IEC 60749-10

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**Semiconductor devices – Mechanical and climatic test methods –
Part 10: Mechanical shock – Device and subassembly**

**Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques –
Partie 10: Chocs mécaniques – Dispositif et sous-ensemble**

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 10: Mechanical shock – Device and subassembly

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This edition cancels and replaces the first edition published in 2002. This edition includes the following significant technical changes with respect to the previous edition:

a) covers both unattached components and components attached to printed wiring boards;

b) tolerance limits modified for peak acceleration and pulse duration;

c) mathematical formulae added for velocity change and equivalent drop height.

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

Draft	Report on voting
47/2752/FDIS	47/2760/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all the parts of the IEC 60749 series, under the general title *Semiconductor devices – Mechanical and climatic test methods*, can be found on the IEC website.

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

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SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 10: Mechanical shock – Device and subassembly

1 Scope

This part of IEC 60749 is intended to evaluate devices in the free state and assembled to printed wiring boards for use in electrical equipment. The method is intended to determine the compatibility of devices and subassemblies to withstand moderately severe shocks. The use of subassemblies is a means to test devices in usage conditions as assembled to printed wiring boards. Mechanical shock due to suddenly applied forces, or abrupt change in motion produced by handling, transportation or field operation can disturb operating characteristics, particularly if the shock pulses are repetitive. This is a destructive test intended for device qualification.

2 Normative references

There are no normative references in this document.

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3 Terms and definitions

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3.1
component
constituent part of device or subassembly

Note 1 to entry: Examples include source and drain regions as components of transistors, lead frames and dice as components of packaged integrated circuits, resistors and integrated circuits as components of printed circuit boards, motherboards as components of computers, LCD screens as components of monitors, ac and dc components of complex waveforms, and loops and algorithms as components of software programs.

Note 2 to entry: The classification of an item as a device or a component depends upon the intention of the owner at the time of classification.

3.2
dead-bug orientation
orientation of a package with the terminals facing upwards

3.3
device
piece of equipment, mechanism, or other entity designed to serve a special purpose or perform a special function

Note 1 to entry: The term device is often used as an abbreviated reference to the type or types of solid-state devices that are within the scope of those documents. Context could indicate otherwise; e.g., in the phrase ’the device used to hold the device under test‘, the first usage of the word ’device‘ refers to a mechanism; the second to a solid-state device.

Note 2 to entry: The classification of an item as a device or as a component depends upon the intention of the owner at the time of classification.

3.4
equivalent drop height
free-fall drop height from which an object at rest must fall, in vacuum, under standard gravity, to attain a velocity equal to the velocity change stated in the test specification

Note 1 to entry: This is the theoretical height that will impart the specified velocity change if impact with zero rebound occurs. This height is provided for reference only in the various service conditions.

3.5
free state
state in which a device or subassembly is rigidly attached to the test apparatus so that the full specified shock level is transmitted to the device or subassembly body

3.6
live-bug orientation
orientation of a package when resting on its terminals

3.7
mounted state
state in which a subassembly is supported by a test fixture that allows flexure to simulate usage conditions and in a manner such that the full specified shock level is transmitted to the subassembly body

3.8
peak acceleration
maximum acceleration during the dynamic motion of the sample under test

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3.9
pulse duration
t_d
time interval 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

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Note 1 to entry: The basic frequency of the pulse is 1/2 × t_d.

3.10
service condition
designation for the severity of stress

3.11
subassembly
printed circuit board and the devices assembled thereon that form a unit or segment of electrical equipment

Note 1 to entry: Devices are preferably located near the centre of the printed circuit board.

3.12
velocity change
integral of the acceleration interval over the duration of the entire shock event including at least the pulse duration interval

3.13
vertical direction
direction that is parallel with gravity, i.e., normal to the normalized surface of the earth

4 Apparatus

The shock-testing apparatus shall be capable of providing shock pulses with a peak acceleration of up to 29 000 m/s^2, a velocity change of 1,00 m/s to 5,44 m/s and a pulse duration between 0,3 ms and 8,0 ms to the body of the device. For free-state testing, a velocity change of 1,25 m/s to 5,44 m/s and a pulse duration between 0,3 ms and 2,0 ms is sufficient. Conversely, for mounted-state testing, apparatus capable of a velocity change of 1,00 m/s to 5,44 m/s and a pulse duration between 5,0 ms and 8,0 ms to the body of the device is sufficient.

The acceleration pulse shall be a half-sine waveform with an allowable deviation from specified peak acceleration not greater than ± 10 %. The test velocity change shall be ± 10 % of the specified level. The pulse duration shall be measured between the points at 10 % of the peak acceleration during rise time and 10 % of the peak acceleration during decay time. Absolute tolerances of the pulse duration shall be ± 15 % of the specified duration. The test equipment transducer shall have a natural frequency greater than 5 times the frequency of the shock pulse being established, and measured through a low-pass filter having a bandwidth greater than 5 times the frequency of the shock pulse being established. Filtering shall not be used in lieu of good measurement setup and procedure practices.

Appropriate equipment calibration shall be considered prior to any testing to ensure conformance to the specified targets and acceptable tolerances. Reserving a set of known good units is recommended for pre-test calibration exercise whenever new samples are to be tested. If calibration tests are conducted regularly, then following periodical preventive maintenance should suffice for the equipment to meet the target and tolerance limits.

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5 Procedure

5.1 Apparatus set-up

The shock-testing apparatus shall be attached to a sturdy laboratory table or equivalent base and levelled before use. Means shall be provided to prevent the shock from being repeated due to “bounce” in the apparatus. In the free state unless otherwise specified, the device or subassembly shall be subjected to a total of 30 shocks, which are five shock pulses of the peak acceleration, velocity change and pulse duration specified in the selected service condition (see Table 1) in each of the positive and negative directions of three orthogonal axes (X, Y and Z). If shock testing is required in the mounted state, the subassembly shall be subjected to a total of 12 shocks, which are two shock pulses of the peak acceleration, velocity change and pulse duration specified in the selected service condition (see Table 2) in each of the positive and negative directions of three orthogonal axes (X, Y and Z). Figure 1 and Figure 2 define the device orientation, positive and negative directions for the three orthogonal axes.

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The values associated with the service conditions of Table 1 and Table 2 are related by the following formulae:

$$\Delta v = \frac{2A t_p}{\pi} \tag{1}$$

$$H = \frac{0{,}5(\Delta v)^2}{9{,}81} \tag{2}$$

where

Δv is the velocity change,

A is the acceleration level (peak),

t_p is the duration of pulse,

H is the equivalent drop height.

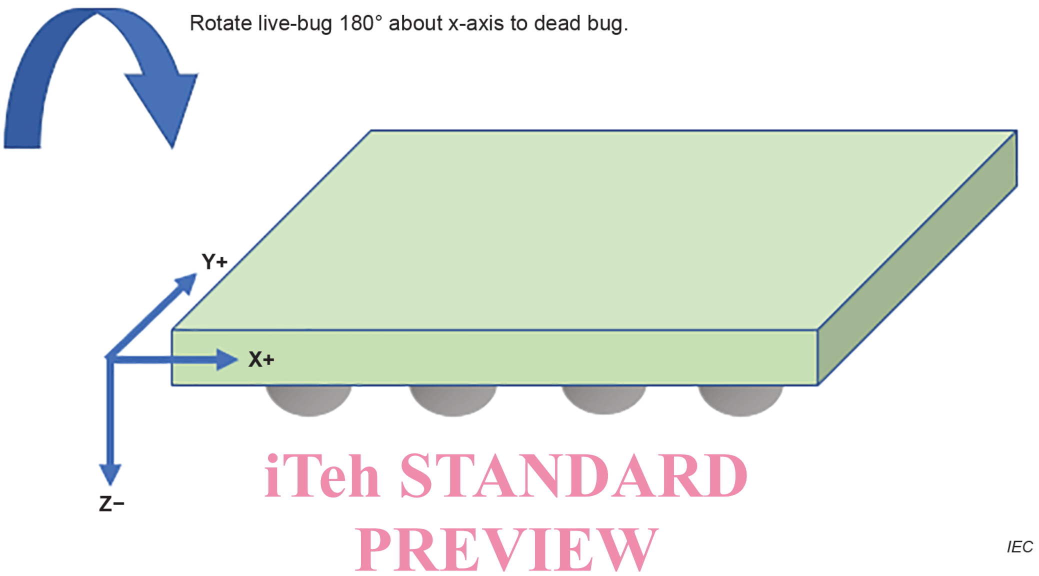

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Figure 1 – Live-bug orientation with solder spheres of device facing downward in either free or mounted state

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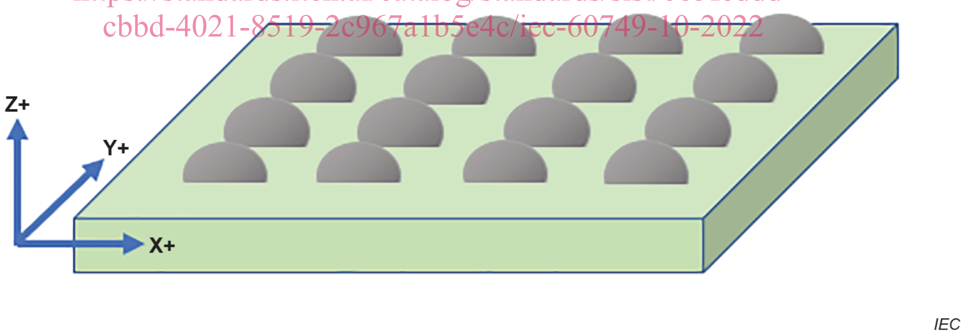

Figure 2 – Dead-bug orientation with solder spheres of device facing upward in either free or mounted state

There are two types of tests that can be performed, based on the test information needed. One is testing of a device or subassembly in the free-state, and another is testing of a subassembly in a mounted-state.

Devices or subassemblies subjected to the test shall be randomly selected and typical of production. In the free-state, the device or subassembly shall be rigidly attached to the test apparatus, so that the full specified shock level is transmitted to the device or subassembly body. If the mounted state test is performed, the method of mounting to the test apparatus shall be typical of the usage condition. If device or subassembly rework, reuse, remounting, burn in, or other stressful process is possible, such a process or processes shall be applied to the device or subassembly prior to the shock test. Use of such processes in the test hardware preparation shall be documented.

5.2 Device or subassembly in free-state

Devices or subassemblies to be tested in the free state shall be subjected to at least one of the service conditions (A to H) shown in Table 1, which shall be documented. The designated shock shall be applied to the device or subassembly body in a manner to simulate expected impacts during processing, packaging, and shipment. The device or subassembly shall be rigidly attached to the test apparatus in such a manner that it experiences the full-specified shock level at the device or subassembly body. At least five shocks in each of two directions of three orthogonal axes shall be applied (minimum total of 30 shocks) at the severity of the designated service condition.

Table 1 – Device or subassembly free state test levels

Test condition	Acceleration level (peak)[a]		Duration of pulse	Velocity change	Equivalent drop height
	m/s^2	(g)	ms	m/s	m
H	28 450	(2 900)	0,3	5,43	1,50
G	19 620	(2 000)	0,4	4,99	1,27
B	14 720	(1 500)	0,5	4,68	1,12
F	8 830	(900)	0,7	3,93	0,79
A	4 910	(500)	1,0	3,12	0,50
E	3 340	(340)	1,2	2,55	0,33
D	1 960	(200)	1,5	1,87	0,18
C	980	(100)	2,0	1,25	0,08

[a] g, standard gravity has a value of 9,81 m/s^2 and multiples of g are used as an alternative unit of acceleration level

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5.3 Subassembly in mounted state

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If required, subassemblies shall also be tested in a mounted state, subject to at least one of the service conditions (1 to 14) shown in Table 2, which shall be documented. The designated shock shall be applied to the subassembly mounted to the test apparatus with fixtures that allow flexure to simulate the usage conditions, and in a manner such that the full specified shock level is transmitted to the subassembly body. Preferred methods to support the subassembly are a slotted/clamping 'picture frame', or a raised-boss bolted fixture with contact points in four regions not closer than one inch from any device. The subassembly, supporting method, test fixture mounting dimensions, and one or more of the lowest resonant frequencies of the subassembly shall be documented. At least two shocks in each of two directions of three orthogonal axes shall be applied (minimum total of 12 shocks) at the severity of the designated service condition.

The optimum test is performed when the subassembly is mounted in a manner that simulates the application configuration. If that information is unknown or unavailable, a recommended printed wiring board for testing the device(s) of the subassembly is the JEDEC standard thermal card (as described in JEDEC Standards JESD51-9, JESD51-10, and JESD51-11), which shall be modified to include device and connection functionality circuitry.

Alternately, if the size or construction of the JEDEC thermal card is not suitable for the given device(s), a printed wiring board shall be used with the dimensions, materials, and construction typical for the device subassembly usage, and shall include electrical circuitry to test for functionality, continuity, and damage of the device on the subassembly. The dimensions and construction of the printed wiring board shall be documented. Test results using subassembly application hardware are most relevant and should take precedence over results obtained using test vehicles.