INTERNATIONAL STANDARD

IEC 60068-2-69

Second edition
2007-05

Environmental testing –

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

Reference number
IEC 60068-2-69:2007(E)

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE T

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

FOREWORD

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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.

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.

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

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- withdrawn;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

A bilingual version of this publication may be issued at a later date.

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.

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 60068-1, *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.

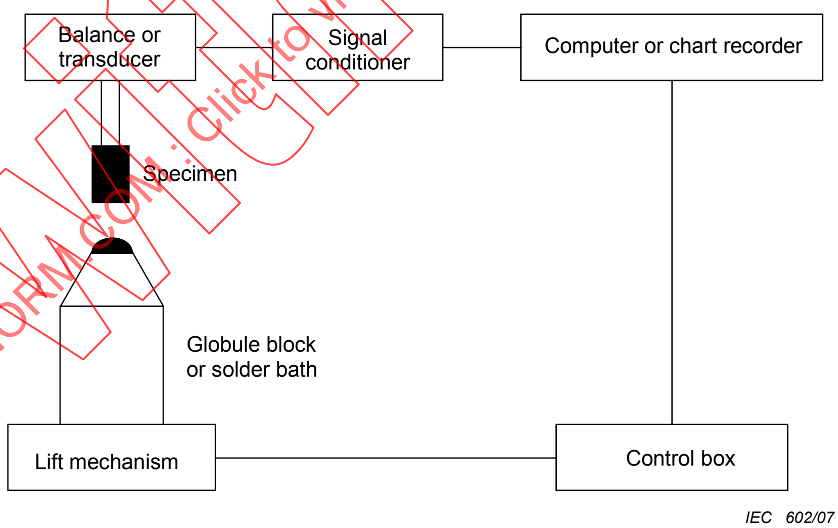


Figure 1 – Test apparatus

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.

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.

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.

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.

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.

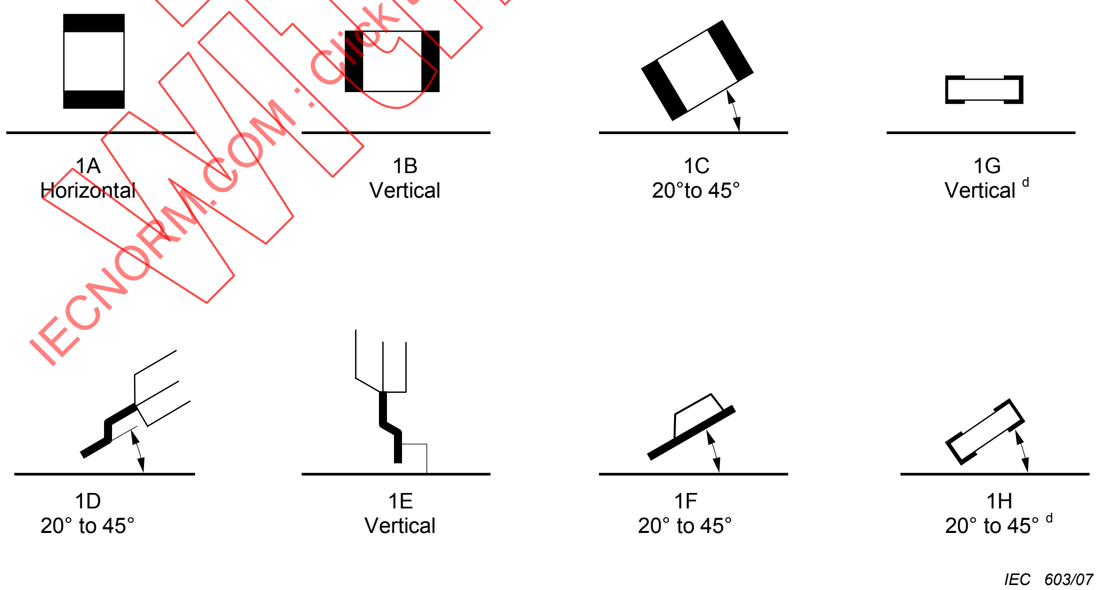
The recommended immersion speed for all components is between 1 mm/s and 5 mm/s.

[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 use Figure 1B.



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.

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

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.

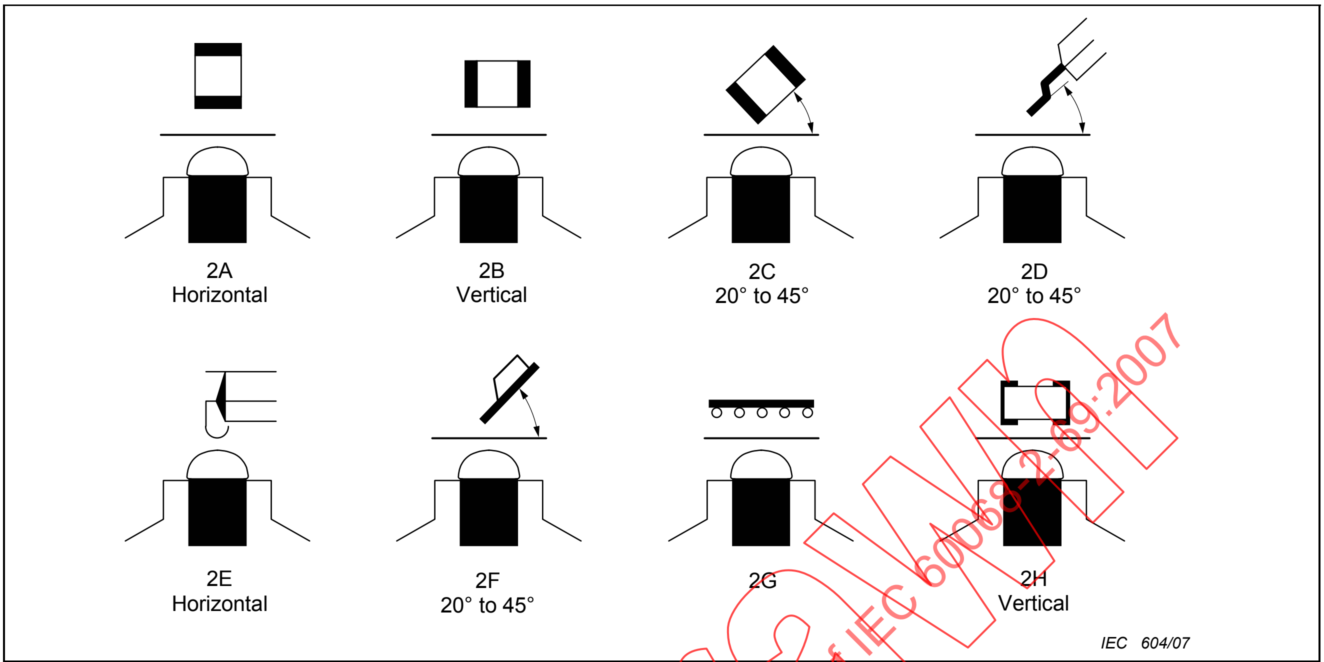
[c] Figure 2H is applicable to the components which do not have electrode toward the solder surface when Figure 2B is applied.

[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.

Table 3 *(continued)*



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 4. The test sequence should be made in the minimum of time whilst maintaining repeatability.

Table 4 – Time sequence of the test (Solder globule)

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) Apply flux to solder globule	~30 s	
5) Preheat	~40 s	30 s ± 15 s
6) Start	~85 s	3 s to 25 s
7) Solder immersion	110 s max.	5 s

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

The flux residues are washed from the specimen, once the specimen has cooled, 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.

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

9 Presentation of results

9.1 Form of force versus time trace

The trace may be recorded in two forms, the only difference being the polarity of the force readings. In this standard, forces acting upwards on the specimen (non-wetting) are shown as negative and forces acting downwards on the specimen (wetting) are shown as positive.

A typical wetting balance trace is shown in Figure 2.

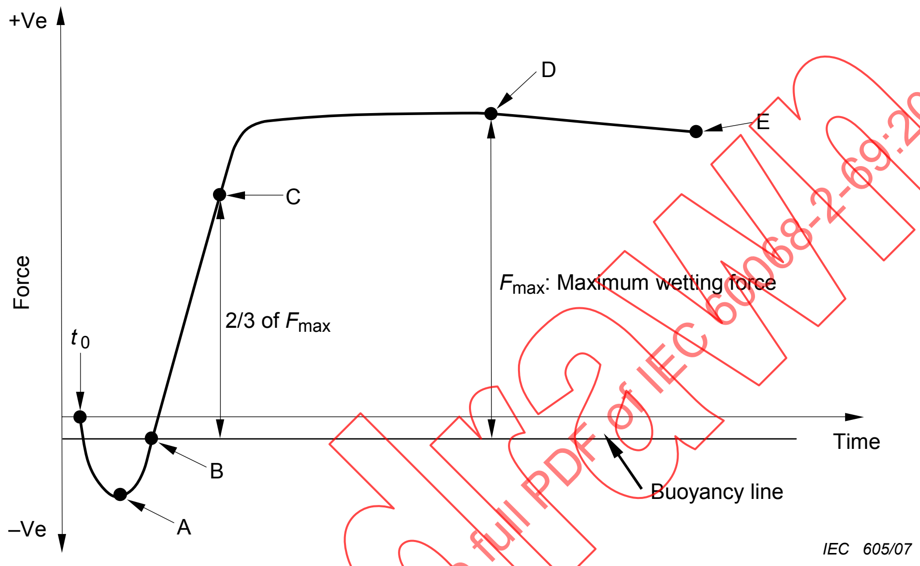


Figure 2 – Typical wetting balance trace

Time t_0 is the time at which the solder surface and the specimen first make contact, as indicated by a small downward movement of the trace from the zero line.

At point A the solder meniscus starts to rise up the specimen termination. This is normally characterized by a significant increase in the wetting force.

At point B the contact angle is 90°. A typical wetting balance trace is shown in Figure 2. The measured force is that due to the buoyancy of the component.

At point C the wetting force reaches 2/3 of the maximum value of the resultant wetting force and the wetting force shall exceed a specified value within a specified time.

At point D the maximum value of the resultant wetting force is reached during the specified immersion period.

Point E is the force reading at the end of the specified test period.

Interpretation of the trace after E, during the withdrawal of the specimen, is not considered.

The wetting force in Figure 2 may be measured from the zero line, the buoyancy line, or the minimum forces at point A (the force excursion).

NOTE Certain components may wet so easily that there may be no downward movement of the trace from the zero line. This represents good solderability.

9.2 Test requirements

The requirements for the solderability of the components shall be expressed in terms of one or more of the following parameters.

a) For the onset of wetting

A maximum value for the time interval (t_0 to B)

b) For the progress of wetting

A maximum value of the time interval (t_0 to C)

c) For the stability of wetting

A minimum value for the ratio: $\frac{\text{force at E}}{\text{force at D}}$

10 Information to be given in the relevant specification

		Clause and subclause
a)	Whether the specimen is to be cleaned prior to testing	6.1
b)	Whether accelerated ageing is to be carried out and, if so, by which method	6.2
c)	Type of flux to be used	7.2
d)	Composition of the solder	7.1
e)	Globule size to be used	8.3
f)	Test temperature, if other than specified	8.1
g)	Portion of the specimen to be tested, if other component than in Table 1 or Table 3	8.2, 8.3
h)	Dipping position and angle if other component than in Table 1 or Table 3	8.2, 8.3
i)	Immersion depth, if other component than in Table 1 or Table 3	8.2, 8.3
j)	Duration of the test, if other than 5 s	8.2, 8.3
k)	Acceptance value for the onset and progress of wetting	9.2
l)	Areas to be examined for wetting and dewetting	8.2, 8.3

Annex A
(normative)

Equipment specification

A.1 Characteristics of the apparatus

For the purpose of this standard the complete apparatus, including the chart recorder or the computer system, is to be considered as a single piece of equipment having the following characteristics.

A.1.1 The response time of the recording device shall be such that return to centre zero on removal of the maximum load shall be accomplished within 0,3 s, with an overshoot not exceeding 1 % of the corresponding maximum reading.

A.1.2 The instrument may have a number of sensitivity settings. On the most sensitive setting, it shall be capable of resolving a force of less than 0,02 mN.

A.1.3 The deflection of the recording device shall be directly proportional to the force applied over the entire range to an accuracy better than ±5 % of the full-scale deflection.

A.1.4 Electrical and mechanical noise on the force trace shall not exceed 10 % of the signal level, on the most sensitive range.

A.1.5 The stiffness of the spring system of a mechanical balance shall be such that a load of 10 mN causes a vertical displacement of the specimen suspension which does not exceed 0,1 mm.

A.1.6 If a chart recorder is used, the chart speed shall be not less than 10 mm/s.

A.1.7 The speed of immersion and withdrawal shall be between 1 mm/s and 5 mm/s.

A.1.8 The immersion depth shall be adjustable to an accuracy of ± 0,01 mm.

A.1.9 The solder temperature shall be maintained at specified temperature in 8.1, but should be adjustable between 200 °C and 260 °C.

A.1.10 The time at maximum immersion shall be adjustable from 0 s to 10 s.

A.2 Solder bath

A.2.1 The bath shall be of sufficient thermal mass to enable the test temperature to be maintained to the required precision. No part of the specimen shall be less than 15 mm from the wall, so that the wetting forces are not affected by the curvature of the solder surface at the edges of the bath. The depth of the bath shall not be less than 15 mm.

A.3 Globule support blocks

A.3.1 The body shall be made from a non-heat-treatable aluminium bar having a minimum yield stress of 170 N/mm^2 and having the following chemical composition:

Magnesium	1,7 % to 2,8 %
Copper	0,1 % maximum
Silicon	0,6 % maximum
Iron	0,5 % maximum
Manganese	0,5 % maximum
Chromium	0,25 % maximum
Zinc	0,2 % maximum
Titanium or other grain refining elements	0,15 % maximum
Aluminium	the remainder

See ISO 6362.

A.3.2 The 2 mm, 3,2 mm and 4 mm diameter iron pins shall be made of pure iron, or low carbon steel having the following composition:

Carbon	0,05 % maximum
Oxygen	0,02 % maximum
Nitrogen	0,02 % maximum
Other impurities	15×10^{-6}
Iron	the remainder

See ISO 683.

A.3.3 The mild steel pin shall be heat shrunk into a reamed hole in the aluminium body.

A.3.4 The aluminium body shall be heated by an electrical heater and the temperature controlled by any means which will ensure a temperature within ± 3 °C of the specified temperature in 8.1.

A.3.5 The temperature shall be measured by inserting a suitable probe, such as a thermocouple, thermistor or platinum resistance wire, into a hole bored into the iron pin.

A.3.6 The top surface of the iron pin shall be tinned. After the completion of the test, the globule support block shall be allowed to cool with a solder globule in position, to prevent oxidation of the iron pin and subsequent dewetting.

A.3.7 The relative positions of the specimen and the solder globule shall be adjustable in both horizontal axes.

Annex B
(informative)

Use of the wetting balance for SMD solderability testing

B.1 Definition of the measure of solderability

The wetting balance method permits the measurement of the vertical force acting on a specimen as a function of time, when the specimen is immersed in a bath of molten solder or a molten solder globule. The solderability of the specimen is deduced from these observations as the time to reach a given degree of wetting or as the degree of wetting reached within a given time.

In general the construction of surface mounted devices does not allow the full meniscus rise to develop, where the contact angle reduces to zero, and so the observed wetting force cannot be compared to the theoretical wetting force, as defined in IEC 60068-2-54.

A specification for solderability may require that several points on the force-time curve conform to particular values. This annex suggests points and values that may be used.

The test equipment shall conform to certain requirements if reproducible and quantitative results are to be obtained; the requirements and methods of verifying that they are complied with are also included in this annex.

The choice of method will depend upon the type of component to be tested and the level of information required from the test. The relevant component specification will indicate which method is preferred.

B.2 Solder globule mass and pin size

The solder globule wetting balance method is standardized using three sizes, 4 mm, 3,2 mm and 2 mm diameter, for the iron insert in the aluminium block, and three corresponding solder pellet sizes, 200 mg, 100 mg and 25 mg.

In general the smaller 25 mg solder pellet size gives improved discrimination with the smaller SMD's and facilitates testing of individual leads on fine pitch devices such as QFPs (Quad Flat Pack) and BGAs (Ball Grid Array). The 200 mg globule is required for all larger SMD and multi-leaded SMD, where the 25 mg solder globule has insufficient volume to completely solder the terminations. The 100 mg globule provides larger wetting force than 200 mg globule and larger thermal inertia than 25 mg globule. With the advent of even smaller SMD, such as 0402 (0201), a smaller pin size, 1 mm diameter, and globule size 5 mg, are required to match these finer SMD sizes.

A list of recommended pin sizes and globule weights is given in Table 3.

The solder globule used with the solder globule wetting balance method is a limited source of heat and so will be able to discriminate between different thermal requirements on a component. An extreme example of this is the SOT 89 and SOT 223 devices where the centre lead has a much higher thermal requirement than the two outer leads.

B.3 Specimen orientation and immersion depth

Surface mounted devices generally have short terminations and so it is advisable to use shallow immersion depths to leave the largest area available above the solder, to develop the largest possible wetting force. The buoyancy forces under these conditions will be relatively small.

However, this should be balanced against the thermal needs of the component. The use of very shallow immersion depths may give poor or unpredictable heat transfer into the component, giving variable times before the onset of wetting. Too high immersion depths will give poor wetting force readings. Table 1 gives a list of recommended immersion depths for a range of common components, for the solder bath method, and Table 3 gives the recommended immersion depths for the solder globule wetting balance method.

As a general guide where a termination can be presented as a straight vertical face, this will provide the best results. However, it is also necessary to ensure that solder can flow along the face that will eventually be soldered to the printed wiring board. The solder shall also be brought into contact with the solderable coating, avoiding contact with unsolderable material, including exposed cut ends. The immersion angle must also allow sufficient thermal contact to provide adequate heat transfer into the component.

These requirements will have a different consequence for dipping orientation and dipping depth, for different components.

B.3.1 Resistors and capacitors

Large capacitors can be immersed into the solder with the terminations horizontal, but resistors will generally give better results when one termination is tested vertically, or at an angle between 20° and 45°. Small size capacitors, 1608M(0603) and smaller, may also give better results when dipped with the terminations vertical, or at an angle between 20° and 45°. The smaller pellet size is preferred for 1005 (0402) and 1608 (0603) sizes. It is also recommended that these components be immersed to one side of the globule generally as shown in Diagram 2B of Table 3.

NOTE Component names in parentheses, dimensions are expressed in Imperial.

B.3.2 Small-leaded components

SOT 89, SOT 23 and SOT 223 devices may be dipped at 45°, as the ends of the terminations are cut in the manufacturing process exposing the bare metal which is generally non-solderable by conventional test fluxes. By using a dipping angle of 45° the molten solder is brought into contact with the solderable part of the termination, allowing the solder to advance over the termination before the contact angle decreases to zero.

These components are heated to such an extent during the test that adjacent leads are reflowed. Thus only one lead may be tested on a device. In general, greater sensitivity is obtained by using the smaller solder globule to test these components.

B.3.3 Multi-leaded devices

A complete row of leads on a multi-leaded device can be tested using the solder bath. Greater discrimination may be obtained by removing alternate leads or alternate pairs of leads to reduce the effect of capillary action between the leads, or individual leads may be carefully cut from the component.

The solder globule wetting balance method can be used to test individual leads on a multi-leaded device, but may also require leads to be removed to prevent solder making contact with two leads or with the solder residue remaining on the previously tested lead.

A complete row of leads on a multi-leaded device may be tested using a single solder globule, but components with a high thermal mass may show variable times for the onset of wetting, because of the differing preheat times and temperatures.

SOIC, VSO and QFP devices may require dipping at an angle of 45°, since these devices have cut ends which are non-wettable by conventional test fluxes. Only by using a shallow dipping angle can the solderable surface be brought into contact with the solder. This problem is common to a large number of devices.

PLCC devices should be dipped with the body horizontal and require alternate leads to be removed, to avoid the solder spike remaining on the previously tested lead making contact with the solder globule.

BGA devices should be dipped with the body horizontal. With this arrangement it is possible to test the outer row of solder balls. Alternate solder balls shall be tested to avoid pickup of solder and flux residue from adjacent solder balls.

B.4 Test flux

For the solder bath test specified in 8.2, flux is only applied to the component termination and either of the fluxes in 7.2 may be specified.

For the solder globule wetting balance method, flux is applied to both the component termination and the solder globule. Either of the fluxes specified in 7.2 may be used on the component termination. It has been found that the pure rosin flux, specified in 7.2, is not capable of maintaining a clean solder surface for the duration of the test. Where a different flux is used on the component termination, it has been found that little intermixing occurs.

B.5 Test temperature

B.5.1 Solder alloy containing lead

The test temperature of 235 °C ± 3 °C is chosen to be consistent with existing IEC standards. If a further enhancement of the discrimination is required, then 215 °C ± 3 °C may be used. If required by the relevant specification, other test temperatures may be specified.

The preferred test temperatures are the following:

235 °C ± 3 °C

215 °C ± 3 °C

245 °C ± 3 °C

Certain coatings, for example organic brightened tin or gold, show a significant change in their rate of solution in solder with 60 % tin and 40 % lead between 235 °C and 245 °C. In such a situation, the relevant specification should state whether a solder bath temperature of 245 °C may be used for testing.

B.5.2 Lead-free solder alloy

The following test temperatures are under consideration: 225 °C, 235 °C, 245 °C and 250 °C as recommended.