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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Surface mounting technology – Environmental and endurance test methods for surface mount solder joint –
Part 1-3: Cyclic drop test

Technologie de montage en surface – Méthodes d'essais d'environnement et d'endurance des joints brasés montés en surface –
Partie 1-3: Essai de chute cyclique

IEC 62137-1-3:2008

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Email: csc@iec.ch
Tél.: +41 22 919 02 11
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SURFACE MOUNTING TECHNOLOGY – ENVIRONMENTAL AND ENDURANCE TEST METHODS FOR SURFACE MOUNT SOLDER JOINT –

Part 1-3: Cyclic drop test

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

FDIS	Report on voting
91/802/FDIS	91/825/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 62137 series, under the general title *Surface mounting technology – Environmental and endurance test methods for surface mount solder joint*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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- withdrawn,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

SURFACE MOUNTING TECHNOLOGY – ENVIRONMENTAL AND ENDURANCE TEST METHODS FOR SURFACE MOUNT SOLDER JOINT –

Part 1-3: Cyclic drop test

1 Scope

The test method described in this part of IEC 62137 applies to solder joints between terminals of surface mounting devices (SMDs) and land patterns on printed wiring boards (PWBs).

This test is intended to evaluate the strength of the solder joints of larger sized multi-terminal components and other components in devices (e.g. handheld mobile devices) in the event that the device is dropped. The properties of the solder joints (e.g. solder alloy, substrate, mounted device or design, etc.) are evaluated to assist in improving the strength of the solder joints.

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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60194, *Printed boards design, manufacture and assembly – Terms and definitions*

IEC 61249-2-7, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

IEC 61188-5 (all parts 5), *Printed boards and printed board assemblies – Design and use – Part 5: Attachment (land-joint) considerations*

IEC 61190-1-2, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes for high-quality interconnects in electronics assembly*

IEC 61192-1, *Workmanship requirements for soldered electronic assemblies – Part 1: General*

IEC 61760-1, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1 and IEC 60194, as well as the following definitions, apply.

3.1
drop impact strength
strength of the test substrate held by a jig that is dropped from a specified height, as represented by the number of cyclic drops that finally cause fracture at the intermetallic, the

surface plating, or within the joint between a surface mounting device (SMD) termination and a printed wiring board (PWB) copper land termination

3.2
strain
substrate surface strain
value indication measured by the strain gauge attached to the surface of the test substrate

NOTE It is a numeric dimensionless quantity representing the degree of stretching observed when the test substrate is distorted.

3.3
maximum strain
maximum strain in the tensile side (+) on the measured strain waveform

3.4
momentary interruption detector
device that detects extremely short electrical discontinuity (momentary interruptions) in a daisy-chain circuit

4 General remarks

The mechanical properties of the joint between a terminal to a land on a printed wiring board using lead-free solder are not the same for the joint using tin-lead solder due to the difference in composing elements of the solders. Thus it becomes important to test the mechanical properties of solder joints using different solder alloys.

This test is to evaluate the durability of joints that are formed by reflow soldering between SMD pins/electrodes and substrate lands in relation to drop heights. To evaluate the drop impact that the specimen joint receives, the strain can be used as an indicator of the impact, and it can quantitatively be measured using a strain gauge.

NOTE This drop impact test is not intended to be targeted at components themselves. Refer to IEC 60068-2-27 and IEC 60068-2-31 for test methods of the components.

Figure 1 is a conceptual illustration of the joint strength evaluation area of this test.

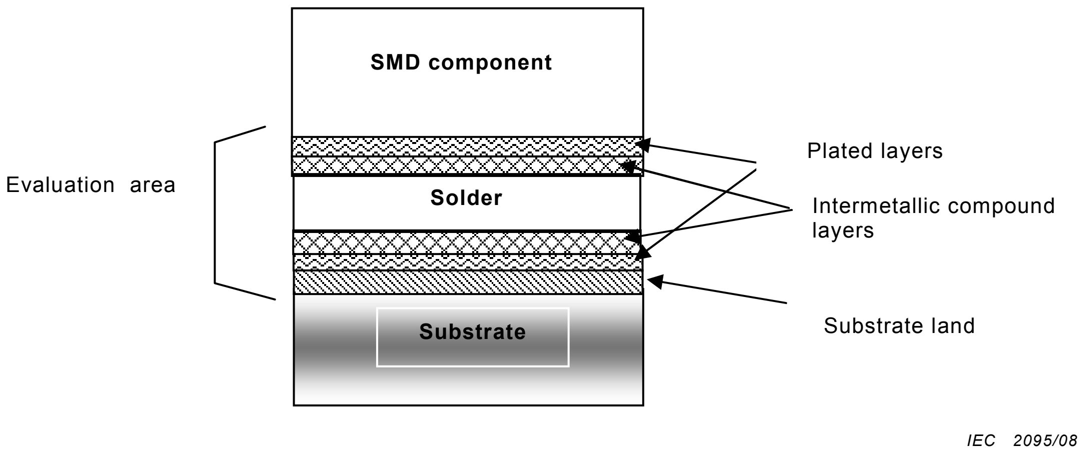


Figure 1 – Area for evaluation in the cyclic drop test

5 Test equipment and materials

5.1 Reflow soldering oven

Unless otherwise specified, the reflow soldering oven shall be able to realize the temperature profile given in Figure 2.

5.2 Drop impact test equipment

This test equipment shall consist of a tester with a substrate securing jig and a measuring instrument. Unless otherwise specified, the following specifications apply.

a) Tester: Use a tester that fulfills the requirements specified in Clause A.2.

b) Substrate securing jig: Use a substrate securing jig that fulfills the requirements specified in A.2.2.

c) Measuring instrument: Use a measurement instrument that fulfills the requirements specified in A.2.3.

5.3 Test substrate

Unless otherwise prescribed by the relevant specification, the test shall be conducted on a specimen (device) mounted by its normal means on the following substrate:

a) **Material**: The substrate shall be a general double-sided board that is, as specified in IEC 61249-2-7.

b) **Thickness**: The substrate thickness shall be either 1,0 mm or as specified in IEC 61249-2-7.

c) **Size**: The substrate shall be of a size that allows testing using the jig specified in 5.2 b).

NOTE Since the substrate is supported at its margins, there should not be lands (e.g., check lands) at the margins of the substrate.

d) **Land geometry**: The shape and size of a land shall comply with the IEC 61188-5 series or as specified by the component manufacturer.

e) **Surface protection**: The solderable areas of the substrate (lands) shall be protected against oxidization by suitable means, e.g. by an organic or inorganic surface protection layer. This protective layer shall not adversely have an effect on the solderability of the lands under the soldering conditions described in Clause 6.

5.4 Solder alloy

Unless otherwise specified, the solder used in this test shall be Sn96,5Ag,30Cu0,5.

5.5 Solder paste

Unless otherwise specified, the solder paste used in this test shall comply with IEC 61190-1-2. The solder alloy specified in 5.4 shall be used for the solder paste.

5.6 Specimen components

Unless otherwise specified, specimen components shall be of a structure that allows continuity to be checked (e.g., daisy chain). They shall be designed based on the same specifications as the actually used components. The solder joints should be checked, as specified in IEC 61192-1, and the pattern design should be in accordance with the IEC 61188-5 series.

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

5.7 Strain gauge

Unless otherwise specified, the following specifications apply:

a) The gauge length shall be 1 mm.

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

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

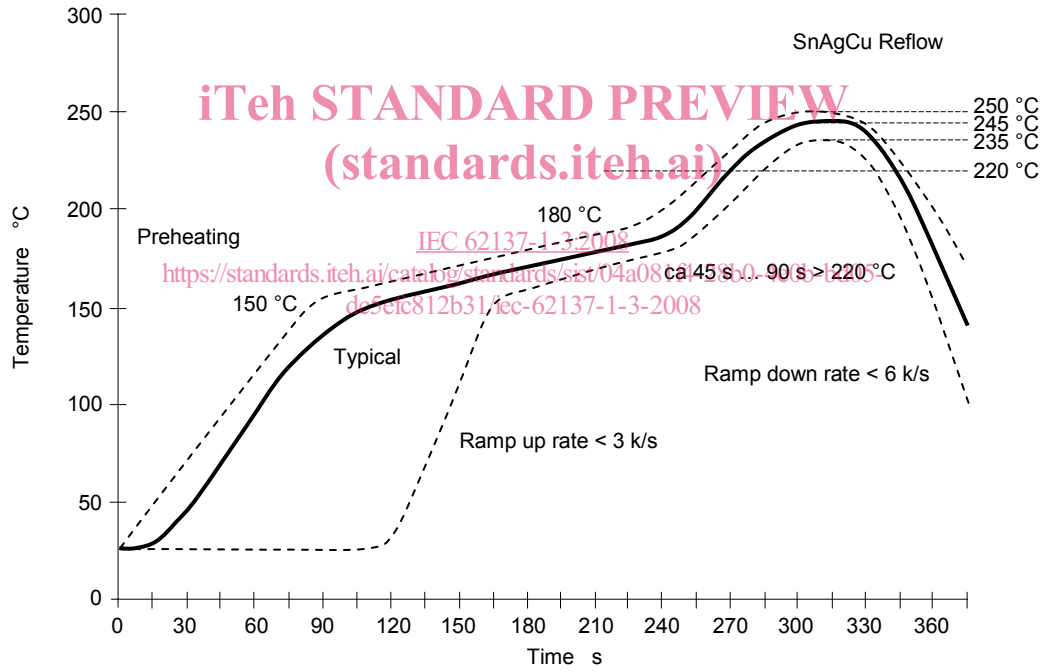
6 Mounting method

The following steps shall be taken:

a) Apply the solder paste specified in 5.5 to the lands of a test substrate as specified in 5.3, using a metal mask with openings of the same size, shape and configuration as the lands on the substrate, made of stainless steel with a thickness of 100 µm to 150 µm.

b) Mount the test specimen on the test substrate with solder paste applied.

c) Use the reflow-soldering oven specified in 5.1 to solder the terminals under the conditions given below. Typical temperature profile of reflow soldering is given in Figure 2 as proposed in IEC 61760-1. The temperature is measured at the land.



Continous line: typical process (terminal temperature)

Dotted line: process limits. Bottom process limit (terminal temperature). Upper process limit (top surface temperature)

IEC 1176/07

Figure 2 – Typical reflow soldering profile

7 Test method and procedure and judgment conditions

7.1 Test procedure

Unless otherwise specified, the following test procedure applies:

a) Attach the strain gauge to the test substrate on the surface where the specimen component is mounted, i.e. close to the component. When attaching the strain gauge, use the procedure specified by the gauge manufacturer.

b) Mount the test substrate on the substrate securing jig.

c) Drop the substrate securing jig holding the test substrate from the height specified in Clause B.2 c) and then read the strain that results from the drop.

d) After the preliminary test (steps a) to c) above) for strain measurement is complete, cyclically drop the substrate securing jig on which the test substrate is mounted from the specified height.

e) Obtain the number of drops that finally cause a discontinuity.

f) When necessary, analyse the condition at the fracture location to identify the failure mode. (see Clause B.2 f) .

7.2 Judgment conditions

When a momentary interruption in electrical continuity is found in the specimen, it shall be judged as a failure.

NOTE There are two methods of failure judgment. One method is to continuously monitor the daisy-chain signal line using a strain measurement instrument to judge occurrence of a momentary interruption. The other method is to use a momentary interruption detector or other instrument for judgment.

8 Items to be included in the test report

The following items shall be included:

a) Date

b) Name of the test organization

c) Name of the electronic component, type, size, dimensions

d) Material of the component terminals, and layer structure, if applicable

e) Material of the test substrate, size, structure of layers, type of protective layers

f) Geometry of substrate lands and layer structure, if applicable

g) Types of solder alloy and solder paste used

h) Temperature profile of reflow soldering and the atmosphere (oxygen content, if soldered in nitrogen atmosphere)

i) Drop impact test equipment (tester specifications, substrate securing jig dimensions and material and measurement instrument specifications), test condition (temperature, RH, sample aging, etc)

j) Graph representing the relationship between the drop height and the number of fractures

k) Graph representing the relationship between the strain and the number of fractures

l) Number of drops

m) Fracture mode (photograph, etc.)

n) Strain gauge model

o) Strain gauge attachment position

9 Items to be given in the product specification

The following items shall be included:

a) Reflow soldering oven (5.1)

b) Drop impact test equipment (5.2)

c) Test substrate (5.3)

d) Solder alloy (5.4)

e) Solder paste (5.5)

f) Specimen components (5.6)
g) Strain gauge (5.7)
h) Mounting method (Clause 6)
i) Test method and procedure and judgment conditions (Clause 7)

Annex A
(normative)

Drop impact test equipment

A.1 Object

Annex A applies to the drop impact test equipment specified in 5.2 and provides details of the equipment.

A.2 Drop impact test equipment

A.2.1 Tester

The tester is an equipment equipped with a mechanism that can drop a substrate securing jig having a protrusion at its base, from a certain height onto a collision plane to apply impact that would result from a free fall or similar situation. The tester shall fulfill the requirements listed below (see also Clause C.2):

a) The tester mechanism shall use a substrate securing jig.

b) The tester mechanism shall be capable of measuring the strain on the substrate surface caused by drop impact.

c) The tester mechanism shall be capable of checking the specimen's electrical continuity during the test.

d) The tester mechanism shall be capable of holding the substrate securing jig in a stable attitude to ensure that the protrusion will collide against the plane when the jig reaches the plane.

e) The collision plane shall be a steel plate. However, this is not mandatory if appropriate strain repeatability can be obtained.

NOTE The collision plane should be firmly fixed to ensure that it does not move.

A.2.2 Substrate securing jig

The substrate securing jig shall carry a protrusion at its base. The test substrate shall be fixed by bolts. The substrate securing jig is directly dropped onto the collision plane in order to apply drop impact to the solder joints. The substrate securing jig shall fulfill the following requirements:

NOTE 1 Figure A.1 is a conceptual illustration of the substrate securing jig.

a) Shape of the colliding part: The colliding part shall be an SR14 protrusion. However, this is not mandatory if appropriate strain repeatability can be obtained.

b) Material of the colliding part: The colliding part shall be made of steel.

NOTE 2 Because the colliding part will be distorted by repeated collisions, a quenched steel plate should be used.

c) Jig shape (thickness): The jig thickness shall be 15 mm. However, this is not mandatory if appropriate strain repeatability can be obtained.

d) Distance between supporting points: This shall measure 80 mm. However, this is not mandatory if the reliability of results can be ensured.

e) Test substrate securing method: The substrate shall be secured with bolts. The substrate shall be fixed directly or indirectly using a plate.

f) Jig material: This shall be in aluminum alloy. However, this is not mandatory if appropriate strain repeatability can be obtained.

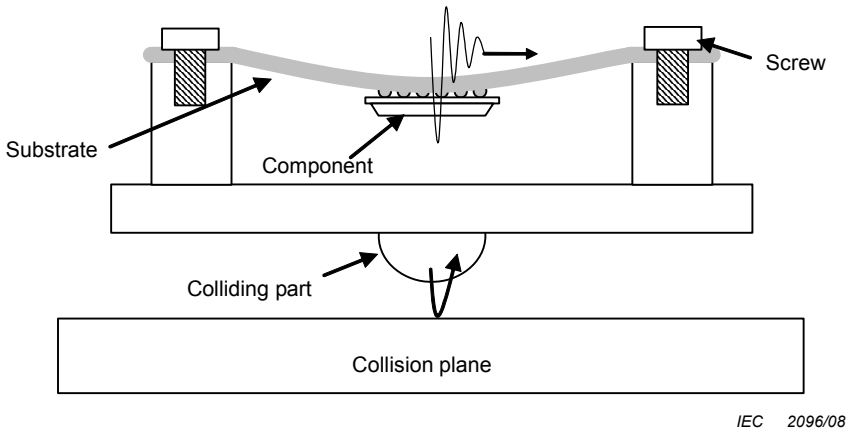


Figure A.1 – Conceptual illustration of a substrate securing jig (reference)

A.2.3 Measurement instruments

The strain measurement instrument and momentary interruption detector shall fulfill the following requirements:

a) Strain measurement instrument: The strain measurement instrument is a device that is used to measure the strain during drop impact tests and to detect electrical discontinuity (momentary interruption) in the daisy-chain circuit. An instrument with a 200 kHz or higher sampling rate shall be used. However, a sampling rate lower than 200 kHz is allowed if the reliability of measurement results can be ensured.

b) Momentary interruption detector: A momentary interruption detector shall be used when momentary interruptions have to be detected using a means other than the measurement instrument specified in A.2.3 a).

NOTE The resolution of the momentary interruption detector should be such that 100 µs momentary interruptions can be detected.

Annex B
(normative)

Test method and procedure

B.1 Object

Annex B applies to Clause 7 and specifies details of the procedure.

B.2 Test method

The test methods and procedures are given below:

a) Strain gauge attachment: Attach the strain gauge to the test substrate. The gauge shall be attached to the surface on which the specimen component is mounted, at a location in the vicinity of the component. The gauge shall be oriented in parallel to the test specimen.

NOTE 1 The position of attachment should be controllable and clearly indicated. Figure B.1 shows an example with a guide mark provided (see Clause D.4.)

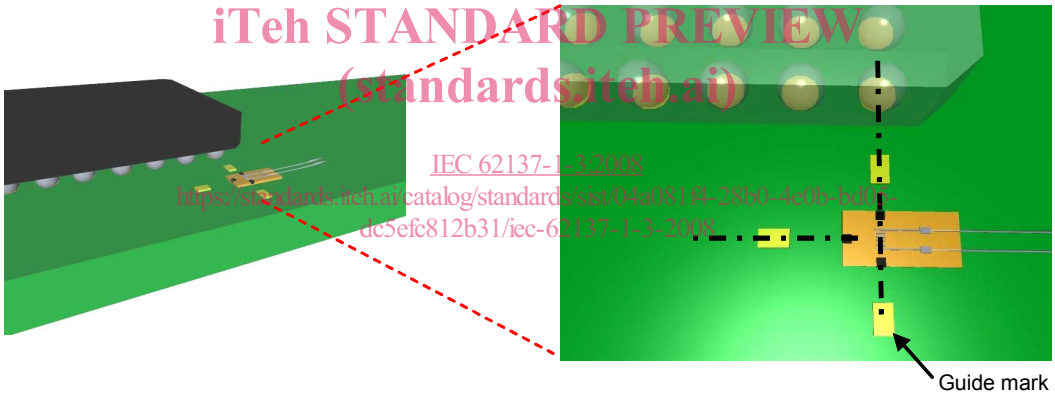


Figure B.1 – Strain gauge attachment example and guide mark

b) Test substrate attachment: The test substrate shall be attached to the substrate securing jig with its component side facing downward.

c) Test level (height): Two test levels (heights), 1,5 m and 0,75 m, shall be used for tests. However, if these two levels are inappropriate for a particular specimen, two different levels can be used for tests.

d) Strain measurement (preliminary test): Strain measurement shall be conducted to read the strain that, measured from the attachment position specified in 7.1 a) of this standard, results from the drop from each test level (height). On the obtained strain waveform, the peak tensile strain (on the + side) shall be considered as the maximum strain. When various types of specimens are used, the strain shall be measured for each type of specimen. If the specimens are of the same type, only one arbitrary specimen shall be measured.

Strain measurement shall be conducted for different purposes, including checking the compatibility between different testers in terms of response to a given drop impact and checking the repeatability of a drop impact that the testers can apply.