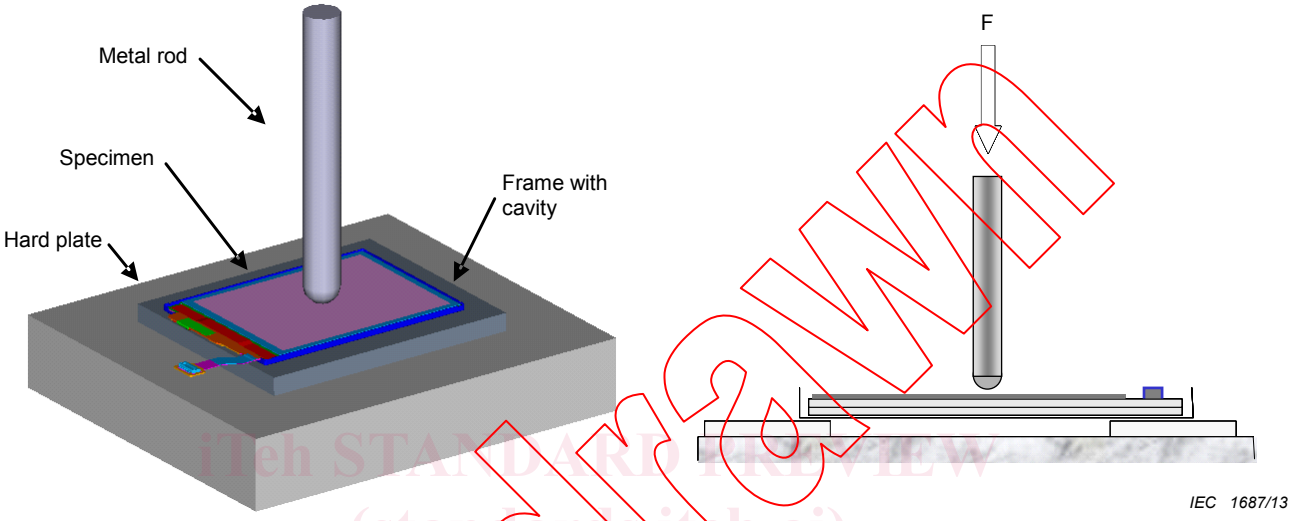
IEC 61747-5-3:2009, 5.4, is applicable with the following specific conditions.

7.4.2 Purpose

The objective of this standard is to establish uniform requirements for accurate and reliable measurements of the quasistatic strength of OLED panels or modules. The quasistatic strength of OLED module may be specified to ensure the mechanical endurance level from the quasistatic external loadings in and around the display area in normal use, such as sitting on the product or touching/pushing fingertip in the display area.

7.4.3 Specimen

This standard applies to the OLED panels or modules for mobile and IT application. OLED module products incorporating additional components, e.g. TSP, protective film and window cover may be used as an acceptable form of the specimen. In all cases a minimum sample size of at least 6 panels or modules shall be used to obtain a statistically significant strength distribution representative of quasistatic resistance of the specimen to external loadings induced by handling, processing and fabrication of the specimen specified as a part of the end product.



a) Boundary support with cavity b) Side support

Figure 2 – Schematic of quasistatic strength measurement apparatus example

7.4.4 Test apparatus

The quasistatic strength of a specimen is measured by supporting the specimen on the mounting frame and loading it at the center as shown in Figure 2. The specimen shall be put on the frame with the rectangular cavity as shown in Figure 2a) or on side supports as shown in Figure 2b). The size of a rectangular cavity in the frame (Figure 2a)) shall be specified by the relevant specification and shall be as big as the edge of the supporting area allows. It is recommended to set the cavity to be around the active area size for mobile application. The tip of metal loading bar shall be rounded in shape and the diameter of the metal rod varies according to the specimen size under testing. It is recommended to use a metal rod of 10 mm in diameter for the samples up to 101,6 mm (4 inches) display diagonal length. For larger modules, such as for notebook computer or monitor applications, a rod of 19 mm diameter is recommended. The same apparatus may also be used for loading the OLED module off-center and obtaining its strength at different locations. For TV applications, this quasistatic strength test is generally not applicable.

7.4.5 Test procedure

7.4.5.1 General

The displacement rate should be slow enough so that there is no significant dynamic response from the loading such that the maximum strain rate upon specimen shall be of the order of $1{,}0 \times 10^{-4}\ s^{-1}$ [3]. Typical loading rate or crosshead speed is 3 mm/min or 5 mm/min for small size displays such that failure may occur within the measurement time of 30 s to 45 s. Depending on the purpose of the test, the following test procedure may be applied.