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Semiconductor devices – Mechanical and climatic test methods – Part 15: Resistance to soldering temperature for through-hole mounted devices

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IEC Central Office
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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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 15: Resistance to soldering temperature for through-hole mounted devices

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International Standard IEC 60749-15 has been prepared by IEC technical committee 47: Semiconductor devices.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

a) inclusion of new Clause 3, Terms and definitions;

b) clarification of the use of a soldering iron for producing the heating effect;

c) inclusion an option to use accelerated ageing.

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

FDIS	Report on voting
47/2630/FDIS	47/2639/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.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60749 series, published 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

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- withdrawn,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

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SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –

Part 15: Resistance to soldering temperature for through-hole mounted devices

1 Scope

This part of IEC 60749 describes a test used to determine whether encapsulated solid state devices used for through-hole mounting can withstand the effects of the temperature to which they are subjected during soldering of their leads by using wave soldering~~ or a soldering iron~~.

In order to establish a standard test procedure for the most reproducible methods, the solder dip method is used because of its more controllable conditions. This procedure determines whether devices are capable of withstanding the soldering temperature encountered in printed wiring board assembly operations, without degrading their electrical characteristics or internal connections.

This test is destructive and may be used for qualification, lot acceptance and as a product monitor.

~~This test is, in general, in conformity with IEC 60068-2-20 but, due to specific requirements of semiconductors, the clauses of this standard apply.~~

~~2 General~~

The heat is conducted through the leads into the device package from solder heat at the reverse side of the board. This procedure does not simulate wave soldering or reflow heat exposure on the same side of the board as the package body.

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 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60749-3, *Semiconductor devices – Mechanical and climatic test methods – Part 3: External visual examination*

IEC 60749-8, *Semiconductor devices – Mechanical and climatic test methods – Part 8: Sealing*

3 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

3.1
colophony
DEPRECATED: rosin
natural resin obtained as the residue after removal of turpentine from the oleo-resin of the pine tree, consisting mainly of abietic acid and related resin acids, the remainder being resin acid esters

Note 1 to entry: "Rosin" is a synonym for colophony, and is deprecated because of the common confusion with the generic term "resin".

3.2
lead-free solder
alloy that does not contain more than 0,1 % lead (Pb) by weight as its constituent and is used for joining components to substrates or for coating surfaces

[SOURCE: IEC 60194:2015, 75.1904, modified – The words "as its constituent" have been added to the definition.]

3.3
resistance to soldering heat
ability of device to withstand the highest temperature of the termination or lead in soldering process, within applicable temperature range of solder alloy

4 Test apparatus

4.1 Solder pot

A solder pot of sufficient size to contain at least 1 kg of solder shall be used. The solder pot dimensions shall allow full immersion of the leads without touching the bottom. The apparatus shall be capable of maintaining the solder at the temperature specified in Table 1.

Table 1 – Parameters for solder dipping

~~Parameter~~		~~Condition A (for wave solder)~~	~~Condition B (for soldering iron)~~
~~Temperature of molten solder~~	~~°C~~	~~260 ± 5~~	~~350 ± 5~~
~~Number of immersions~~		~~≤2~~	~~≤2~~
~~Immersion rate~~	~~mm s^{-1}~~	~~25 ± 5~~	~~25 ± 5~~
~~Dwell time~~	~~s~~	~~10 ± 5~~	~~10 ± 5~~
~~Emersion rate~~	~~mm s^{-1}~~	~~25 ± 5~~	~~25 ± 5~~
~~Distance between solder bath and device body~~	~~mm~~	~~1,5 ± 0,5~~	~~1,5 ± 0,5~~

Parameter		SnPb solder	Pb-free solder
Temperature of molten solder	°C	260 ± 5	270 ± 5
Number of immersions		≤ 2	≤ 2
Immersion rate	mm s^{-1}	25 ± 6	25 ± 6
Dwell time	s	10^{+2}_{0}	7^{+2}_{0}
Emersion rate	mm s^{-1}	25 ± 6	25 ± 6

4.2 Dipping device

A mechanical dipping device shall be used that is capable of controlling the rates of immersion and emersion of the leads and providing the dwell time as specified in Table 1.

4.3 Heatsinks or shielding

If applicable, heatsinks or shielding shall be attached to the devices prior to the test and shall be as specified in the relevant specification.

5 Materials

5.1 Solder

The solder specification shall be as follows.

Chemical composition:

- for SnPb solder, the composition in percentage by weight shall be as follows:
  ~~Tin: 59 % to 65 %;~~
  ~~Lead: the remainder.~~
  Sn60Pb40 or Sn63Pb37 (Sn ± 1 %) chemical composition
- for Pb-free solder, the composition in percentage by weight shall be as follows:
  Silver: 3 % to 4 %;
  Copper: 0,5 % to 1 %;
  Tin: the remainder.

The solder shall not contain impurities which will adversely affect its properties.

Other solders and their applicable bath temperatures may be used as ~~specified~~ detailed in the relevant specification.

5.2 Flux

If flux is applied prior to solder dipping, the flux shall consist of 25 % by weight of colophony in 75 % by weight of isopropyl alcohol, unless otherwise detailed in the relevant specification.

6 Procedure

6.1 Test method

The method used in this procedure requires the specimen to be dipped into a solder bath under specified conditions. The solder bath method is the one which simulates most closely the soldering procedures of flow soldering and similar soldering processes. In circumstances where the solder dip method is considered to impracticable the specimen can be tested by the application of a heated soldering iron under controlled conditions. This is described in IEC 60068-2-20.

6.2 Ageing and pre-conditioning of specimens

If required by the relevant specification, the test conditioning shall be preceded by accelerated ageing such as steam ageing, damp heat conditioning, dry heat conditioning or unsaturated pressurized vapour conditioning. Accelerated ageing shall be performed in accordance with IEC 60068-2-20.

Any other special pre-conditioning of the specimens prior to testing shall be as ~~specified~~ detailed in the relevant specification. This preparation may include operations such as bending or other relocation of leads, and the attachment of heat sinks or protective shielding prior to solder dipping.

6.3 Preparation of the solder bath

The molten solder shall be stirred to assure that the temperature is uniform. The dross shall be skimmed from the surface of the molten solder just prior to dipping the part.

6.4 Use of flux

Where detailed in the relevant specification, all leads of the specimen shall be dipped in flux prior to solder dip; excess flux shall be removed by draining for a suitable time.

6.5 Solder dip

The part shall be attached to the dipping device (see 4.2) and the leads immersed in the molten solder ~~until~~ to within 1 mm of the body of the device under test ~~reaches the dimensions specified in Table 1~~. The parameters for solder temperature, dwell time, number of immersions and rates of immersion and emersion are defined in Table 1. ~~Unless otherwise detailed in the procurement specification, Condition A shall be used.~~ After the dipping process, the part shall be allowed to cool in air and, if flux has been used, residues shall be removed with isopropanol or ethanol.

6.6 Precautions

Prior to and after the solder immersion, precautionary measures shall be taken to prevent undue exposure of the part to the heat radiated by the solder bath.

6.7 Measurements

~~Hermeticity tests for hermetic devices, visual examination and electrical measurements that consist of parametric and functional tests, shall be made as specified in the relevant specification.~~

Hermeticity tests for hermetic devices and visual examination shall be made in accordance with IEC 60749-8 and IEC 60749-3 respectively. Electrical measurements that consist of parametric and functional tests shall be made as required by the relevant specification.

6.8 Failure criteria

A device shall be defined as a failure if hermeticity for hermetic devices cannot be demonstrated in accordance with IEC 60749-8~~, if parametric limits are exceeded or if functionality cannot be demonstrated under nominal and worst-case conditions specified in the relevant specification~~. Mechanical damage such as cracking, chipping or breaking of the package (~~10× – 20× magnification~~ to be inspected with a magnification of 10× to 20×) and failure to meet the requirements of IEC 60749-3 will also be considered a failure, provided such damage was not induced by fixturing or handling. Devices shall be classified as failures if parametric limits are exceeded or if functionality cannot be demonstrated under nominal and worst-case conditions specified in the relevant specification.

7 Summary

The following details shall be specified in the relevant specification:

a) use of heatsinks or shielding, if applicable (see 4.3);

b) flux composition, if applicable (see 5.2);

c) solder composition, if other than detailed in this document (see 5.1);

d) pre-conditioning of specimens, if applicable (see 6.2);

e) time of immersion and number of immersions, if other than as specified in Table 1;

f) ~~condition (A or B), time and~~ depth of immersion if other than ~~as~~ specified in ~~Table 1~~ 6.5;

~~f) method of hermeticity tests, visual examination and electrical measurements (see 5.6);~~

g) failure criteria of ~~hermeticity tests, visual examination and~~ electrical measurements (see 6.8);

h) sample size.