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IEC 60068-2-69

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Environmental testing –
Part 2-69: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method

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Essais d'environnement –
Partie 2-69: Essais – Essai Te: Essai de brasabilité des composants électroniques pour les composants de montage en surface (CMS) par la méthode de la balance de mouillage

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IEC Central Office
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CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
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ENVIRONMENTAL TESTING –

Part 2-69: Tests –
Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method

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International Standard IEC 60068-2-69 has been prepared by IEC technical committee 91: Electronics assembly technology.

This second edition cancels and replaces the first edition published in 1995 and constitutes a technical revision. The main changes from the previous edition are as follows:

– Inclusion of lead-free alloy test conditions;
– Inclusion of new fluxes for testing, reflecting development of fluxes that have happened in the industry in the past 20 years;
– Inclusion of new component types, and updating test parameters for the whole component list.

This bilingual version, published in 2008-04, corresponds to the English version.

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

FDIS	Report on voting
91/648/FDIS	91/680/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

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

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 publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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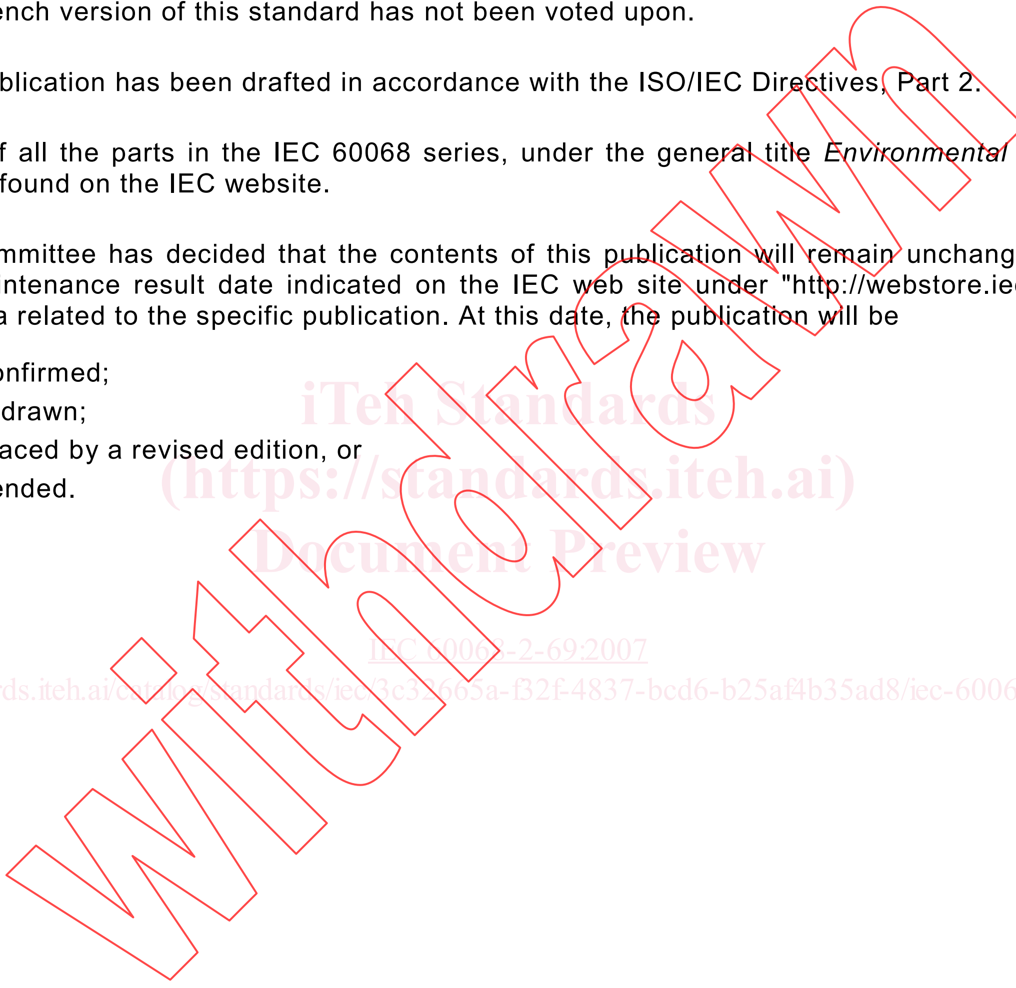

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ENVIRONMENTAL TESTING –

Part 2-69: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method

1 Scope

This part of IEC 60068 outlines test Te, solder bath wetting balance method and solder globule wetting balance method, applicable for surface mounting devices. These methods determine quantitatively the solderability of terminations on surface mounting devices. IEC 60068-2-54 is also available for surface mounting devices and should be consulted if applicable.

The procedures describe the solder bath wetting balance method and the solder globule wetting balance method and are both applicable to components with metallic terminations and metallized solder pads.

This standard provides the standard procedures for solder alloys containing lead (Pb) and for lead-free solder alloys.

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-69:2007
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IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-20:1979, *Basic environmental testing procedures – Part 2: Tests – Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-54:2006, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

IEC 61190-1-3:2002, *Attachment materials for electronic assemblies – Part 1-3: Requirements for electronic grade solder alloys and fluxed/non-fluxed solid solder for electronic soldering applications*

ISO 683 (all parts), *Heat-treatable steels, alloy steels and free-cutting steels*

ISO 6362 (all parts), *Wrought aluminium and aluminium alloy extruded rods/bars, tubes and profiles*

3 Terms and definitions

For the purpose of this document, the terms and definitions as defined in IEC 60068-1 and IEC 60068-2-20 apply.

4 General description of the method

After applying the liquid flux to the component termination and mounting the component in a suitable holder, the specimen is suspended from a sensitive balance. The component termination is brought into contact with the cleaned surface of a solder bath or the apex of a solder globule, and immersed to the prescribed depth.

The resultant forces of buoyancy and surface tension acting upon the immersed termination are detected by a transducer and converted to a signal which is continuously monitored as a function of time, and recorded on a high speed chart recorder or displayed on a computer screen.

The wetting speed and the extent of wetting are derived from the force against time curve.

5 Description of the test apparatus

A diagram showing a suitable arrangement for the test apparatus is shown in Figure 1. The specimen is suspended from a sensitive balance and a mechanism used to either raise the solder to meet the specimen or lower the specimen into the solder.

After conditioning, the transducer signal is passed to either a chart recorder or a computer, where the force against time curve may be displayed and analysed.

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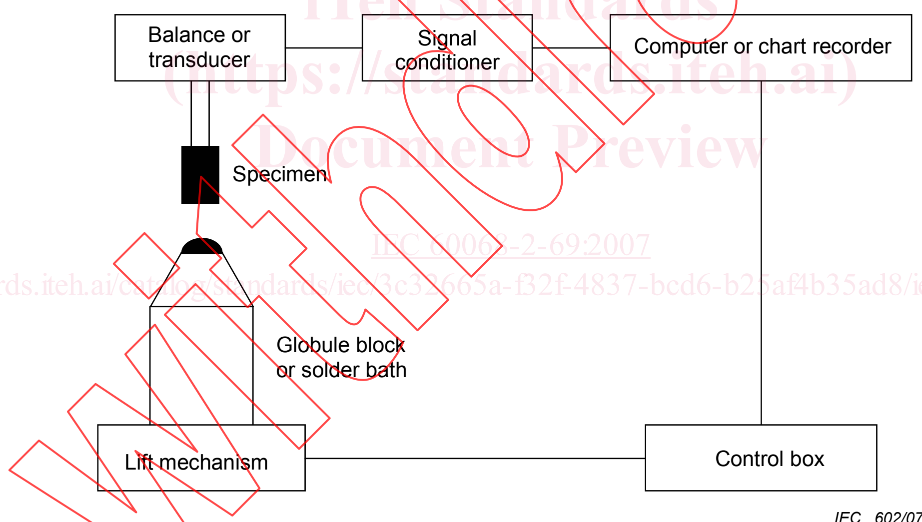

Figure 1 – Test apparatus

Any other system capable of measuring the vertical forces acting on a specimen is admissible, providing that the system has the characteristics given in A.1, and the solder bath and globule support block meet the requirements of A.2 and A.3 respectively.

6 Preconditioning

6.1 Preparation of specimens

Unless otherwise specified, the specimen shall be tested in the as-received condition and care should be taken to ensure that no part of the surface to be tested becomes contaminated, particularly by contact with the fingers, during the preparation and handling of the specimen.

If required by the component specification, the specimen may be cleaned by immersion in a neutral organic solvent at room temperature. The specimen should be allowed to dry in air before testing. No other cleaning is permitted.

6.2 Ageing

If required by the component specification, the component may be subjected to accelerated ageing before testing. Ageing shall be performed in accordance with one of the following conditions:

– ageing 1a of IEC 60068-2-20, Subclause 4.5.1;

– ageing 1b of IEC 60068-2-20, Subclause 4.5.1;

– ageing 3 of IEC 60068-2-20, Subclause 4.5.3;

– ageing according to method 1 of IEC 60068-2-20, but for 8 h.

7 Materials

7.1 Solder

7.1.1 General

The solder to be used for both the solder bath and for the solder globule wetting balance test shall be as specified in 7.1.2 and 7.1.3.

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7.1.2 Solder alloy containing lead

The solder shall be Sn60Pb40A, Sn63Pb37A or Sn62Pb36Ag02B (Refer to IEC 61190-1-3 alloy name).

NOTE The presence of silver in the solder reduces the dissolution effect on silver containing metallization on components and therefore should be used when required by the relevant component specification.

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7.1.3 Lead-free solder alloy

The preferred alloy composition to be used should consist of either 3,0 wt% Ag, 0,5 wt% Cu, 96,5 wt% Sn (Sn96,5Ag3Cu,5) or 0,7 wt% Cu, 99,3 wt% Sn (Sn99,3Cu,7). (Refer to IEC 61190-1-3 for alloy name.)

NOTE A solder alloy consisting of 3,0 wt% to 4,0 wt% Ag, 0,5 wt% to 1,0 wt% Cu and the remainder of Sn may also 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.

7.1.4 Solder mass for solder globule wetting balance method

For the solder globule wetting balance method, the solder shall be in the form of pellets or cut wire with a mass of 200 mg ± 10 mg for use on the 4 mm diameter pin globule support block,100 mg ± 10 mg for use on 3,2 mm diameter pin support block or 25 mg ± 2,5 mg for use on the 2 mm diameter pin globule support block.

Pin diameter mm	Pellet mass mg	Pellet mass tolerance mg
2	25	±2,5
3,2	100	±10
4	200	±10

7.2 Flux

7.2.1 General

The flux used for the test shall be either rosin based or carboxylic acid based. The rosin based flux is either non-activated or activated. The carboxylic acid based flux is either water solution or alcohol solution.

Information about the used flux type shall be specified in the relevant specification.

7.2.2 Rosin based flux

a) Non-activated: consist of 25 wt% colophony in 75 wt% of 2-propanol (isopropanol) or of ethyl alcohol (as specified in Appendix C of IEC 60068-2-20).

b) Activated flux: the activated flux which is above flux with the addition of diethylammonium chloride (analytical reagent grade), up to amount of 0,2 % or 0,5 % chloride (expressed as free chlorine based on the colophony content).

7.2.3 Carboxylic acid based flux

a) Water solution: consist of 90,1 % De-ionised Water, 5,0 % Glycol Ester (CAS No. 34590-94-8) 1,6 % Adipic Acid, 1,6 % Succinic Acid, 1,6 % Glutaric Acid and 0,1 % alcohol ethoxylate surfactant (CAS no 68131-39-5).

b) Alcohol solution: consist of 94 % Propan-2-ol, 1,5 % Adipic Acid, 1,5 % Succinic Acid, 1,5 % Glutaric Acid and 1,5 % Rosin.

NOTE These fluxes reflect modern flux formulations and have similar discriminating powers to the rosin test fluxes.

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8 Procedures

8.1 Test temperature

8.1.1 Solder alloy containing lead

Solder temperature prior to test and during test shall be 235 °C ± 3 °C.

8.1.2 Lead-free solder alloy

Unless otherwise specified in the relevant specification, the temperature of the solder prior to the test shall be 245 °C ± 3 °C for Sn96,5Ag3Cu,5 solder and 250 °C ± 3 °C for Sn99,3Cu,7 solder.

8.2 Solder bath wetting balance procedure

The specimen is mounted in a suitable holder to give the desired dipping angle and the termination(s) is/are centred above the solder bath. Preferred dipping angles are given in Table 1.

The temperature of the solder prior to the test shall be as described in 8.1.

Prior to testing, a continuous layer of the appropriate flux is applied to the portion of the component termination to be tested, using a cocktail stick, cotton bud or similar applicator, and excess flux droplets are removed by touching against absorbent paper. It is very important that excess flux is not allowed to enter the specimen holder or remain on the component. The presence of excess flux will cause explosive boiling as the flux solvent makes contact with the molten solder.

Immediately prior to testing, wipe the oxide from the solder surface with a non-wettable blade. If required, the apparatus suspension and chart recorder are adjusted to the zero position.

Hang the specimen on the apparatus so that the lower edge of the component is 20 mm ± 5 mm above the solder surface during the preheat period and allow the specimen to preheat/dry for 30 s ± 15 s prior to immersion in the solder. This period is required to remove the solvent from the flux prior to the test and to prevent explosive boiling when the solder, specimen and flux come into contact.

After preheating, the specimen and solder are brought into contact at a speed between 1 mm/s and 5 mm/s. The recommended immersion depth into the solder of the surface to be tested shall be as specified in Table 1.

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Table 1 – Recommended solder bath wetting balance test conditions

Component		Dipping angle [a]	Figure reference	Immersion depth mm
Capacitors	1608 (0603) [b] 2012 (0805) [b] 3216 (1206) [b] 4532 (1812) [b]	Horizontal, Vertical or 20° to 45°	1A,1B, 1C	0,04 to 0,10
Resistors	1608 (0603) [b] 2012 (0805) [b] 3216 (1206) [b]	Horizontal, Vertical or 20° to 45°	1A, 1B,1C, 1G [d],1H [d]	
Leaded SMD	SOT 23 SOT 89 SOT 223 SOIC 16 [c] SOIC 28 [c] VSO 40 [c] QFP 48 [c] QFP 160 [c] PLCC 44 [c] PLCC 84 [c]	Vertical or 20° to 45°	1D, 1E, 1F	
Cylindrical SMD		Horizontal, Vertical or 20° to 45°	1A,1B, 1C	
SOD 80		Vertical or 20° to 45°	1B, 1C	

Not recommended for sizes below 1608 (0603).

The recommended dwell time is 5 s, except for SOT 89 and SOT 223 components, where 10 s is recommended.

The recommended immersion speed for all components is between 1 mm/s and 5 mm/s.

[a] Orientation of the specimen terminals or leads towards the solder surface.

[b] Component names in parentheses, dimensions are expressed in Imperial.

[c] These leads may be cut and tested individually, but care should be taken not to deform the part of the lead to be tested. This operation should be performed after ageing, if any ageing procedure is applied.

[d] Figures 1G and 1H are applicable to the components which do not have electrode toward the solder surface when Figure 1B is applied.

1A Horizontal

1B Vertical

1C 20°to 45°

1G Vertical [d]

1D 20° to 45°

1E Vertical

1F 20° to 45°

1H 20° to 45° [d]

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The solder and specimen are held in this position for not less than 5 s and then separated. The withdrawal rate is not specified as the force curve is not analysed once the specimen starts to separate from the solder.

Time sequence of the test is shown in Table 2. The test sequence should be made in the minimum time whilst maintaining repeatability.

Table 2 – Time sequence of the test (solder bath)

Procedure	Time	Duration
1) Fluxing	0 s	5 s
2) Hang the specimen on the apparatus	~15 s	--
3) Wipe the oxide from the solder surface	~20 s	--
4) Preheat	~30 s	30 s ± 15 s
5) Start	~75 s	3 s to 25 s
6) Solder immersion	100 s max.	5 s

The vertical force acting on the specimen is recorded during the period of contact between the solder and the specimen. The force during withdrawal need not be recorded as the withdrawal part of the curve is not analysed.

Once the specimen has cooled, the flux residues are washed from the specimen, using a neutral organic solvent. The specimen is visually examined using a magnification of 10 ×. Special attention should be paid to de-wetting, as de-wetting does not often occur until the specimen is withdrawn from the solder.

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Note that de-wetting may be obscured by the presence of solder icicles frozen onto the termination as it is withdrawn from the solder.

8.3 Solder globule wetting balance procedure

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Select the appropriate globule block for the component to be tested. Recommended globule support block pin sizes are given in Table 3.

Set the temperature of the solder as specified in 8.1. Note that the globule blocks should never be heated without solder covering the iron pin. Heating the uncovered pin could cause the iron to become oxidized and difficult to wet.

The specimen is mounted in the appropriate holder, to give the desired dipping angle, and the termination to be tested is centred above the solder globule. Recommended dipping angles and immersion depths for a typical range of components are given in Table 3.

Prior to testing, a continuous layer of the appropriate flux is applied to the portion of the component termination to be tested, using a cocktail stick, cotton bud or similar applicator and excess flux droplets are removed by touching against absorbent paper. It is very important that excess flux is not allowed to enter the specimen holder or remain on the component. The presence of excess flux will cause explosive boiling as the flux solvent makes contact with the molten solder.

Immediately before the test, the solder from the previous test should be removed, by wiping the globule block with a cotton bud, and replaced with a new pellet of the appropriate mass. Sufficient activated rosin flux (0,5 % halide, as specified in 7.2) shall be applied to the solder globule. This maintains a clean surface for the duration of the test, and ensures that the iron pin is fully wetted and the solder formed into a regular hemispherical shape. If required the apparatus suspension and recording device are adjusted to the zero position.

Hang the specimen on the apparatus so that the lower edge of the component is 20 mm ± 5 mm above the solder globule and allow the specimen to preheat/dry for 30 s ± 15 s prior to immersion into the solder globule. This period is required to remove the solvent from the flux prior to the test and to prevent explosive boiling when the specimen and solder come into contact.

After preheating, the specimen and solder are brought into contact at a speed between 1 mm/s and 5 mm/s. The immersion depth of the surface to be tested into the solder shall be as specified in Table 3, which gives immersion depths for a typical range of components.

Table 3 – Recommended solder globule wetting balance test conditions

Component [a]		Dipping angle [b]	Figure	Immersion depth mm	Pin size mm	Globule weight mg	Remarks
Capacitors	1005 (0402)	Horizontal or Vertical	2A, 2B	0,10	2	25	
	1608 (0603)						
	2012 (0805)	Horizontal	2A		3,2 or 4	100 or 200	
	3216 (1206)				4	200	
Resistors	1005 (0402)	Vertical	2B	0,10	2	25	
	1608 (0603)	Horizontal or Vertical	2A, 2H [c]				
	2012 (0805)				3,2 or 4	100 or 200	
	3216 (1206)				4	200	
Tantalum capacitors, LEDs	Case sizes A [d],B,C,D	Vertical	2H [c]	0,10	4	200	
Leaded SMD[e]	SOT 23, 25, 26, 323, 343, 353, 363	20 - 45	2D	0,10	2	25	
	SOT 89,		2F	0,20	4	200	1 outer pin only
	SOT 223, 523			0,25			
	Gull wing diode						
	Any SOIC VSO QFP, SOP		2D	0,20			Remove sufficient leads to avoid bridging between tested leads
	PLCC, SOJ	Horizontal	2E	0,10			
QFN		Horizontal	2H [c]	0,10	2	25	Caution from bridging
Cylindrical SMD		Horizontal or Vertical	2A , 2B	0,25	4	200	
SOD 80		Vertical	2B	0,20	4	200	
Any BGA,CSP or LGA [f]		Horizontal	2G	0,10	2	25	Only peripheral balls can be tested, and only test down to 1,0 mm pitch

Not recommended for sizes below 1005 (0402).
Bath method is preferred for capacitors 3216 (1206) size.
The recommended dwell time is 5 s, except for SOT 89 and SOT 223 components where 10 s is recommended.
For Figure 2B, rightward offset may be used. Rightward offset distance from the crest of the solder globule shall be 0 % to 15 % of the pin diameter and shall avoid leftward offset.

[a] Component names in parentheses, dimensions are expressed in Imperial.

[b] Orientation of the specimen terminals or leads towards the solder surface.

[c] Figure 2H is applicable to the components which do not have electrode toward the solder surface when Figure 2B is applied.

[d] This test may only be applicable with certain test equipment.

[e] These leads may be cut and tested individually, but care should be taken not to deform the part of the lead to be tested. This operation should be performed after ageing, if any ageing procedure is applied.

[f] This test is recommended only for those balls and bumps that will not melt at the respective temperature and are not designed to melt during reflow operation.

Withdrawn
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