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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Environmental testing –
Part 2-20: Tests – ~~Test T~~ Tests Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60068-2-20:2008. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60068-2-20 has been prepared by IEC technical committee 91: Electronics assembly technology. It is an International Standard.

This sixth edition cancels and replaces the fifth edition published in 2008. This sixth edition constitutes a technical revision.

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

a) update of and clarification of pre-conditioning (former "aging") and its relation to natural aging.

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

Draft	Report on voting
91/1701/FDIS	91/1711/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 in the IEC 60068 series, under the general title *Environmental testing*, 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- withdrawn,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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ENVIRONMENTAL TESTING –

Part 2-20: Tests – ~~Test T~~ Tests Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads

1 Scope ~~and object~~

This part of IEC 60068 outlines ~~Test T~~ Tests Ta and Tb, applicable to devices with leads and leads themselves. Soldering tests for surface mounting devices (SMD) are described in IEC 60068-2-58.

This document provides procedures for determining the solderability and resistance to soldering heat of devices in applications using solder alloys, which are eutectic or near eutectic tin lead (Pb), or lead-free alloys.

The procedures in this document include the solder bath method and soldering iron method.

The objective of this document is to ensure that component lead or termination solderability meets the applicable solder joint requirements of IEC 61191-3 and IEC 61191-4. In addition, test methods are provided to ensure that the component body can ~~resist against~~ be resistant to the heat load to which it is exposed during soldering.

NOTE Information about wetting time and wetting force can be obtained by test methods using a wetting balance. ~~See IEC 60068-2-54 (solder bath method) and~~ IEC 60068-2-69 (solder bath and solder globule method ~~for SMDs~~) can be consulted.

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

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-66, *Environmental testing – Part 2: Test methods – Test Cx: Damp heat, steady state (unsaturated pressurized vapour)*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 61191-3, *Printed board assemblies – Part 3: Sectional specification – Requirements for through-hole mount soldered assemblies*

IEC 61191-4, *Printed board assemblies – Part 4: Sectional specification – Requirements for terminal soldered assemblies*

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
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
contact angle
in general, the angle enclosed between two planes, tangent to a liquid surface and a solid/liquid interface at their intersection (see Figure 1); in particular, the contact angle of liquid solder in contact with a solid metal surface

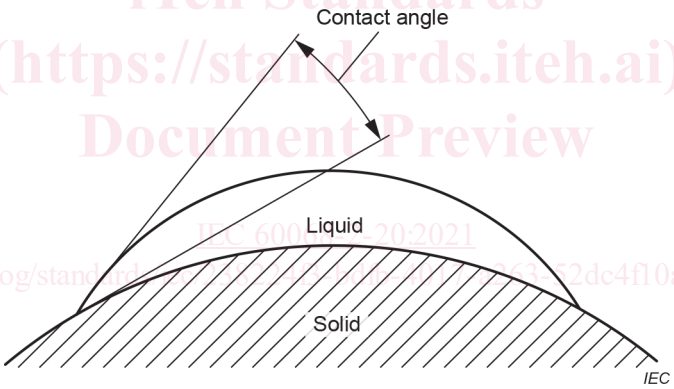

Figure 1 – Diagram of contact angle

3.3
wetting
formation of an adherent coating of solder on a surface

Note 1 to entry: A small contact angle is indicative of wetting.

3.4
non-wetting
inability to form an adherent coating of solder on a surface

Note 1 to entry: In this case the contact angle is greater than 90°.

3.5
de-wetting
retraction of molten solder on a solid area that it has initially wetted

Note 1 to entry: In some cases, an extremely thin film of solder may remain. As the solder retracts the contact angle increases.

3.6
solderability
ability of the lead, termination or ~~lead of device~~ electrode of a component to be wetted by solder at the temperature of the termination or ~~lead~~ electrode, which is assumed to be the lowest temperature in the soldering process within ~~solderable~~ the applicable temperature range of the solder alloy

3.7
soldering time
time required for a defined surface area to be wetted under specific conditions

3.8
resistance to soldering heat
ability of ~~device~~ the component to withstand the highest temperature ~~of the termination or lead~~ stress in terms of temperature gradient, peak temperature and duration of the soldering process, where the temperature of the component body is within the applicable temperature range of the solder alloy

3.9
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

~~[75.1904 of IEC 60194]~~

[SOURCE: IEC 60194-2:2017, 3.12.5, modified – The words "as its constituent" have been added.]

4 Test Ta: Solderability of wire and tag terminations

4.1 Objective and general description of the test

4.1.1 Test methods

Test Ta provides two different test methods to determine the solderability of areas on wire and tag terminations that are required to be wetted by solder during the assembly operation.

– Method 1: solder bath;
– Method 2: soldering iron.

The test method to be used shall be indicated in the relevant specification. The solder bath method is the one which most closely simulates the soldering procedures of flow soldering and similar soldering processes.

The soldering iron method may be used in cases where Method 1 is impracticable.

~~If required by the relevant specification, the test conditioning may be preceded by accelerated ageing. The following are recommended conditions:~~

If required by the relevant specification, the test specimen shall be preconditioned according to 4.1.4. The following are typical methods for preconditioning:

~~Ageing~~ Type 1a: 1 h steam ~~ageing~~
~~Ageing~~ Type 1b: 4 h steam ~~ageing~~
~~Ageing~~ Type 2: 10 days damp heat, steady state condition (40 ± 2) °C; (93 ± 3) % RH (Test Cab)
~~Ageing~~ Type 3a: 4 h at 155 °C dry heat (Test Bb)

~~Ageing~~ Type 3b: 16 h at 155 °C dry heat (Test Bb).

~~Ageing~~ Type 4: 4 h unsaturated pressurized vapour (Test Cx)

~~NOTE The test specimens may be introduced into the chamber at any temperature from laboratory temperature to the specified temperature.~~

NOTE 1 In general, the acceleration for ageing prior to solderability testing is estimated by simulating the degradation in storage environment. However, the steam ageing condition does not correspond with storage conditions because the failure mode derived from steam ageing is clearly different from that derived from storage conditions. Therefore, an accelerated correlation between steam ageing and natural ageing in storage condition is impossible and steam ageing conditions such as type 1a and type 1b are inappropriate as accelerated ageing.

NOTE 2 For Ni/Au surface, Type 2 or Type 4 is appropriate as preconditioning.

4.1.2 Specimen preparation

The surface to be tested shall be in the "as received" condition and shall not be subsequently touched by the fingers or otherwise contaminated.

The specimen shall not be cleaned prior to the application of a solderability test. If required by the relevant specification, the specimen may be degreased by immersion in a neutral organic solvent at room temperature.

4.1.3 Initial measurements

The specimens shall be visually examined and, if required by the relevant specification, electrically and mechanically checked.

4.1.4 ~~Accelerated ageing~~ Preconditioning

4.1.4.1 General

If ~~accelerated ageing~~ preconditioning is required by the relevant specification, one of the following procedures ~~shall~~ may be adopted. At the end of the conditioning, the specimen shall be subjected to standard atmospheric conditions for testing for not less than 2 h and not more than 24 h.

~~NOTE~~ Terminations may be detached if the ~~ageing~~ conditioning temperature is higher than the component's maximum operating or storage temperature, or if the component is likely to degrade considerably at 100 °C in steam and thus affect the solderability in a manner which would not normally occur in natural ageing.

4.1.4.2 ~~Ageing~~ Type 1

The relevant specification shall indicate whether ~~ageing~~ type 1a (1 h in steam) or ~~ageing~~ type 1b (4 h in steam) is to be used. For these procedures the specimen is suspended, preferably with the termination vertical, with the area to be tested positioned 25 mm to 30 mm above the surface of boiling distilled water which is contained in a borosilicate glass or stainless steel vessel of suitable size (e.g., a 2 liter beaker). The termination shall be ~~not less than~~ at least 10 mm from the walls of the vessel.

The vessel shall be provided with a cover of similar material, consisting of one or more plates which are capable of covering approximately seven-eighths of the opening. A suitable method of suspending the specimens shall be devised; perforations or slots in the cover are permitted for this purpose. The specimen holder shall be non-metallic.

The level of water shall be maintained by the addition of hot distilled water, added gradually in small quantities, so that the water will continue to boil vigorously; alternatively a reflux condenser may be ~~provided~~ used if desired. (See Figure A.1).

NOTE There are many problems for steam conditioning. For example, dew always condenses on the terminations and liquid water directly drops onto specimens in some cases.

4.1.4.3 ~~Ageing~~ Type 2

Specimens are subjected to 10 days damp heat, steady state, according to IEC 60068-2-78, Test Cab: Damp heat, steady state.

4.1.4.4 ~~Ageing~~ Type 3

Specimens are subjected to 4 h (~~Ageing~~ Type 3a) or 16 h (~~Ageing~~ Type 3b) dry heat at 155 °C according to IEC 60068-2-2, Test B: Dry heat.

The test specimens may be introduced into the chamber at any temperature from laboratory ambient to the specified temperature.

4.1.4.5 ~~Ageing~~ Type 4

Specimens are subjected to 4 h at 120 °C and 85 % RH according to IEC 60068-2-66, Test Cx: Damp heat, steady state (unsaturated pressurized vapour).

4.2 Method 1: Solder bath

4.2.1 General

This method provides a procedure for assessing the solderability of wires, tags, and terminations of irregular form.

4.2.2 Description of the solder bath

The solder bath shall be of adequate dimensions to accommodate the specimens and contain sufficient solder to maintain the solder temperature during testing, and to prevent exceeding the contamination levels applicable to the type of solder used for testing. If not otherwise defined by the relevant specification, the solder bath shall be not less than 40 mm in depth and not less than 300 ml in volume. The bath shall contain solder as specified in Table 1.

NOTE 1 When the specimens are of a small size and heat capacity, a solder bath with dimensions less than described above can be appropriate.

NOTE 2 Clause A.2 of IEC 60068-2-69:2017 can be consulted as an example of the solder bath corresponding to NOTE 1.

4.2.3 Flux

~~The flux to be used shall consist of 25 % by weight of colophony in 75 % by weight of 2-propanol (isopropanol) or of ethyl alcohol, as specified in Annex B.~~

~~When non-activated flux is inappropriate, the above flux with the addition of diethylammonium chloride (analytical reagent grade), up to an amount of 0,2 % chloride (expressed as free chlorine based on the colophony content), may be used as required by the relevant specification.~~

A colophony based flux as described in Annex B shall be used. The flux shall be non-activated (see Table B.1).

If non-activated flux is inappropriate, the relevant specification may require the use of a low activated flux (see Table B.1).

4.2.4 Procedure

The dross on the surface of the molten solder shall be ~~wiped clean and bright~~ removed with a piece of suitable thermally resistant material, immediately before each test, to ensure a clean and bright surface.

The termination to be tested shall be immersed first in the flux (described in 4.2.3) at ~~laboratory~~ ambient temperature, and excess flux shall be eliminated either by draining off for a suitable time, or by using any other procedure likely to produce a similar result. In case of dispute, drainage shall be carried out for (60 ± 5) s.

NOTE It sometimes happen that excessive remaining flux ~~may~~ boil when coming into contact with the liquid solder and gas bubbles ~~may~~ stick to the surface of terminations and prevent wetting of the termination in ~~the respective area~~ such areas.

The termination is then immersed immediately in the solder bath in the direction of its longitudinal axis. The point of immersion of the termination shall be at a distance not less than 10 mm from the walls of the bath.

The speed of immersion shall be ~~(25 ± 2,5) mm/s~~ determined at 25 mm/s or less. and the termination shall remain immersed for the time selected from Table 1 with the body of the component at the distance above the solder prescribed in the relevant specification. The specimen shall then be withdrawn at (25 ± 2,5) mm/s.

For components having a high thermal capacity, an immersion time of (5,0 ± 0,5) s or (10 ± 1) s may be selected from Table 1.

If required by the relevant specification, a screen of thermally insulating material of (1,5 ± 0,5) mm thickness with clearance holes appropriate to the size of the termination, may be placed between the body of the component and solder.

Any flux residues shall be removed with 2-propanol (~~isopropanol~~ isopropyl alcohol) or ethanol (ethyl alcohol) after testing.

4.2.5 Test conditions

The duration and temperature of immersion shall be selected from Table 1, unless otherwise prescribed by the relevant specification.

Table 1 – Solderability, solder bath method: Test severities (duration and temperature)

Alloy composition	Severity					
	(215 ± 3) °C (3 ± 0,3) s	(10 ± 1) s	(235 ± 3) °C (2 ± 0,2) s	(5 ± 0,5) s	(245 ± 3) °C (3 ± 0,3) s	(250± 3) °C (3 ± 0,3) s
SnPb	X	X	X	X		
Sn96,5Ag3Cu,5					X	
Sn99,3Cu,7						X

~~Alloy composition for test purposes only. The solder alloys consist of 3,0 wt % to 4,0 wt % Ag, 0,5 wt % to 1,0 wt % Cu, and the remainder of Sn may be used instead of Sn96,5Ag3Cu,5. The solder alloys consist of 0,45 wt % to 0,9 wt % Cu and the remainder of Sn may be used instead of Sn99,3Cu,7.~~

The alloy compositions are given for test reference purposes only.

SnPb: The solder alloys consisting of a mass fraction of 37 % or 40 % Pb, and the remainder of Sn may be used;
Sn96,5Ag3Cu,5: The solder alloys consisting of a mass fraction of 3,0 % to 4,0 % Ag, 0,5 % to 1,0 % Cu, and the remainder of Sn may be used;
Sn99,3Cu,7: The solder alloys consisting of a mass fraction of 0,45 % to 0,9 % Cu and the remainder of Sn may be used.

The basic lead-free solder alloys listed in this table represent compositions that are currently preferred for lead-free soldering processes. If solder alloys other than those listed here are used, it needs to be verified that the given severities are applicable.

~~NOTE 1 "X" denotes 'applicable'.~~

~~NOTE 2 Refer to 4.1 of IEC 61190-1-3 to identify alloy composition.~~

~~NOTE 3 The basic lead-free solder alloys listed in this table represent compositions that are currently preferred for lead-free soldering processes. If solder alloys other than those listed here are used, it has to be verified that the given severities are applicable.~~

NOTE 1 "X" denotes 'applicable'.

NOTE 2 Annex B of IEC 61190-1-3:2017 can be consulted to identify alloy compositions.

4.2.6 Final measurements and requirements

~~Inspection shall be carried out under adequate light with normal eyesight or with the assistance of a magnifier capable of giving a magnification of 4 x to 25 x, depending on the size of objects.~~

The visual inspection shall be carried out under adequate light with a binocular microscope of magnification in a range of 4x to 100x.

The specimens shall be visually examined and, if required by the relevant specification, electrically and mechanically checked.

The dipped surface relevant for soldering shall be covered with solder coating with no more than small amounts of scattered imperfections such as pin-holes or un-wetted or de-wetted areas. All leads shall exhibit a continuous solder coating free from defects for a minimum of 95 % of the critical area of any individual lead. For solder alloys containing lead (Pb), solder shall be smooth and bright.

4.3 Method 2: Soldering iron at 350 °C

4.3.1 General

This method provides a procedure for assessing the solderability of terminations in cases where the solder bath method is impracticable. It applies to lead containing and lead-free solder alloys.