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Semiconductor devices –
Mechanical and climatic test methods –

Part 21:
Solderability

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60749-21 has been prepared by IEC technical committee 47: Semiconductor devices.

This standard cancels and replaces IEC/PAS 62173 published in 2000. This first edition constitutes a technical revision.

This part of IEC 60749 series completes the full revision of IEC 60749 (1996).

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

FDIS	Report on voting
47/1741/FDIS	47/1749/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.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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- withdrawn;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

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 21: Solderability

1 Scope

This part of IEC 60749 establishes a standard procedure for determining the solderability of device package terminations that are intended to be joined to another surface using tin-lead (SnPb) or lead-free (Pb-free) solder for the attachment.

This test method provides a procedure for 'dip and look' solderability testing of through hole, axial and surface mount devices (SMDs) as well as an optional procedure for a board mounting solderability test for SMDs for the purpose of allowing simulation of the soldering process to be used in the device application. The test method also provides optional conditions for ageing.

This test is considered destructive unless otherwise detailed in the relevant specification.

NOTE 1 This test method is in general accord with IEC 60068, but due to specific requirements of semiconductors, the following text is applied.

NOTE 2 This test method does not assess the effect of thermal stresses which may occur during the soldering process. Reference should be made IEC 60749-15 or IEC 60749-20.

NOTE 3 This mechanical and climatic test method as it relates to solderability, is a complete rewrite of the test contained in Subclause 2.1 of Chapter 2 of IEC 60749 (1996).

2 Test apparatus

This test method requires the following equipment.

2.1 Solder bath

The solder bath shall be not less than 40 mm in depth and not less than 300 ml in volume such that it can contain at least 1 kg of solder. The apparatus shall be capable of maintaining the solder at the specified temperature within ±5 °C.

2.2 Dipping device

A mechanical dipping device capable of controlling the rates of immersion and emersion of the terminations and providing a dwell time (time of total immersion to the required depth) in the solder bath as specified shall be used.

2.3 Optical equipment

An optical microscope capable of providing magnification inspection from 10× to 20× shall be used.

2.4 Steam ageing equipment

A non-corrodible container and cover of sufficient size to allow the placement of specimens inside the vessel shall be used. The specimens shall be placed such that the lowest portion of the specimen is a minimum of 40 mm above the surface of the water. A suitable method of supporting the specimens shall be improvised using non-contaminating material.

NOTE During steam ageing, the test devices should be located in a manner so as to prevent water (steam condensate) from dripping on them.

2.5 Lighting equipment

A lighting system shall be used that will provide a uniform, non-glare, non-directional illumination of the specimen.

2.6 Materials

2.6.1 Flux

Unless otherwise detailed in the relevant specification, the flux shall consist of 25 % by weight colophony in 75 % by weight of a 99,5 % (min.) by weight 2-propanol (issopropanol) solvent. The specific gravity of the flux shall be maintained within the range of 0,838 to 0,913 at 25 °C. The specification shall be as follows:

Colophony

Colour	To WW colour specification or paler
Acid value (mg KOH/g colophony)	155 (minimum)
Softening point (ball and ring)	70 °C (minimum)
Flow point (Ubbelohde)	76 °C (minimum)
Ash	0,05 % (maximum).
Solubility	A solution of the colophony in an equal part by weight of 2-propanol (isopropanol) shall be clear, and after a week at room temperature there shall be no sign of a deposit.

2-propanol (isopropanol)

Purity	Minimum 99,5 % 2-propanol (isopropanol) by weight
Acidity as acetic acid	Maximum 0,002 % weight (other than carbon dioxide)
Non-volatile matter	Maximum 2 mg per 100 ml.

2.6.2 Solder

2.6.2.1 Tin-lead

Unless otherwise detailed in the relevant specification, the solder specification for SnPb shall be as follows:

Chemical composition

The composition in percentage by weight shall be as follows:

Tin	59 % to 61 %
Antimony	0,5 % maximum
Copper	0,1 % maximum
Arsenic	0,05 % maximum
Iron	0,02 % maximum
Lead	the remainder.

The solder shall not contain such impurities as aluminium, zinc or cadmium in amounts which will adversely affect the properties of the solder.

Melting temperature range

The melting temperature range of the 60 % solder is as follows:

Completely solid	183 °C
Completely liquid	188 °C.

2.6.2.2 Lead-free

Unless otherwise detailed in the relevant specification, the solder specification for Pb-free shall be as follows:

The composition in percentage by weight shall be as follows:

Tin	95 % to 96,5 %
Silver	3 % to 4 %
Copper	0,5 % to 1 %.

2.7 SMD reflow equipment

2.7.1 Stencil or screen

A stencil or screen with pad geometry opening that is appropriate for the terminals being tested. Unless otherwise agreed upon between vendor and user, nominal stencil thickness should be 0,1 mm for terminals with less than 0,5 mm component lead pitch, 0,15 mm for a component with lead pitch of 0,5 mm to 0,65 mm and 0,2 mm for a component with lead pitch greater than 0,65 mm.

2.7.2 Rubber squeegee or metal spatula

Solder paste shall be applied on to the stencil or screen using a spatula for fine pitch or a squeegee for standard pitch.

2.7.3 Test substrate

SMD specimens for simulated board mounting reflow solderability testing shall be evaluated using a substrate.

NOTE 1 A ceramic (alumina 90 % – 98 %) may be used for all reflow requirements.

NOTE 2 A glass epoxy substrate may be used for all reflow requirements. The glass epoxy substrate should be capable of withstanding the soldering temperature (e.g. it is not suitable for hot plate soldering).

NOTE 3 For visual inspection of the tested device terminations, the test substrate should be unmetallized (no lands).

2.7.4 Solder paste

Unless otherwise specified, the composition of the solder paste shall be as follows:

2.7.4.1 Pb-containing paste

The solder composition shall be as specified in 2.6.2.

Unless otherwise specified in the relevant specification, the particle size of the solder powder shall be 20 µm to 45 µm.

The composition of the flux shall be as specified in 2.6.1.

The viscosity range of the solder paste and method of measurement shall be detailed in the relevant specification.

2.7.4.2 Pb-free paste

The solder composition shall be as specified in 2.6.2.

The solder powder size shall be as follows:

- less than 1 %, larger than 53 µm;
- at least 90 %, between 22-53 µm;
- less than 10 %, smaller than 22 µm.

The shape of solder powder shall be spherical.

The flux to be used shall consist of 30 wt % of polymerization rosin (softening point, approximately 95 °C), 30 wt % of dibasic acid degeneration rosin (softening point, approximately 140 °C), 34,7 wt % of diethylene glycol monobutyl ether, 0,9 wt % of 1,3-diphenylguanidine-HBr, 0,5 wt % of adipic acid (chlorine content less than 0,1 wt %) and 4 wt % of stiffening castor oil.

The solder paste to be used shall consist of 88 wt % of solder powder and 12 wt % of flux. The viscosity range shall be (180 ± 5) Pa s.

NOTE Paste storage and shelf life should be in accordance with manufacturer's specifications.

2.7.5 Reflow equipment

Convection reflow ovens (preferred) or infrared reflow ovens capable of reaching the reflow temperature profile of the paste may be used.

2.7.6 Flux removal solvent

Material used for cleaning flux from leads and terminations shall be capable of removing visible flux residues and meet local environmental regulations.

3 Procedure

3.1 Preconditioning

Preconditioning, also known as accelerated ageing, is an optional step which may be required before solderability testing.

3.1.1 Preconditioning by steam ageing

Steam age preconditioning options are given in Table 1.

Table 1 – Steam ageing conditions

Condition	Exposure time h ± 0,5
A	1
B	4
C	8
D	16

NOTE 1 Ageing may be interrupted once for 10 min maximum.

NOTE 2 PRECAUTION: Mounting should be such that water does not collect on the surface to be tested.

NOTE 3 Unless otherwise stated in the relevant specification, steam age precondition B should be used.