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INTERNATIONAL STANDARD

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Semiconductor devices – Mechanical and climatic test methods – Part 40: Board level drop test method using a strain gauge

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Dispositifs à semiconducteurs – Méthodes d'essais climatiques et mécaniques – Partie 40: Méthode d'essai de chute au niveau de la carte avec utilisation d'une jauge de contrainte

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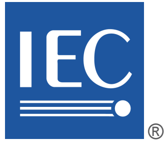

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SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –

Part 40: Board level drop test method using a strain gauge

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International Standard IEC 60749-40 has been prepared by IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47/2094/FDIS	47/2100/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 of the IEC 60749 series, under the general title *Semiconductor devices – Mechanical and climatic test methods*, can be found in 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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SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –

Part 40: Board level drop test method using a strain gauge

1 Scope

This part of IEC 60749 is intended to evaluate and compare drop performance of a surface mount semiconductor device for handheld electronic product applications in an accelerated test environment, where excessive flexure of a circuit board causes product failure. The purpose is to standardize test methodology to provide a reproducible assessment of the drop test performance of a surface mounted semiconductor devices while duplicating the failure modes normally observed during product level test.

This international standard uses a strain gauge to measure the strain and strain rate of a board in the vicinity of a component. Test method IEC 60749-37 uses an accelerometer to measure the mechanical shock duration and magnitude applied which is proportional to the stress on a given component mounted on a standard board. The detailed specification shall state which test method is to be used.

NOTE 1 Although this test can evaluate a structure where the mounting method and its conditions, the design of a printed wired board, solder material, the mounting capability of a semiconductor device, etc. are combined, it does not solely evaluate the mounting capability of a semiconductor device.

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NOTE 2 The result of this test is strongly influenced by the differences between soldering conditions, the design of the land pattern of a printed wired board, solder material, etc. Therefore, in carrying out this test, it is necessary to recognize that this test cannot intrinsically guarantee the reliability of the solder joint of the semiconductor devices.

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NOTE 3 When the mechanical stress which is generated by this test does not occur in the actual application of the device, implementation of this test is unnecessary.

2 Normative references

The following referenced documents are indispensable for the application 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 60749-37, *Semiconductor devices – Mechanical and climatic test methods – Part 37: Board level drop test method using an accelerometer*

3 Terms and definitions

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

3.1
device
single electronic component to be surface mounted

3.2
drop impact strength
strength of the test substrate held by a jig that is dropped from a defined height, as represented by the number of cyclic drops that finally cause fracture on the joint between a device and a PWB copper land

3.3
strain
strain of surface of substrate
degree of stretching observed when the test substrate is distorted

NOTE The strain is a numeric dimensionless quantity.

3.4
maximum strain
tensile side (+) of the strain waveform

3.5
pulse duration
duration between the instant when the acceleration first reaches 10 % of its specified peak level and the instant when the acceleration first returns to 10 % of the specified peak level after having reached that peak level

3.6
momentary interruption detector
equipment which detects extremely short electrical discontinuity (momentary interruptions) in a daisy-chain circuit

4 Test equipment

The equipment shall be selected to satisfy the test conditions specified in Clause 6. Alternatively, the test method described in Annex A can be used.

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5 Test procedure

5.1 Test specimen

Unless otherwise specified, specimen devices shall be of a structure that allows continuity to be checked (e.g., daisy chain). They shall be of a design based on the same specifications as devices in actual use.

The test specimens shall be on a daisy-chained substrate on the lead frame of a surface mounted device or on a substrate that is a carrier of a BGA, LGA, or SON, or the actual device shall be used.

NOTE When using daisy-chain connections, care should be taken not to cause any failure in wiring patterns on the test substrate. For example, the wiring patterns should be drawn in a crosswise direction on the test substrate, not in a longitudinal direction.

5.2 Test substrate

The test substrate shall be prepared in accordance with the relevant specification, preferably using a substrate of the same structures an actual electrical device.

Unless otherwise specified, a solder mask defined (SMD) land is desirable for a BGA and a non solder mask defined (NSMD) land for a QFP. For a BGA, it is desirable to match the land size of the test substrate with the land size of the package.

5.3 Solder paste

The solder paste shall be prepared in accordance with the relevant specification.

5.4 Mounting method

The mounting method shall prepared in accordance with the relevant specification. However, one test specimen shall be mounted in the centre of the test substrate.

5.5 Pre-conditionings

When specified in the relevant specification, carry out moisture soaking and soldering heat stress testing before the board level drop test.

5.6 Initial measurements

The initial measurement shall be carried out in accordance with the relevant specification.

5.7 Intermediate measurement

Intermediate measurement shall be carried out in accordance with the relevant specification.

NOTE When determining failure after a drop test, a failure can wrongly be considered as acceptable because of electrical contact of a disconnect. Therefore, when determining failure, checking the daisy-chain signal lines with a momentary interruption detector or other similar equipment is advised. When using this technique, the resolution of the momentary interruption detector shall be capable of detecting 100µs of momentary discontinuity.

5.8 Final measurement

The final measurement shall be carried in accordance with the relevant specification.

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A sufficient number of failures from the test lot shall be subjected to failure analysis to determine the root cause and to identify the failure mechanism. Each failure site shall be clearly identified as “device failure”, “interconnect failure”, or “board failure”.

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6 Test method

6.1 Purpose of test method

This test method specifies the drop test conducted with the fall height based on measured strain using a strain gauge set on the test substrate.

NOTE This test method uses drop test equipment, a substrate-securing jig and a strain measurement instrument. Because the test equipment is verified using the value of strain measured by a strain gauge attached to the surface of the test substrate, the test result does not depend on the drop test equipment or the substrate-securing jig. Accordingly, this standard does not prescribe the drop test equipment, the structure of the jig, or its form Correlation of a test result with the device and equipment type is straightforward since the test results are quantified in terms of the strain values. However, details of the device and equipment should be recorded.

6.2 Example of drop test equipment

The drop test equipment is designed to drop a substrate-securing jig with a protrusion on its base, from a specified height onto a collision plane to apply the impact that would result from a free fall or similar situation (Figure 1).

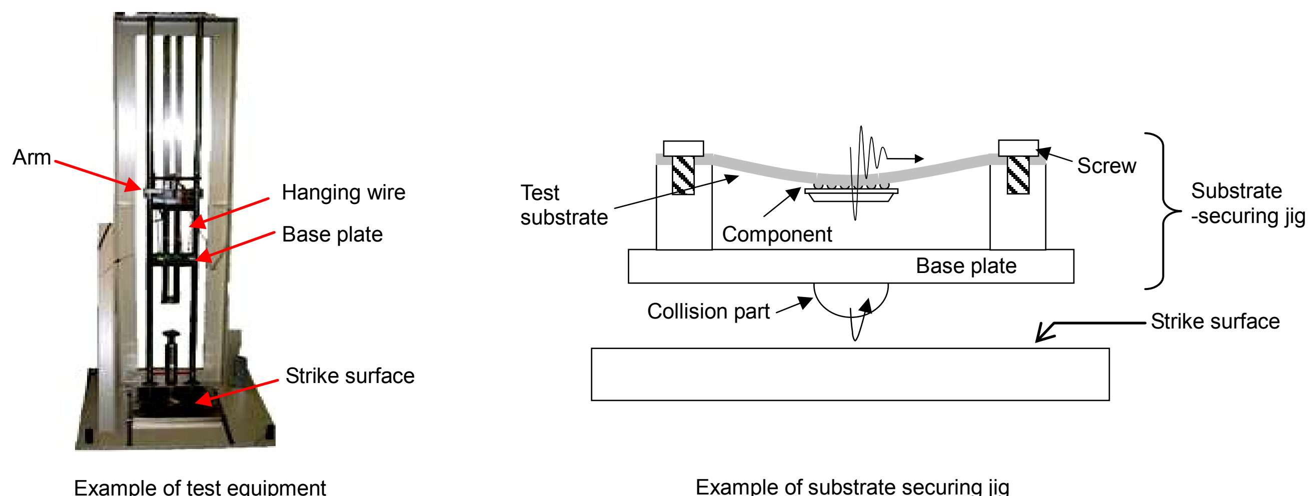

Figure 1 – Example of drop test equipment and substrate securing jig

6.3 Example of substrate-securing jig

Unless otherwise specified, the substrate-securing jig shall be constructed to allow the attachment of the test substrate with screws, and give a drop impact to the solder joints. The test substrate is fixed so that the device is in the centre of the substrate-securing jig. Unless otherwise specified, the colliding interface shall be a hemispherical protrusion as shown in Figure 1 in order to obtain the reproducibility of strain. However, this is not mandatory if appropriate repeatability can be obtained by another method.

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6.4 Example of distance between supporting points

The distance between the supporting points shall be in accordance with the relevant specification. The recommended distance between supporting points is 50 mm to 80 mm for a mobile phone (see 6.9.4).

6.5 Example of impacting surface

Unless otherwise specified, the drop test shall be performed on a flat concrete or steel plate floor.

NOTE Since destruction of the concrete or deformation of the steel plate might be caused by repetitive impacts, it is desirable to check the surface of floor at each test. When a steel plate floor is used, hardened-steel plate is recommended in order to prevent deformation due to impact.

6.6 Strain gauge

Unless otherwise specified, the strain gauge shall satisfy following:

a) the gauge length shall be from 1 mm to 2 mm.

b) the strain gauge shall be a foil-type gauge.

c) the strain gauge shall be of a single-axis type.

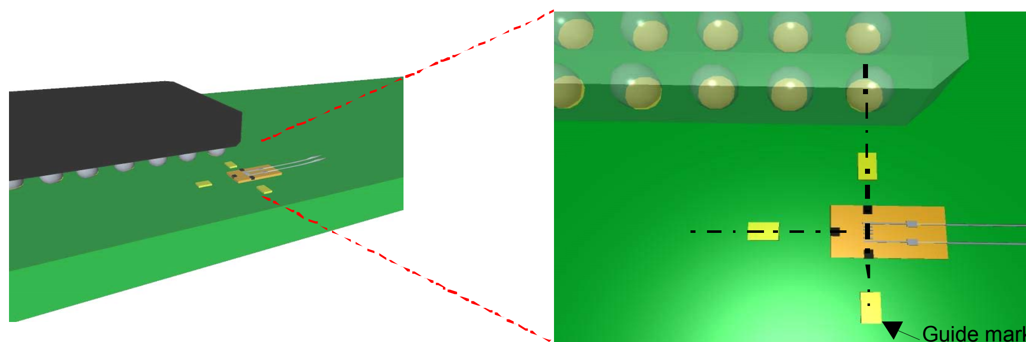
6.7 Strain gauge attachment

Attach the strain gauge to the test substrate as shown in Figure 2. The strain gauge is attached to the extension of a corner land central line in the vicinity of the device, taking care not to stick the gauge on the substrate wiring.

NOTE 1 If attachment is difficult, the substrate can be made smooth with the emery paper etc. It is better to apply adhesives thinly so that cracking and peeling of the interfaces do not occur in during the drop test.

NOTE 2 Test results can differ depending upon the strain gauge attachment method. Refer to Annex B (example of strain gauge attachment procedure).

NOTE 3 Strain can differ depending upon the strain gauge attachment position on the test board. Therefore, it is necessary to adjust the position on the board to that of the actual electronic device.



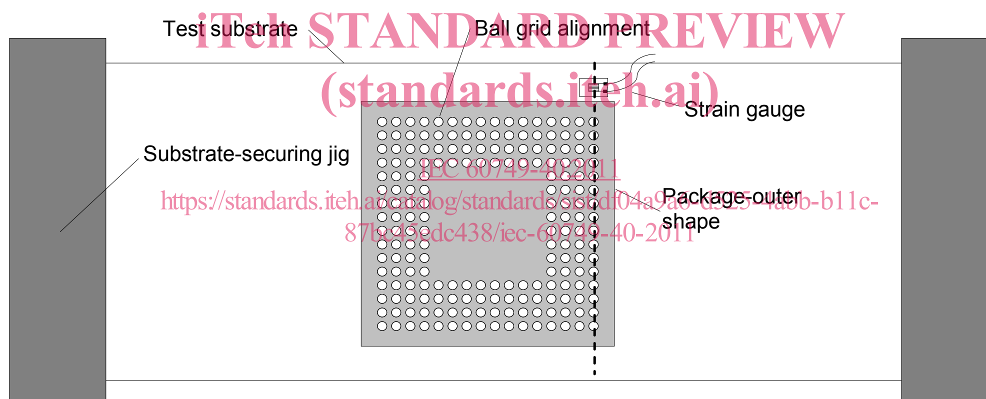


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Figure 2 – Position of strain gauge attachment

6.8 Strain measurement instrument

The strain measurement instrument used during the drop test shall have sampling rate that is higher than 150 kHz. When the sampling rate of an instrument is low, strain values and strain wave patterns are not shown correctly because the peak value of the maximum strain sometimes cannot be picked up. Therefore, an instrument that has higher sampling rate than 150 kHz is desirable (Figure 3 and Figure 4). However, a sampling rate that is lower than 150 kHz is acceptable if the measuring result is otherwise correctly assured.

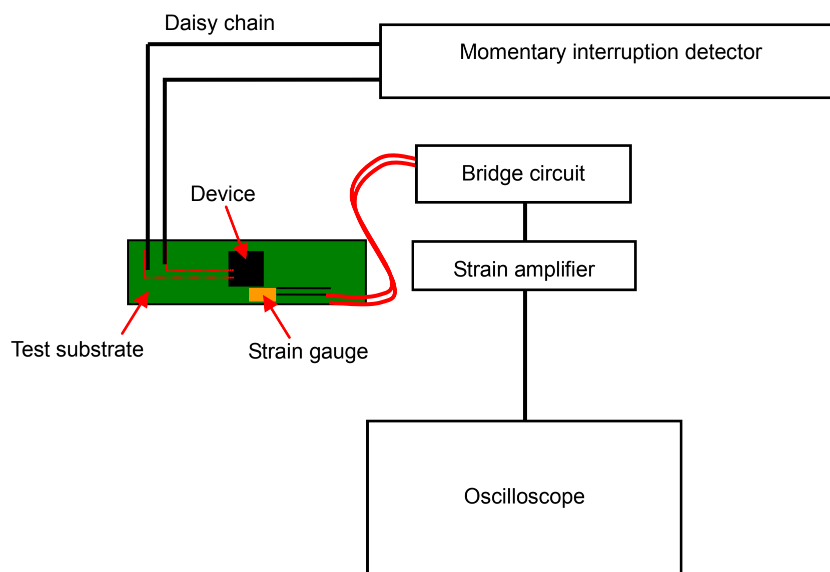

Figure 3 – Strain measurement instrument

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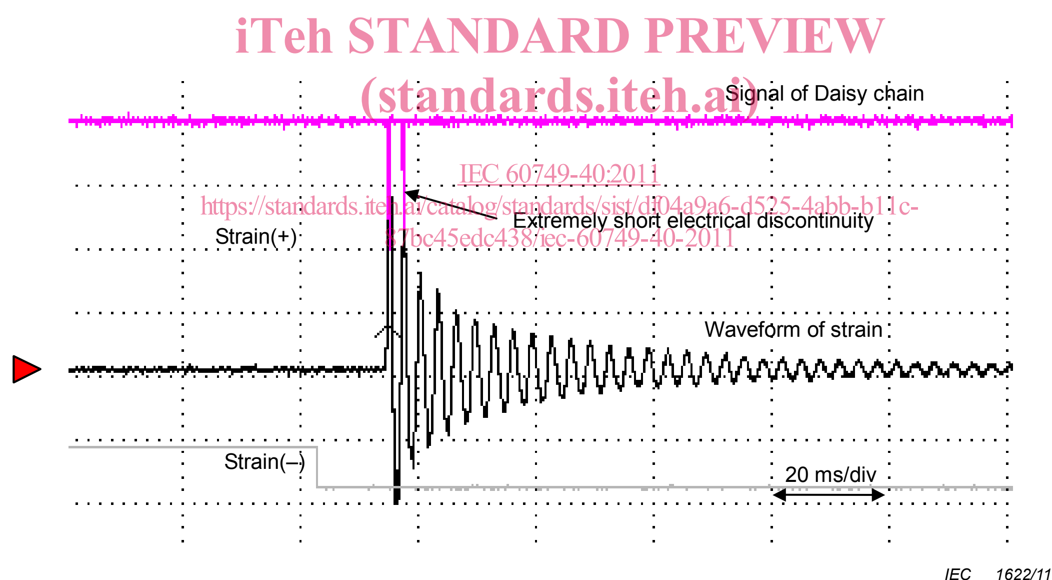

Figure 4 – Waveform of strain and electrical conductivity of daisy chain

6.9 Test condition

6.9.1 Drop test conditions

The method and conditions of the drop test shall be specified in the relevant specification.

6.9.2 Test procedure

The drop test method shall be natural free fall.

6.9.3 Drop height

The drop shall be defined in accordance with 6.9.4 by using a strain gauge set on the test substrate.