

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Environmental testing –
Part 2-83: Tests – Test Tf: Solderability testing of electronic components for
surface mounting devices (SMD) by the wetting balance method using solder
paste**

**Essais d'environnement –
Partie 2-83: Essais – Essai Tf: Essai de brasabilité des composants
électroniques pour les composants montés en surface (CMS) par la méthode de
la balance de mouillage utilisant de la pâte à braser**



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ENVIRONMENTAL TESTING –

Part 2-83: Tests – Test Tf: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method using solder paste

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IEC 60068-2-83 has been prepared by IEC technical committee 91: Electronics assembly technology. It is an International Standard.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

- a) Revise Clause 5 to align with that in IEC 60068-2-20:2021.

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

Draft	Report on voting
91/2026/FDIS	91/2037/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/publications.

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ENVIRONMENTAL TESTING –

Part 2-83: Tests – Test Tf: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method using solder paste

1 Scope

This part of IEC 60068 provides methods for comparative investigation of the wettability of the metallic terminations or metallized terminations of SMDs with solder paste.

Data obtained by these methods are not intended to be used as absolute quantitative data for pass/fail purposes.

NOTE Different solderability test methods for SMD are described in IEC 60068-2-58 and IEC 60068-2-69. IEC 60068-2-58 specifies visual evaluation using solder bath and reflow method, IEC 60068-2-69 specifies wetting balance evaluation using solder bath and solder globule method.

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 60068-2-20:2021, *Environmental testing – Part 2-20: Tests – Test Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

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 60194-2, *Printed boards 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, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solder for electronic soldering applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1, IEC 60068-2-20, IEC 60068-2-58, IEC 60194-2, and IEC 61190-1-3 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

wettability

intrinsic property of the termination material to form an alloy with the solder

Note 1 to entry: Wettability depends on the base metal used to produce the termination or, in the case of a plated termination, the condition and material used to plate the base metal.

[SOURCE: IEC 60068-3-13:2016, 3.1.3]

3.2

wetting balance method

method to measure wetting performance and solderability by measuring vertical force (difference with surface tension and buoyancy) to the specimen and recording as a function of time, when the specimen is immersed into molten solder

3.3

zero line

line extended to the time axis of the force experienced by the specimen as indicated by the test equipment (force sensor) when the specimen is taken out from the molten solder after the end of the measurement

4 Test

4.1 General description

The specimen is held on a holder suitable to the specimen and is suspended from sensitive balance. The specimen is immersed into solder paste applied onto the test jig plate, then solder paste is heated to melt. The resultant of the vertical forces of buoyancy and surface tension (hereafter, referred to as “acting force”) acting upon the immersed specimen by force sensor and converted into a signal which is continuously recorded or monitored as a function of time on recorder.

NOTE The wetting force can be evaluated only for components of the same shape and size. The absolute evaluation is not achieved by this method.

4.2 Test methods

There are three methods as described below. The choice of the method shall be specified in the relevant specification.

- a) Quick heating method: the wettability of electrodes of a component is evaluated while the solder paste is melted in a rapid temperature rise. The specimen is immersed in the solder paste before the temperature rise starts.
- b) Synchronous method: the wettability of electrodes of a component is evaluated while the solder paste is melted due to a rapid temperature rise. The specimen is immersed in the solder paste when the temperature rise starts.
- c) Temperature profile method: solder paste is melted using a similar temperature profile used in production and the wettability of the electrodes of a component is evaluated.

NOTE 1 This test (Tf) can be applicable to leaded SMD packages. In order to achieve comparable and repeatable results, test Tf should be done on straight leads.

NOTE 2 Solder paste to be used is agreed between the trading partners.

5 Preconditioning

The test shall be made on the specimens as received and the specimens shall not be contaminated by fingers and other items, unless otherwise specified in the detailed specification of the component. The specimen may be immersed in organic solvent at room temperature to remove possible contamination such as grease attached to the surface if cleaning is required by the relevant specification. No other method shall be used to clean the specimen. The specimen thus cleaned may be dried in air.

If required by the relevant specification, one of the preconditioning methods specified in IEC 60068-2-20:2021, 4.1.1, may be used.

6 Preparation

6.1 Solder paste

Use solder paste that has been stored in a sealed container and stored in a dark environment and below 10 °C, avoiding exposure to direct sunlight. Before conducting this test, the solder paste preparation procedure is important.

Expiration date of the solder paste shall be checked before initiating the solder paste preparation procedure listed below.

- a) The solder paste shall be allowed to achieve ambient conditions that shall be nominally $25\text{ °C} \pm 5\text{ °C}$ and relative humidity of $(50 \pm 10)\%$ for 8 h or in accordance with the manufacturer's data sheet.
- b) Open the supply container(s). Remove any internal cover, scrape off the paste adhering to the lid(s), internal covers, and the container walls. Add this material to the paste in the supply container(s). Check that the solder paste is not obviously deteriorated nor separated.
- c) Using a spatula, stir the paste gently for 1 min to 2 min to homogenize it, ensuring that no air is introduced.
- d) Gently transfer the paste to a test container of sufficient volume, ensuring that no air is introduced. The solder paste that is once taken out from the container and not used for the test shall be discarded. The remaining solder paste in the supply container shall be stored in the original dark and cool environment.

6.2 Test jig plate

Test jig plates shall be stored in a sealed container. Immediately prior to their use, they shall be cleaned using acid such as dilute hydrochloric acid. A new test jig plate shall be used for each test. Unused test jig plates shall be discarded and not be returned to the sealed container.

6.3 Specimen holder

The specimen holder is usually contaminated by creeping of flux used in a test. A specimen holder shall be cleaned using a neutral organic solvent. It is recommended to use ultrasonic agitation in cleaning.

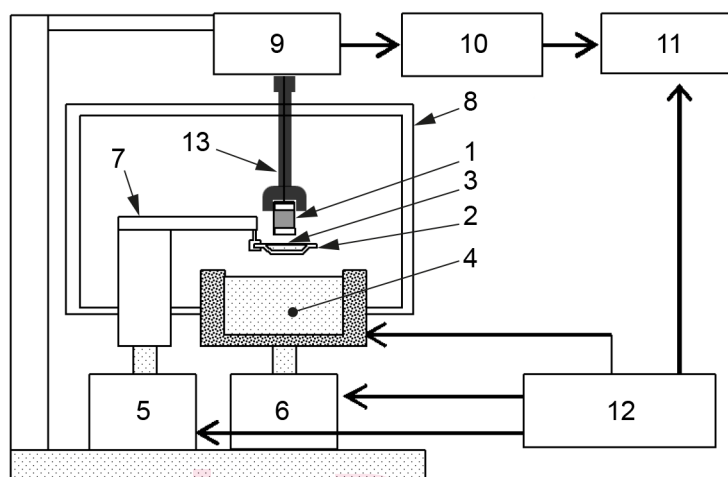
7 Quick heating method

7.1 Equipment

The equipment used for the quick heating method consists of a measurement, heating and lift system, as shown in Figure 1. The detailed requirements to the equipment are specified in Annex A.

The measurement, heating and lift system shall be as follows.

- The measuring system consists of the force sensor that can measure the force vertically acted on a specimen, signal transducer and a recorder.
- The heating system shall be capable of controlling the determined set temperature within $\pm 3\text{ }^{\circ}\text{C}$.
- The lift system shall be capable of carrying out immersion and withdrawal of the specimen, as specified in 7.4.3.



Key

- | | | | |
|---|---------------------------------|----|-----------------|
| 1 | specimen | 8 | housing |
| 2 | test jig plate | 9 | sensor |
| 3 | solder paste | 10 | transducer |
| 4 | heating bath | 11 | recorder |
| 5 | lift for test jig plate | 12 | controller |
| 6 | lift for heating bath | 13 | specimen holder |
| 7 | holding jig of a test jig plate | | |

Figure 1 – Example of quick heating method test equipment

7.2 Test jig plate

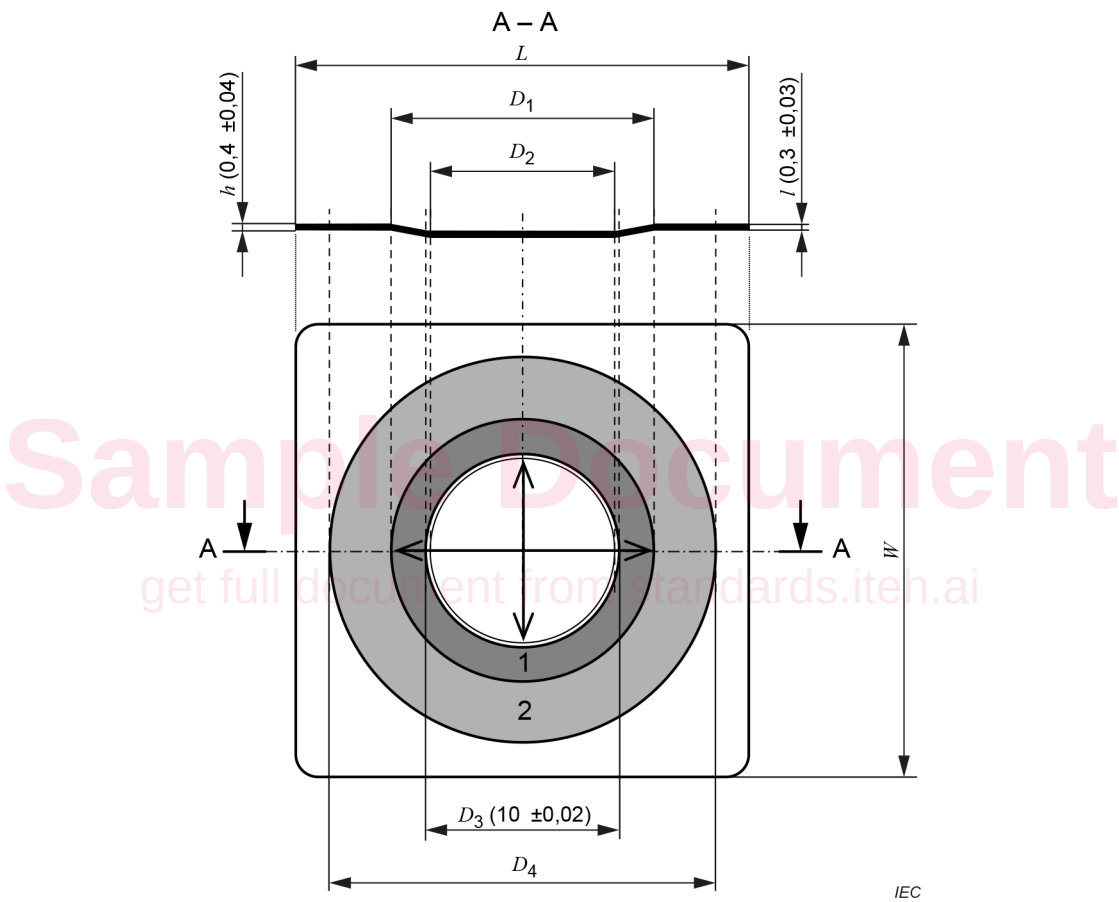
The test jig plate shall be as specified in Table 1.

Table 1 – Specification of the test jig plate for quick heating and synchronous method

Item	Specification of the test jig
material	oxygen-free phosphate copper
shape	circular indented pan
dimensions (L , W)	less than 30 mm on one side, or less than a total area of 900 mm ²
thickness (l)	0,3 mm $\pm$ 0,03 mm
drawing diameter (D_1 , D_2)	9 mm to 10 mm at the bottom, 13 mm to 14 mm at the top
drawing depth (h)	0,4 mm $\pm$ 0,04 mm

Item	Specification of the test jig
solder resist diameter (D_3 , D_4)	10 mm $\pm$ 0,02 mm for the inner diameter, over 20 mm for the outer diameter
solder resist thickness	0,035 mm $\pm$ 0,01 mm
warp	$\pm$ 0,05 mm (for the longer side for a rectangular shape)

An example of the test jig plate used in the quick heating and synchronous method is shown in Figure 2.



Key

- | | | | |
|-----------|---------------------------|-------|------------------------------|
| 1 | drawing for solder resist | D_1 | drawing outer diameter |
| 2 | solder resist | D_2 | drawing inner diameter |
| L , W | outer dimension | D_3 | solder resist inner diameter |
| l | thickness | D_4 | solder resist outer diameter |
| h | drawing depth | | |

Figure 2 – Example of test jig plate for quick heating and synchronous method

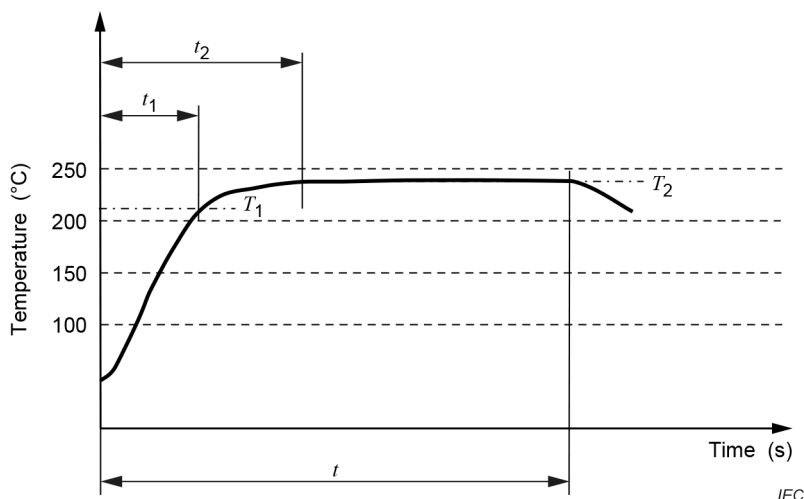
7.3 Preparation

The preparation shall be as specified in Clause 6.

7.4 Test condition

7.4.1 Test temperature

The test jig plate shall be processed using the temperature profile as specified. Figure 3 shows a typical example.



Symbol	Sn-Ag-Cu (SAC) type ^a	Sn-Pb type ^a
T_1	217 °C	183 °C
T_2	245 °C ± 3 °C	235 °C ± 3 °C
^a If agreed between the trading partners, the other types of solder paste can be used.		

Key

T_1 liquidous temperature

T_2 test temperature

T test duration (5 s to 15 s)

t_1 time from start to T_1

t_2 time from start to T_2

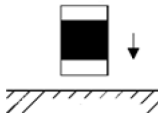
The test starts at a temperature of 50 °C or below. Time from start to T_1 (t_1) shall be 1,5 s or less. Time from start to T_2 (t_2) shall be 3 s or less. The ramp down rate is not specified.

Figure 3 – Example of temperature profile

7.4.2 Feed of solder paste and immersion condition

The recommended condition of immersing a specimen into the solder paste is given in Table 2. For components not specified in Table 2, test conditions shall be specified in the relevant specification or agreed upon between the trading partners.

Table 2 – Recommended test conditions of the quick heating and synchronous method for rectangular SMD

Sizes of specimen ^a		Immersion depth ^{b, c}	Direction of specimen immersing into solder paste
resistors	1005 (0402)	0,15 mm	Horizontal Rectangular SMD  Solder paste IEC
	1608 (0603)	0,20 mm	
	2012 (0805)		
	3216 (1206)		
capacitors	1005 (0402)	0,15 mm	
	1608 (0603)	0,20 mm	
	2012 (0805)		
	3216 (1206)		

^a Designation of the size, for example of 1005, means a specimen with a length of 1,0 mm and a width of 0,5 mm. The dimensions in parentheses are expressed in imperial units.

^b The immersion depths specified in this table are recommended since the buoyancy force varies depending on the electrode configuration.

^c The immersion depths are the target values.

7.4.3 Immersion and withdrawal conditions for test specimen

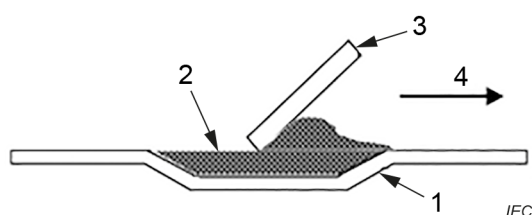
The immersion speed of the specimen into the solder paste shall be 0,5 mm/s to 1 mm/s. The immersion speed of the test jig into the heating bath shall be 1 mm/s to 5 mm/s.

NOTE Since the speed of taking out the specimen from the solder paste and the speed of taking out the test jig plate from the heating bath after the tests does not affect to the test results, these speeds are arbitrary.

7.5 Test procedure

The test procedure shall be as follows.

- a) Apply solder paste to the test jig keeping the surface flat. Figure 4 shows an example.



Key

- 1 test jig plate
- 2 solder paste
- 3 squeegee
- 4 direction of squeeze movement

Figure 4 – Example of application of solder paste to a test jig plate

- b) Mount a specimen into the clip so that the direction specified in 7.4.2 (horizontal) is realized. The clip shall be centralised to the upper surface of a test jig plate into which the solder paste has been applied.
- c) Adjust the output of the force sensor and the recorder to zero before the test commences.

d) Immerse the specimens as follows.

- 1) The specimen shall be immersed into the solder paste to the specified depth in 7.4.2. Then, heat the jig plate to melt the solder paste in accordance with the temperature profile as specified in Figure 3.
- 2) The specimen can be required to be immersed into the solder paste to the depth of twice or more the specified depth, and then the specified depth.

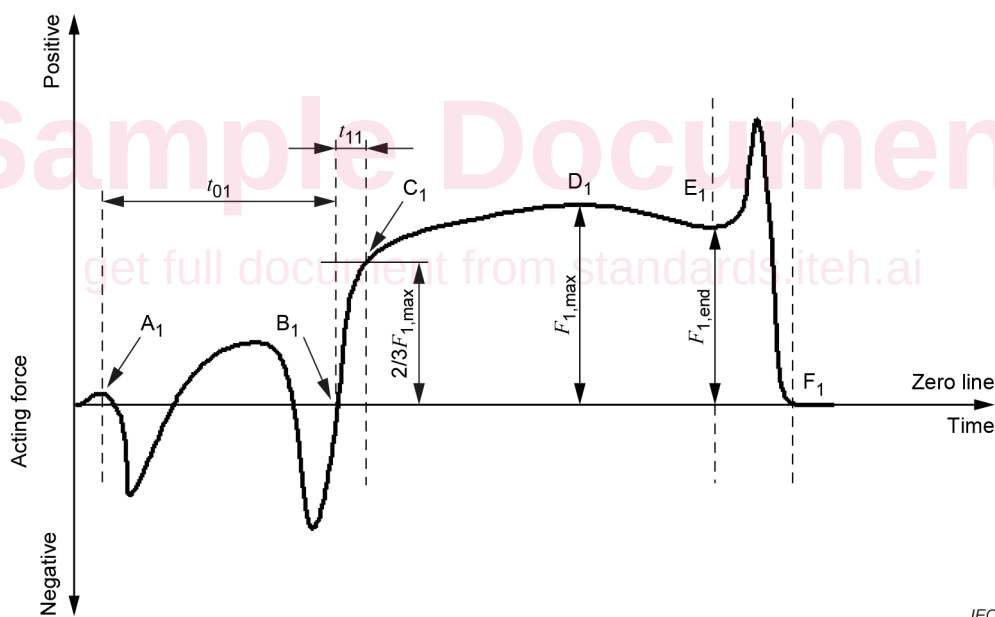
The purpose of this procedure is to apply flux on the portion of the specimen which corresponds to the immersion depth before heating.

e) Withdraw the specimen from the molten solder paste when measurement is finished. Recording of the result is completed when the force reaches to a stable state or specified duration.

7.6 Presentation of the result

The recorder records the force acted to the specimen in the vertical direction. The force acted upward (pushing force or buoyancy) is recorded as a negative value, and the force acted downward (wetting force) is recorded as a positive value.

A typical shape of the output signal obtained is shown in Figure 5. The meaning and correction of the data if different from the shape shown in Figure 5 are given in Annex B.



IEC

Key

- A_1 reference point to start time measurement (point A_1 is the first positive force peak during the test)
- B_1 instance when the force curve crosses the zero line
- C_1 instance when the wetting force reaches $2/3$ of the maximum wetting force
- D_1 instance when the maximum force is obtained in the measurement
- E_1 instance when the specimen is withdrawn after the measurement is completed
- F_1 instance when the force reaches stable state after the specimen is withdrawn from the jig plate
- t_{01} time to start wetting (time duration from point A_1 to point B_1)
- t_{11} wetting time (time duration from point B_1 to point C_1)
- $F_{1,max}$ maximum wetting force - maximum force obtained (the value from the zero line) in the measurement
- $F_{1,end}$ final wetting force - force obtained (the value from the zero line) at the end of the test

Figure 5 – Typical output shape of signal in the quick heating method