IEC 60068-2-20

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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

IEC 60068-2-20:2021-03 RLV(en)

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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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ENVIRONMENTAL TESTING –

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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.

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- reconfirmed,
- withdrawn,
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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*

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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

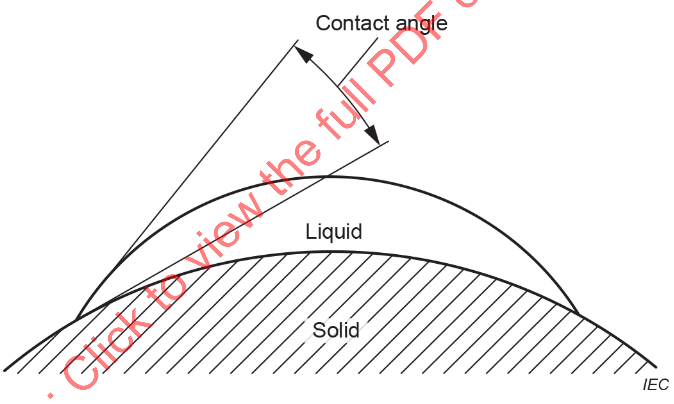

Figure 1 – Diagram of contact angle

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.

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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)

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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.

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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.

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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.

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

Alloy composition	Severity					
	(215 ± 3) °C (3 ± 0,3) s	(215 ± 3) °C (10 ± 1) s	(235 ± 3) °C (2 ± 0,2) s	(235 ± 3) °C (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.

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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.

4.3.2 Description of soldering iron

To keep the ~~bit~~ tip temperature during test within the specified limits, usage of a temperature controlled soldering iron is recommended.

Size A

- ~~Bit~~ Tip temperature: (350 ± 10) °C
- ~~Bit~~ Tip diameter: 8 mm
- Exposed length: 32 mm reduced to a wedge shape over a length of approximately 10 mm.

Size B

- ~~Bit~~ Tip temperature: (350 ± 10) °C
- ~~Bit~~ Tip diameter: 3 mm
- Exposed length: 12 mm reduced to a wedge shape over a length of approximately 5 mm.

The ~~bit~~ tip shall be made of copper, preferably plated with iron, or of an erosion-resistant copper alloy, in accordance with usual practice, and tinned ~~at~~ on the ~~test~~ surface in contact with the test termination.

4.3.3 Solder and flux

A cored solder wire shall be used comprising of solder as specified in Table 1, with a core or cores containing 2,5 % to 3,5 % colophony as specified in Clause B.1. A visual check shall be made during the test for the presence of flux.

4.3.4 Procedure

According to the type of component, a soldering iron with a tip of either Size A or Size B shall be used as ~~prescribed~~ required in the relevant specification.

The nominal diameter of the cored solder wire to be used with Size A soldering iron tip is 1,2 mm and 0,8 mm with Size B soldering iron tip.

The termination shall be positioned horizontally so that the soldering iron can be applied to the test surface as shown in Figure 2.

If mechanical support for the terminations is required while performing this test, such support shall be of thermally insulating material.

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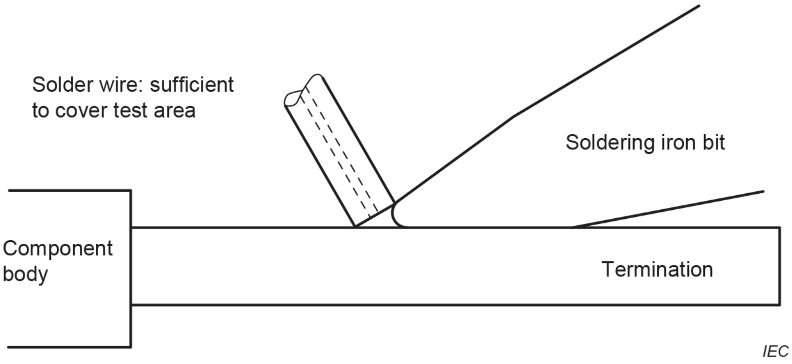

Figure 2 – Position of soldering iron

When testing heat-sensitive components, the relevant specification shall specify the distance of the test area from the component body, or it shall specify the use of a specific heat sink.

The relevant specification may specify different conditions where the geometry of the terminations renders the above procedure impracticable.

Surplus solder that has remained on the test surface of the iron from a previous test shall be ~~wiped off~~ removed prior to the test.

The iron and the solder shall, unless otherwise specified, be applied to the termination for 2 s to 3 s at the position stated in the relevant specification. During this period of time, the iron shall be kept stationary.

If the relevant specification requires that several terminations of the component shall be tested, an interval in the order of 5 s to 10 s shall be observed between the applications to the different terminations of the component, to avoid ~~it being overheated~~ overheating.

Any flux residue shall be removed from the terminations with 2-propanol (~~isopropanol~~ isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

4.3.5 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 solder shall have wetted the test area and there shall be no droplets.

4.4 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable.

	Subclause
a) Whether degreasing is required	4.1.2
b) Initial measurements	4.1.3
c) ~~Ageing~~ Preconditioning method (if required)	4.1.4

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d)	Test method	4.2 or 4.3
e)	Whether activated flux shall be used	4.2.3
f)	Immersion depth, temperature and duration	4.2.4, 4.2.5
g)	Whether a thermal screen is to be used	4.2.4
h)	Size of soldering iron tip (A or B)	4.3.2
i)	Distance of test area from component body or use of a heat sink	4.3.4
j)	Different test conditions, if required by geometry of termination	4.3.4
k)	Position of the soldering iron	4.3.4
l)	Application time of soldering iron, if not 2 s to 3 s	4.3.4
m)	Number of terminations to be tested	4.3.4
n)	Final measurements and requirements	4.2.6, 4.3.5
o)	Type of solder alloy	Table 1, 4.3.3

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5 Test Tb: Resistance to soldering heat

5.1 Objective and general description of the test

5.1.1 Test methods

Test Tb provides two different methods to determine the ability of a specimen to withstand the heating stresses produced by soldering.

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

Method 1 is identical to Test Ta, Method 1, but with different immersion times and temperatures.

Method 2 is identical to Test Ta, Method 2, but with the iron applied to the test surface for 10 s.

5.1.2 Initial measurements

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

5.2 Method 1: Solder bath

5.2.1 Description of the solder bath

~~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 2.~~

As required in 4.2.2.

The bath shall contain solder as specified in Table 2.

5.2.2 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 0,5 % chloride (expressed as free~~

~~chlorine based on the colophony content), may be used as required by the relevant specification.~~

~~When the test forms part of a test sequence and is applied prior to a humidity test, a non-activated flux comprising 25 % by weight of colophony in 75 % by weight 2-propanol (isopropanol) or ethyl alcohol shall be used. In this case, the test shall be made on specimens which have a surface which has satisfactorily passed the solderability Test Ta, Method 1, within the previous 72 h period.~~

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

When the test forms part of a test sequence and is applied prior to a humidity test, a non-activated flux (see Table B.1) shall be used. In this case, the test shall be made on specimens taken from a lot that has satisfactorily passed the solderability Test Ta, Method 1, within the previous 72 h period.

For the test resistance to soldering heat, highly activated flux is required to simulate the worst case of heat transfer into the component body (highest wetting speed). But, if the intent is to subject the test specimen, after the 'resistance to soldering heat' test, to a humidity environment the highly activated flux may lead to corrosion effects. To avoid such unintended effects or failures in this scenario, it is permitted to use non-activated flux for the "resistance to soldering heat" test, provided sufficient wettability of the specimen is proven. This could be achieved, for example, by taking test specimens from the same lot that have already satisfactorily passed the solderability test. Under that condition, a comparable wetting speed can be assumed.

5.2.3 Procedure

The dross on the surface of the molten solder shall be ~~wiped clean and bright by wiping~~ 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 5.2.2 at ~~laboratory~~ ambient temperature, and then 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.

Immersion of the termination to within 2,0 mm to 2,5 mm from the component body or seating plane, unless otherwise specified in the relevant specification, shall be completed in a time not exceeding 1 s.

The termination shall remain immersed to the specified depth for one of the durations given in Table 2, or as ~~prescribed~~ required in the relevant specification.

Any flux residues shall be removed from the terminations with 2-propanol (isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

5.2.4 Test conditions

The duration and temperature of immersion shall be selected from Table 2, unless otherwise ~~prescribed~~ required by the relevant specification.

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Table 2 – Resistance to soldering heat, solder bath method: Test severities (duration and temperature)

Alloy composition	Severity		
	(235 ± 3) °C (10 ± 1) s	(260 ± 3) °C (5 ± 0,5) s	(260 ± 3) °C (10 ± 1) s
SnPb	X	X[b]	X[c]
Lead-free alloy [a]		X[b]	X[c]

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

~~NOTE 2~~ Certain soldering methods may require higher severity of (270 ± 3) °C for (5 ± 0,5) s or the more severe condition of (10 ± 1) s. Such conditions should be provided by the ~~detail~~ relevant specification as agreed between the trading partners.

~~NOTE 3~~ Care should be taken, that heat / moisture sensitive devices are handled according to the instructions of the supplier.

[a] Any alloys may be used, provided they are completely liquid at the required temperature.

[b] The shorter immersion time of 5 s is mainly intended for heat-sensitive components to be mounted on printed circuits. A warning should be given to the user that such components should be soldered to the printed circuit board in less than 4 s.

[c] This test severity is also used for the de-wetting test. As an optional test condition (260 ± 5) °C for (30 ± 3) s ~~is~~ may also be used.

Unless otherwise ~~prescribed~~ required in 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, shall be placed between the body of the component and the molten solder.

When the relevant specification ~~prescribes~~ requires the use of a heat sink during this test, it shall give full details of the size and type of heat sink to be used, which should be related to the method used for production soldering.

5.2.5 De-wetting

The relevant specification shall prescribe whether this test is required.

A total immersion of 10 s is required because de-wetting can occur slowly; this immersion shall be divided into two periods of 5 s each in order that any rapid de-wetting is not masked by any subsequent re-wetting.

5.3 Method 2: Soldering iron

5.3.1 Description of soldering iron

As ~~prescribed~~ required in 4.3.2.

The relevant specification shall state whether iron tip A or iron tip B is to be used.

5.3.2 Solder and flux

As ~~prescribed~~ required in 4.3.3.

5.3.3 Procedure

As ~~prescribed~~ required in 4.3.4 (Method 2, with the soldering iron of Test Ta), but with the iron applied to the test surface of the termination for one of the following temperatures and durations, as prescribed in the relevant specification.

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Temperature: 350 °C or 370 °C

Duration: (5 ± 1) s or (10 ± 1) s

If the relevant specification does not indicate the duration, 10 s shall apply.

~~NOTE~~ In testing certain types of electromechanical and other heat-sensitive components, prolonged heat stress ~~may~~ can provoke non-repairable defects. The usual soldering times used in practice are in the range of 1 s to 2 s; this and the heat sensitivity of the component should be considered when selecting the test duration. Additional precautions (e.g. automatic switching off of the heat source) may be necessary.

For heat-sensitive components, the relevant specification shall specify the distance of the test area from the component body, or shall specify the use of a specific heat sink.

If the relevant specification requires that several terminations of the component shall be tested, an interval in the order of 5 s to 10 s shall be observed between the applications to the different terminations of the component to avoid ~~it being overheated~~ overheating.

Any flux residues shall be removed from the terminations with 2-propanol (isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

5.4 Recovery

The specimen shall remain under standard atmospheric conditions for testing as prescribed in IEC 60068-1 for a period of 30 min, or until thermally stabilized.

NOTE ~~It may occur with~~ For certain components, such as some semiconductors and capacitors, it can happen that the electrical properties ~~are stabilized~~ only stabilize some hours after heat stability is reached.

5.5 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 specimens shall be visually examined and electrically and mechanically checked, including dimensional tolerances, as required by the relevant specification.~~

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.

5.6 De-wetting (if required)

The criteria for wetting described in 4.2.6 shall also apply.

If de-wetting or un-wetted areas occur, this should be noted.

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5.7 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Subclause
a) Initial measurements	5.1.2
b) Test method to be applied	5.2; 5.3
c) Immersion depth, if different from 2,0 mm to 2,5 mm from the component	5.2.3
d) Test severity	5.2.4
e) Whether a thermal screen is to be used or not, and details of a heat sink, if required	5.2.4
f) Whether de-wetting test applies	5.2.5
g) Size (A or B) of soldering iron tip	5.3.1
h) Distance of the test area from the component body or use of a specific heat sink	5.3.3
i) Number of terminations to be tested	5.3.3
j) Temperature and duration of the soldering iron test	5.3.3
k) Type of solder alloy in case de-wetting is tested	Table 2, 5.3.2
l) Final measurements and requirements	5.5, 5.6

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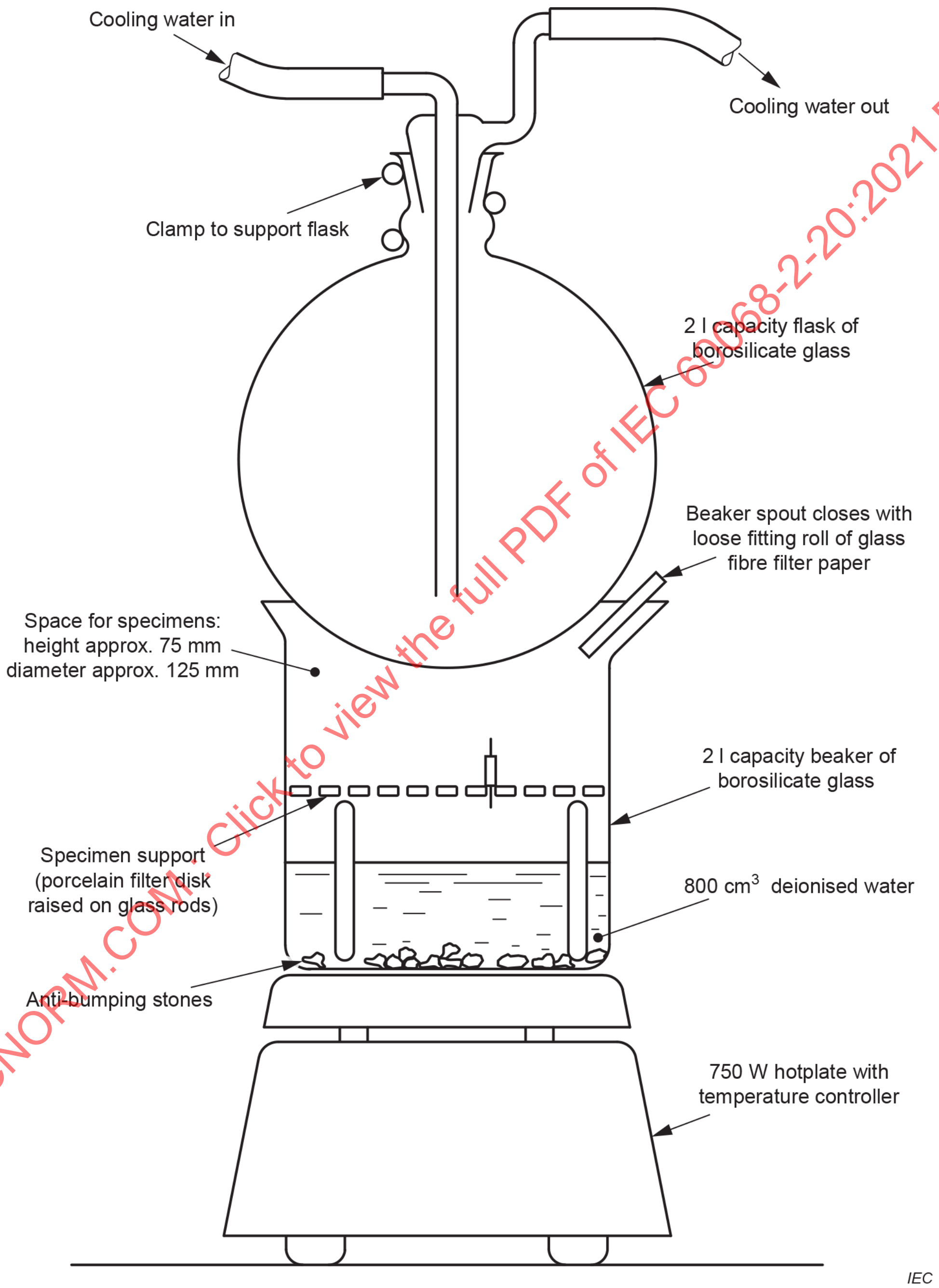
Annex A
(informative)

Example of apparatus for accelerated steam ageing conditioning process



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NOTE Specimens should not be placed under the lowest portion of the cooling flask because of dripping water.

Figure A.1 – Example of apparatus

Annex B
(normative)

Specification for flux constituents

B.1 Colophony

Colour	To WW grade 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~~ isopropyl alcohol) shall be clear, and after a week at room temperature, there shall be no sign of a deposit.

B.2 2-propanol (~~isopropanol~~ isopropyl alcohol)

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

B.3 Ethyl alcohol

Purity	Minimum 96,2 % ethanol (ethyl alcohol) by ~~weight~~ mass
Free acids (other than carbon dioxide)	Maximum 4 mg/l

~~NOTE When an activated flux is called for this may be conveniently made up as follows:~~

~~Colophony~~	~~25 g~~	
~~2-propanol (isopropanol) or Ethyl alcohol~~	~~75 g~~	~~for 0,5 % chloride activation~~
~~Diethylammonium chloride~~	~~0,39 g~~	

B.4 Flux composition

Non-activated and activated flux compositions are described in Table B.1.

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Table B.1 – Colophony based flux compositions

Constituent	Composition by mass fraction %		
	Non-activated	**Low activated**	**High activated**
Colophony	25 ± 0,5	25 ± 0,5	25 ± 0,5
Diethylammonium hydrochloride (CAS No. 660-68-4)	None	0,15 ± 0,01	0,39 ± 0,01
2-propanol (Isopropyl alcohol) (CAS No. 67-63-0) or ethyl alcohol (CAS No. 64-17-5) as an alternative	75 ± 0,5	74,85 ± 0,5	74,61 ± 0,5
Mass of chlorine of solids [a]	0	0,2	0,5

[a] Expressed as free chlorine based on the colophony content.

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Bibliography

~~IEC 60068-2-54, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*~~

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-69:2017, *Environmental testing – Part 2-69: Tests – Test Te/Tc: Solderability testing of electronic components ~~for surface mounting devices (SMD)~~ and printed boards by the wetting balance (force measurement) method*

IEC 60194-2:2017, *Printed board design, manufacture and assembly – Vocabulary – Part 2: Common usage in electronic technologies as well as printed board and electronic assembly technologies*

IEC 61190-1-3:~~2007~~2017, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications*

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

Essais d'environnement –
Partie 2-20: Essais – Essais Ta et Tb: Méthodes d'essai de la brasabilité et de la résistance à la chaleur de brasage des dispositifs à broches

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ENVIRONMENTAL TESTING –

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

1 Scope

This part of IEC 60068 outlines 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 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. IEC 60068-2-69 (solder bath and solder globule method) 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 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.

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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

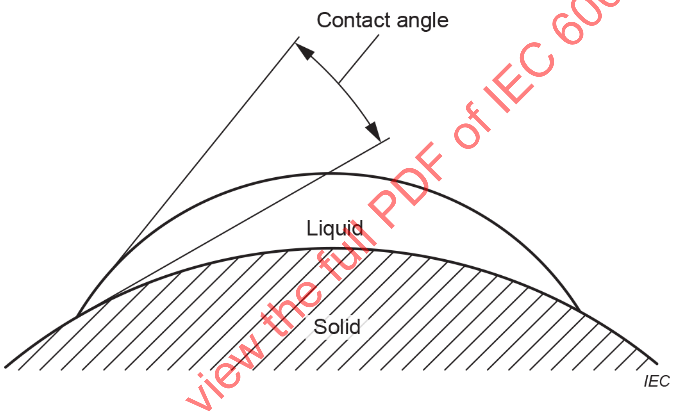

Figure 1 – Diagram of contact angle

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 electrode of a component to be wetted by solder at the temperature of the termination or electrode, which is assumed to be the lowest temperature in the soldering process within the applicable temperature range of the solder alloy

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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 the component to withstand the highest temperature 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

[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 specimen shall be preconditioned according to 4.1.4. The following are typical methods for preconditioning:

Type 1a: 1 h steam
Type 1b: 4 h steam
Type 2: 10 days damp heat, steady state condition (40 ± 2) °C; (93 ± 3) % RH (Test Cab)
Type 3a: 4 h at 155 °C dry heat (Test Bb)
Type 3b: 16 h at 155 °C dry heat (Test Bb).
Type 4: 4 h unsaturated pressurized vapour (Test Cx)

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.

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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 Preconditioning

4.1.4.1 General

If preconditioning is required by the relevant specification, one of the following procedures 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.

Terminations may be detached if the 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 Type 1

The relevant specification shall indicate whether type 1a (1 h in steam) or 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 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 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 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 Type 3

Specimens are subjected to 4 h (Type 3a) or 16 h (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 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).

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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

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 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 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 boil when coming into contact with the liquid solder and gas bubbles stick to the surface of terminations and prevent wetting of the termination in 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 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 (isopropyl alcohol) or ethanol (ethyl alcohol) after testing.

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

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

4.2.6 Final measurements and requirements

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.

4.3.2 Description of soldering iron

To keep the tip temperature during test within the specified limits, usage of a temperature controlled soldering iron is recommended.

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Size A

Tip temperature: (350 ± 10) °C

Tip diameter: 8 mm

Exposed length: 32 mm reduced to a wedge shape over a length of approximately 10 mm.

Size B

Tip temperature: (350 ± 10) °C

Tip diameter: 3 mm

Exposed length: 12 mm reduced to a wedge shape over a length of approximately 5 mm.

The tip shall be made of copper, preferably plated with iron, or of an erosion-resistant copper alloy, in accordance with usual practice, and tinned on the surface in contact with the test termination.

4.3.3 Solder and flux

A cored solder wire shall be used comprising of solder as specified in Table 1, with a core or cores containing 2,5 % to 3,5 % colophony as specified in Clause B.1. A visual check shall be made during the test for the presence of flux.

4.3.4 Procedure

According to the type of component, a soldering iron with a tip of either Size A or Size B shall be used as required in the relevant specification.

The nominal diameter of the cored solder wire to be used with Size A soldering iron tip is 1,2 mm and 0,8 mm with Size B soldering iron tip.

The termination shall be positioned horizontally so that the soldering iron can be applied to the test surface as shown in Figure 2.

If mechanical support for the terminations is required while performing this test, such support shall be of thermally insulating material.

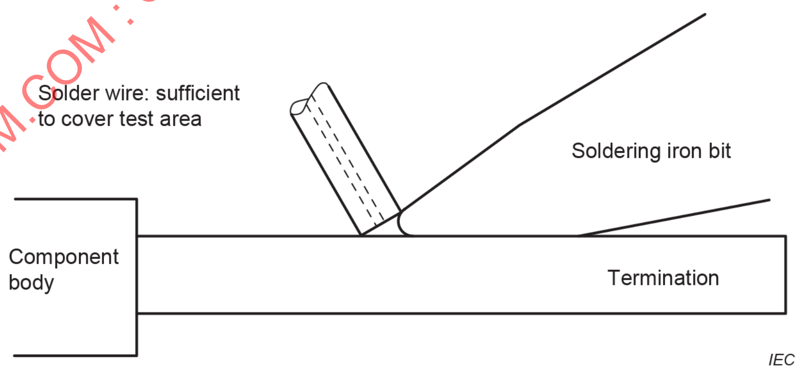

Figure 2 – Position of soldering iron

When testing heat-sensitive components, the relevant specification shall specify the distance of the test area from the component body, or it shall specify the use of a specific heat sink.

The relevant specification may specify different conditions where the geometry of the terminations renders the above procedure impracticable.

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Surplus solder that has remained on the test surface of the iron from a previous test shall be removed prior to the test.

The iron and the solder shall, unless otherwise specified, be applied to the termination for 2 s to 3 s at the position stated in the relevant specification. During this period of time, the iron shall be kept stationary.

If the relevant specification requires that several terminations of the component shall be tested, an interval in the order of 5 s to 10 s shall be observed between the applications to the different terminations of the component, to avoid overheating.

Any flux residue shall be removed from the terminations with 2-propanol (isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

4.3.5 Final measurements and requirements

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 solder shall have wetted the test area and there shall be no droplets.

4.4 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable.

	Subclause
a) Whether degreasing is required	4.1.2
b) Initial measurements	4.1.3
c) Preconditioning method (if required)	4.1.4
d) Test method	4.2 or 4.3
e) Whether activated flux shall be used	4.2.3
f) Immersion depth, temperature and duration	4.2.4, 4.2.5
g) Whether a thermal screen is to be used	4.2.4
h) Size of soldering iron tip (A or B)	4.3.2
i) Distance of test area from component body or use of a heat sink	4.3.4
j) Different test conditions, if required by geometry of termination	4.3.4
k) Position of the soldering iron	4.3.4
l) Application time of soldering iron, if not 2 s to 3 s	4.3.4
m) Number of terminations to be tested	4.3.4
n) Final measurements and requirements	4.2.6, 4.3.5
o) Type of solder alloy	Table 1, 4.3.3

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5 Test Tb: Resistance to soldering heat

5.1 Objective and general description of the test

5.1.1 Test methods

Test Tb provides two different methods to determine the ability of a specimen to withstand the heating stresses produced by soldering.

– Method 1: solder bath;

– Method 2: soldering iron.

Method 1 is identical to Test Ta, Method 1, but with different immersion times and temperatures.

Method 2 is identical to Test Ta, Method 2, but with the iron applied to the test surface for 10 s.

5.1.2 Initial measurements

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

5.2 Method 1: Solder bath

5.2.1 Description of the solder bath

As required in 4.2.2.

The bath shall contain solder as specified in Table 2.

5.2.2 Flux

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

When the test forms part of a test sequence and is applied prior to a humidity test, a non-activated flux (see Table B.1) shall be used. In this case, the test shall be made on specimens taken from a lot that has satisfactorily passed the solderability Test Ta, Method 1, within the previous 72 h period.

For the test resistance to soldering heat, highly activated flux is required to simulate the worst case of heat transfer into the component body (highest wetting speed). But, if the intent is to subject the test specimen, after the 'resistance to soldering heat' test, to a humidity environment the highly activated flux may lead to corrosion effects. To avoid such unintended effects or failures in this scenario, it is permitted to use non-activated flux for the "resistance to soldering heat" test, provided sufficient wettability of the specimen is proven. This could be achieved, for example, by taking test specimens from the same lot that have already satisfactorily passed the solderability test. Under that condition, a comparable wetting speed can be assumed.

5.2.3 Procedure

The dross on the surface of the molten solder shall be 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 5.2.2 at ambient temperature, and then 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.

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Immersion of the termination to within 2,0 mm to 2,5 mm from the component body or seating plane, unless otherwise specified in the relevant specification, shall be completed in a time not exceeding 1 s.

The termination shall remain immersed to the specified depth for one of the durations given in Table 2, or as required in the relevant specification.

Any flux residues shall be removed from the terminations with 2-propanol (isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

5.2.4 Test conditions

The duration and temperature of immersion shall be selected from Table 2, unless otherwise required by the relevant specification.

Table 2 – Resistance to soldering heat, solder bath method: Test severities (duration and temperature)

Alloy composition	Severity		
	(235 ± 3) °C (10 ± 1) s	(260 ± 3) °C (5 ± 0,5) s	(260 ± 3) °C (10 ± 1) s
SnPb	X	X[b]	X[c]
Lead-free alloy [a]		X[b]	X[c]

"X" denotes "applicable".

Certain soldering methods may require higher severity of (270 ± 3) °C for (5 ± 0,5) s or the more severe condition of (10 ± 1) s. Such conditions should be provided by the relevant specification as agreed between the trading partners.

Care should be taken, that heat / moisture sensitive devices are handled according to the instructions of the supplier.

[a] Any alloys may be used, provided they are completely liquid at the required temperature.

[b] The shorter immersion time of 5 s is mainly intended for heat-sensitive components to be mounted on printed circuits. A warning should be given to the user that such components should be soldered to the printed circuit board in less than 4 s.

[c] This test severity is also used for the de-wetting test. As an optional test condition (260 ± 5) °C for (30 ± 3) s may also be used.

Unless otherwise required in 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, shall be placed between the body of the component and the molten solder.

When the relevant specification requires the use of a heat sink during this test, it shall give full details of the size and type of heat sink to be used, which should be related to the method used for production soldering.

5.2.5 De-wetting

The relevant specification shall prescribe whether this test is required.

A total immersion of 10 s is required because de-wetting can occur slowly; this immersion shall be divided into two periods of 5 s each in order that any rapid de-wetting is not masked by any subsequent re-wetting.

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5.3 Method 2: Soldering iron

5.3.1 Description of soldering iron

As required in 4.3.2.

The relevant specification shall state whether iron tip A or iron tip B is to be used.

5.3.2 Solder and flux

As required in 4.3.3.

5.3.3 Procedure

As required in 4.3.4 (Method 2, with the soldering iron of Test Ta), but with the iron applied to the test surface of the termination for one of the following temperatures and durations, as prescribed in the relevant specification.

Temperature: 350 °C or 370 °C

Duration: (5 ± 1) s or (10 ± 1) s

If the relevant specification does not indicate the duration, 10 s shall apply.

In testing certain types of electromechanical and other heat-sensitive components, prolonged heat stress can provoke non-repairable defects. The usual soldering times used in practice are in the range of 1 s to 2 s; this and the heat sensitivity of the component should be considered when selecting the test duration. Additional precautions (e.g. automatic switching off of the heat source) may be necessary.

For heat-sensitive components, the relevant specification shall specify the distance of the test area from the component body, or shall specify the use of a specific heat sink.

If the relevant specification requires that several terminations of the component shall be tested, an interval in the order of 5 s to 10 s shall be observed between the applications to the different terminations of the component to avoid overheating.

Any flux residues shall be removed from the terminations with 2-propanol (isopropyl alcohol) or with ethanol (ethyl alcohol) after each test.

5.4 Recovery

The specimen shall remain under standard atmospheric conditions for testing as prescribed in IEC 60068-1 for a period of 30 min, or until thermally stabilized.

NOTE For certain components, such as some semiconductors and capacitors, it can happen that the electrical properties only stabilize some hours after heat stability is reached.

5.5 Final measurements and requirements

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.

5.6 De-wetting (if required)

The criteria for wetting described in 4.2.6 shall also apply.

If de-wetting or un-wetted areas occur, this should be noted.

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5.7 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Subclause
a) Initial measurements	5.1.2
b) Test method to be applied	5.2; 5.3
c) Immersion depth, if different from 2,0 mm to 2,5 mm from the component	5.2.3
d) Test severity	5.2.4
e) Whether a thermal screen is to be used or not, and details of a heat sink, if required	5.2.4
f) Whether de-wetting test applies	5.2.5
g) Size (A or B) of soldering iron tip	5.3.1
h) Distance of the test area from the component body or use of a specific heat sink	5.3.3
i) Number of terminations to be tested	5.3.3
j) Temperature and duration of the soldering iron test	5.3.3
k) Type of solder alloy in case de-wetting is tested	Table 2, 5.3.2
l) Final measurements and requirements	5.5, 5.6

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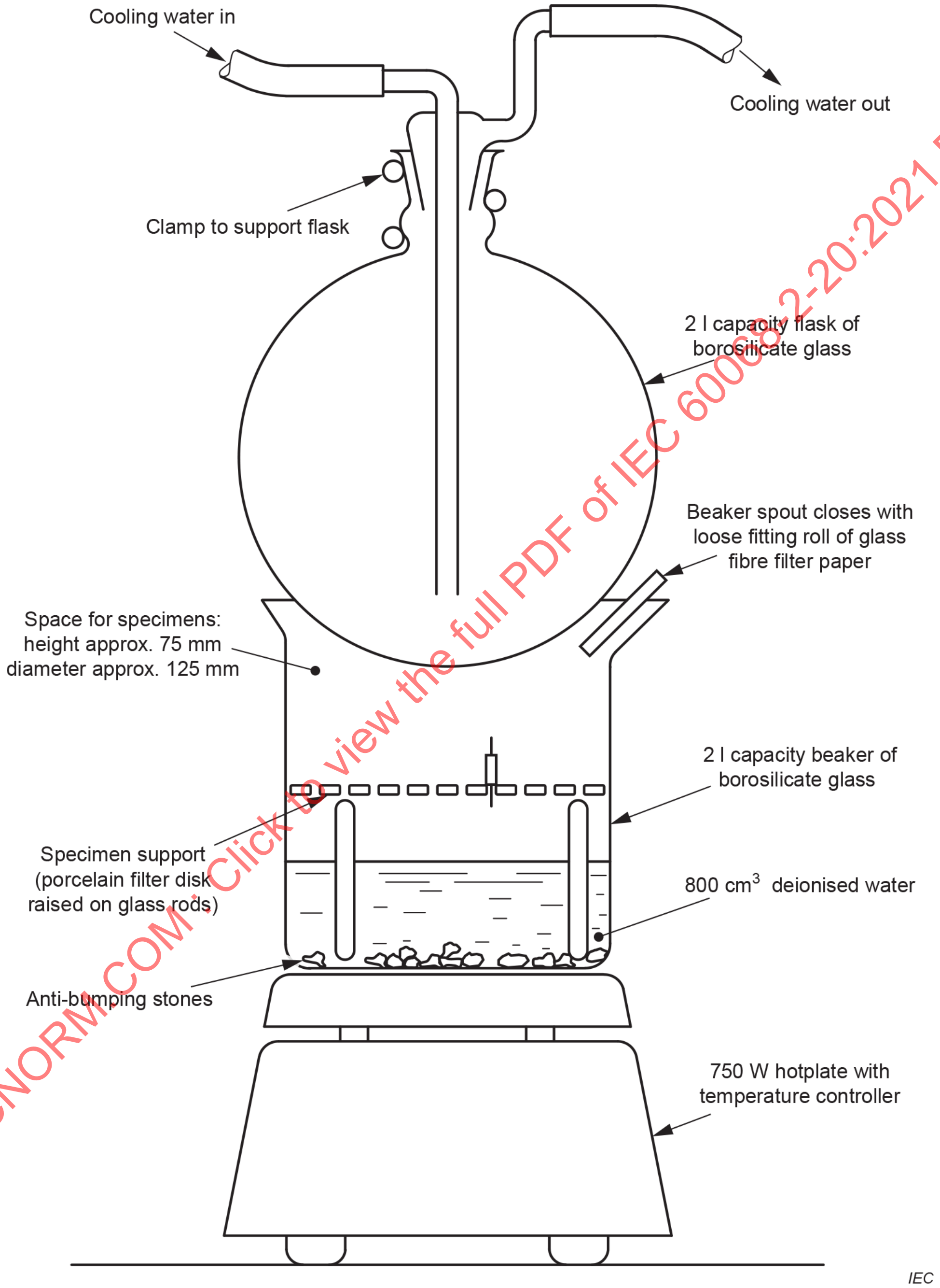
Annex A
(informative)

Example of apparatus for steam conditioning process



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Specimens should not be placed under the lowest portion of the cooling flask because of dripping water.

Figure A.1 – Example of apparatus

Annex B
(normative)

Specification for flux constituents

B.1 Colophony

Colour	To WW grade 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 (isopropyl alcohol) shall be clear, and after a week at room temperature, there shall be no sign of a deposit.

B.2 2-propanol (isopropyl alcohol)

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

B.3 Ethyl alcohol

Purity	Minimum 96,2 % ethanol (ethyl alcohol) by mass
Free acids (other than carbon dioxide)	Maximum 4 mg/l

B.4 Flux composition

Non-activated and activated flux compositions are described in Table B.1.

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Table B.1 – Colophony based flux compositions

Constituent	Composition by mass fraction %		
	Non-activated	Low activated	High activated
Colophony	25 ± 0,5	25 ± 0,5	25 ± 0,5
Diethylammonium hydrochloride (CAS No. 660-68-4)	None	0,15 ± 0,01	0,39 ± 0,01
2-propanol (Isopropyl alcohol) (CAS No. 67-63-0) or ethyl alcohol (CAS No. 64-17-5) as an alternative	75 ± 0,5	74,85 ± 0,5	74,61 ± 0,5
Mass of chlorine of solids [a]	0	0,2	0,5

[a] Expressed as free chlorine based on the colophony content.

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Bibliography

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-69:2017, *Environmental testing – Part 2-69: Tests – Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method*

IEC 60194-2:2017, *Printed board design, manufacture and assembly – Vocabulary – Part 2: Common usage in electronic technologies as well as printed board and electronic assembly technologies*

IEC 61190-1-3:2017, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications*

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SOMMAIRE

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ESSAIS D'ENVIRONNEMENT –

Partie 2-20: Essais – Essais Ta et Tb: Méthodes d'essai de la brasabilité et de la résistance à la chaleur de brasage des dispositifs à broches

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Cette sixième édition annule et remplace la cinquième édition parue en 2008. Cette sixième édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) mise à jour et clarification du préconditionnement (auparavant "vieillissement") et sa relation au vieillissement naturel.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
91/1701/FDIS	91/1711/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

La langue utilisée pour l'élaboration de la présente Norme internationale est l'anglais.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2 et élaboré conformément aux directives ISO/IEC, Partie 1 et Supplément IEC, qui sont disponibles à l'adresse www.iec.ch/members_experts/refdocs. Les principaux types de documents élaborés par l'IEC sont décrits de manière détaillée à l'adresse www.iec.ch/standardsdev/publications.

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ESSAIS D'ENVIRONNEMENT –

**Partie 2-20: Essais –
Essais Ta et Tb: Méthodes d'essai de la brasabilité
et de la résistance à la chaleur de brasage des dispositifs à broches**

1 Domaine d'application

La présente partie de l'IEC 60068 décrit les essais Ta et Tb qui s'appliquent aux dispositifs à broches et aux broches elles-mêmes. Les essais de brasage des composants pour montage en surface (CMS) sont décrits dans l'IEC 60068-2-58.

Le présent document fournit des procédures pour déterminer la brasabilité et la résistance à la chaleur de brasage des dispositifs dans les applications qui utilisent des alliages de brasure, qui sont soit des brasures étain plomb (Pb) eutectique ou quasi eutectique, soit des alliages de brasure sans plomb.

Les procédures du présent document incluent les méthodes dites de bain de brasage et de fer à braser.

Le but du présent document est d'assurer que les broches des composants ou la brasabilité de leurs bornes sont en mesure de satisfaire aux exigences applicables aux joints de brasures de l'IEC 61191-3 et de l'IEC 61191-4. De plus, des méthodes d'essai sont fournies pour assurer que le corps du composant peut résister à la charge calorifique à laquelle il est exposé pendant le brasage.

NOTE Des informations concernant le temps et la force de mouillage peuvent être obtenues par des méthodes d'essai qui emploient une balance de mouillage. L'IEC 60068-2-69 (bain de brasage et méthode de gouttelette de brasure) peut être consultée.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-1, *Essais d'environnement – Partie 1: Généralités et lignes directrices*

IEC 60068-2-2, *Essais d'environnement – Partie 2-2: Essais – Essai B: Chaleur sèche*

IEC 60068-2-66, *Essais d'environnement – Partie 2: Méthodes d'essai – Essai Cx: Essai continu de chaleur humide (vapeur pressurisée non saturée)*

IEC 60068-2-78, *Essais d'environnement – Partie 2-78: Essais – Essai Cab: Chaleur humide, essai continu*

IEC 61191-3, *Ensembles de cartes imprimées – Partie 3: Spécification intermédiaire – Exigences relatives à l'assemblage par brasage de trous traversants*

IEC 61191-4, *Printed board assemblies – Part 4: Sectional specification – Requirements for terminal soldered assemblies* (disponible en anglais seulement)

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3 Termes et définitions

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- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
colophane
résine naturelle obtenue comme résidu des huiles résineuses du pin, après distillation de la térébenthine, et constituée principalement d'acide abiétique et d'acides résiniques, le reste étant des esters d'acides terpéniques

Note 1 à l'article: En anglais, le terme "rosin" est un synonyme de "colophony", et est déconseillé du fait de sa confusion courante avec le terme générique "resin".

3.2
angle de contact
en général, angle formé par deux plans, l'un tangent à la surface du liquide, l'autre à l'interface solide/liquide, en un point de leur intersection (voir Figure 1); en particulier, angle de contact entre la brasure liquide et une surface métallique solide

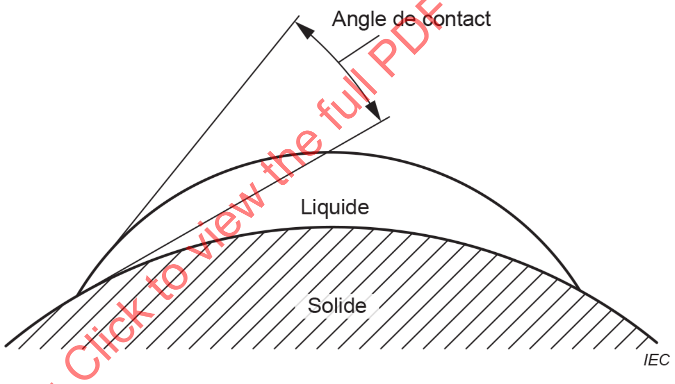

Figure 1 – Schéma de l'angle de contact

3.3
mouillage
formation d'un revêtement adhérent de brasure sur une surface

Note 1 à l'article: Un angle de contact faible est indicatif du mouillage.

3.4
non-mouillage
incapacité de former un revêtement adhérent de brasure sur une surface

Note 1 à l'article: Dans ce cas, l'angle de contact est supérieur à 90°.

3.5
démouillage
retrait de la brasure fondue d'une surface solide, initialement mouillée

Note 1 à l'article: Dans certains cas, un film extrêmement mince de brasure peut subsister. Comme la brasure se retire, l'angle de contact augmente.

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3.6
brasabilité
aptitude de la broche, de la borne ou de l'électrode d'un composant à être mouillées par la brasure à la température de la borne ou de l'électrode, qui est réputée être la température la plus basse du procédé de brasage dans la plage de températures applicable de l'alliage de brasure

3.7
temps de brasage
temps nécessaire pour une surface définie à être mouillée dans des conditions spécifiques

3.8
résistance à la chaleur de brasage
aptitude d'un composant à résister à la contrainte de température la plus forte en matière de gradient de température, de température de crête et de durée du procédé de brasage, lorsque la température du composant se situe dans la plage de températures applicable de l'alliage de brasure

3.9
brasure sans plomb
alliage ne contenant pas plus de 0,1 % de plomb (Pb) en masse comme constituant et qui est utilisé pour relier les composants aux substrats ou pour revêtir les surfaces

[SOURCE: IEC 60194-2:2017, 3.12.5, disponible en anglais seulement.]

4 Essai Ta: Brasabilité des sorties par fils ou par cosses

4.1 Objectif et description générale de l'essai

4.1.1 Méthodes d'essai

L'essai Ta prévoit deux méthodes d'essai différentes pour déterminer la brasabilité des zones sur les sorties par fils et par cosses qui doivent être mouillées par la brasure pendant l'opération d'assemblage.

– Méthode 1: bain de brasage.
– Méthode 2: fer à braser.

La méthode d'essai à utiliser doit être indiquée dans la spécification applicable. La méthode du bain de brasage est la méthode qui simule le mieux les procédés de brasage du brasage à la vague et les procédés de brasage analogues.

La méthode du fer à braser peut être utilisée dans les cas où la méthode 1 n'est pas réalisable.

Si la spécification applicable l'exige, l'éprouvette d'essai doit être préconditionnée selon 4.1.4. Les méthodes suivantes sont des méthodes types de préconditionnement:

Type 1a:	1 h dans la vapeur d'eau bouillante
Type 1b:	4 h dans la vapeur d'eau bouillante
Type 2:	10 jours en condition d'essai continu de chaleur humide (40 ± 2) °C; (93 ± 3) % d'humidité relative (HR) (Essai Cab)
Type 3a:	chaleur sèche de 155 °C pendant 4 h (Essai Bb)
Type 3b:	chaleur sèche de 155 °C pendant 16 h (Essai Bb)
Type 4:	4 h à la vapeur pressurisée non saturée (Essai Cx)

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NOTE 1 En règle générale, l'accélération du vieillissement avant les essais de brasabilité est estimée en simulant la dégradation dans l'environnement de stockage. Toutefois, la condition de vieillissement à la vapeur d'eau bouillante ne correspond pas aux conditions de stockage, car le mode d'échec provenant du vieillissement à la vapeur d'eau bouillante est nettement différent de celui provenant des conditions de stockage. Ainsi, une corrélation accélérée entre le vieillissement à la vapeur d'eau bouillante et le vieillissement naturel dans les conditions de stockage est impossible et les conditions de vieillissement à la vapeur d'eau bouillante telles que dans le Type 1a et le Type 1b ne conviennent pas pour un vieillissement accéléré.

NOTE 2 Pour une surface Ni/Au, le Type 2 ou le Type 4 est une méthode de préconditionnement adéquate.

4.1.2 Préparation de l'éprouvette

La surface à soumettre aux essais doit être dans l'état de livraison et ne doit pas être touchée postérieurement avec les doigts ou contaminée de toute autre manière.

L'éprouvette ne doit pas être nettoyée avant l'exécution de l'essai de brasabilité. Si la spécification applicable l'exige, l'éprouvette peut être dégraissée par immersion dans un solvant organique neutre à température ambiante.

4.1.3 Mesurages initiaux

Si la spécification applicable l'exige, les éprouvettes doivent être examinées visuellement et soumises aux vérifications électriques et mécaniques.

4.1.4 Préconditionnement

4.1.4.1 Généralités

Si la spécification applicable exige d'effectuer un préconditionnement, l'une des méthodes suivantes peut être adoptée. À la fin du conditionnement, l'éprouvette doit être soumise aux conditions atmosphériques normalisées pour les essais pendant une durée comprise entre 2 h et 24 h.

Les bornes peuvent se détacher si la température de conditionnement est supérieure à la température maximale de fonctionnement ou de stockage du composant, ou si le composant risque d'être gravement endommagé à 100 °C dans la vapeur d'eau bouillante, ce qui peut affecter la brasabilité d'une manière qui ne se produit normalement pas en vieillissement naturel.

4.1.4.2 Type 1

La spécification applicable doit indiquer si le Type 1a (1 h dans la vapeur d'eau bouillante) ou le Type 1b (4 h dans la vapeur d'eau bouillante) doit être appliqué. Pour ces procédures, l'éprouvette est suspendue, de préférence avec ses bornes en position verticale, de façon que la zone à soumettre aux essais soit située entre 25 mm et 30 mm au-dessus la surface de l'eau distillée en ébullition, contenue dans un récipient en verre borosilicate ou en acier inoxydable de dimensions appropriées (par exemple, un bécher de 2 litres). Les bornes doivent se trouver à au moins 10 mm des parois du récipient.

Le récipient doit comporter un couvercle d'un matériau similaire, formé d'une ou de plusieurs plaques capables de couvrir approximativement les sept huitièmes de l'ouverture. Un système qui permet de suspendre les éprouvettes doit être réalisé; à cet effet, des perforations ou des fentes dans le couvercle sont admises. Le porte-éprouvette ne doit pas être en métal.

Le niveau de l'eau doit être maintenu en ajoutant de l'eau chaude distillée, de façon progressive et en petites quantités, de telle sorte que l'eau ne cesse de bouillir vigoureusement. En variante, un condenseur à reflux peut être utilisé, si souhaité. (Voir Figure A.1).

NOTE Le conditionnement à la vapeur d'eau bouillante pose de nombreux problèmes. Par exemple, de la rosée se condense toujours sur les bornes et, dans certains cas, de l'eau liquide coule directement sur les éprouvettes.

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4.1.4.3 Type 2

Les éprouvettes sont soumises pendant 10 jours à l'essai continu de chaleur humide, conformément à l'IEC 60068-2-78, Essai Cab: Chaleur humide, essai continu.

4.1.4.4 Type 3

Les éprouvettes sont soumises pendant 4 h (Type 3a) ou 16 h (Type 3b) à une chaleur sèche de 155 °C, conformément à l'IEC 60068-2-2, Essai B: Chaleur sèche.

Les éprouvettes d'essai peuvent être introduites dans la chambre à une température quelconque depuis la température ambiante du laboratoire jusqu'à la température spécifiée.

4.1.4.5 Type 4

Les éprouvettes sont soumises pendant 4 h à 120 °C et à une HR de 85 %, conformément à l'IEC 60068-2-66, Essai Cx: Essai continu de chaleur humide (vapeur pressurisée non saturée).

4.2 Méthode 1: Bain de brasage

4.2.1 Généralités

Cette méthode fournit une procédure pour évaluer la brasabilité des fils, des cosses et des bornes de forme irrégulière.

4.2.2 Description du bain de brasage

Le bain de brasage doit être aux dimensions adéquates afin d'accueillir les éprouvettes et de contenir suffisamment de brasure pour maintenir la température de la brasure pendant les essais, et afin d'empêcher le dépassement des niveaux de contamination applicables au type de brasure utilisé pour l'essai. Sauf si la spécification applicable le définit autrement, le bain de brasage doit avoir une profondeur d'au moins 40 mm et un volume d'au moins 300 ml. Le bain doit contenir de la brasure telle qu'indiquée dans le Tableau 1.

NOTE 1 Lorsque les éprouvettes sont de petite taille et d'une faible capacité calorifique, un bain de brasage aux dimensions inférieures à celles décrites ci-dessus peut être approprié.

NOTE 2 L'Article A.2 de l'IEC 60068-2-69:2017 peut être consulté pour trouver un exemple de bain de brasage correspondant à la NOTE 1.

4.2.3 Flux

Un flux à base de colophane tel que décrit à l'Annexe B doit être utilisé. Le flux doit être non activé (voir Tableau B.1).

Si un flux non activé ne convient pas, la spécification applicable peut exiger l'utilisation d'un flux faiblement activé (voir Tableau B.1).

4.2.4 Mode opératoire

Les scories présentes à la surface de la brasure fondue doivent être ôtées à l'aide d'un matériau thermiquement résistant, juste avant chaque essai, afin d'assurer une surface propre et brillante.

La borne à soumettre aux essais doit être en premier lieu plongée dans le flux décrit en 4.2.3, à température ambiante, et l'excès de flux doit être éliminé soit par un égouttage d'une durée appropriée soit par tout autre moyen pouvant conduire à des résultats similaires. En cas de contestation, il faut procéder à l'égouttage pendant (60 ± 5) s.

NOTE L'excès de flux restant peut bouillir lorsqu'il entre en contact avec la brasure liquide. Des bulles de gaz peuvent se coller à la surface des bornes et empêcher le mouillage de la borne dans de telles zones.

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