IEC 60068-2-54

Edition 2.0 2006-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Essais d'environnement –
Partie 2-54: Essais – Essai Ta: Essais de la soudabilité des composants électroniques à l'aide de la méthode de la balance de mouillage

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method

FOREWORD

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International Standard IEC 60068-2-54 has been prepared by IEC technical committee 91: Electronics assembly technology.

This second edition cancels and replaces the first edition, published in 1985 and constitutes a technical revision.

The major technical changes with regard to the previous edition concern:

– the addition of lead free solder alloy (see Clause 7, Materials);
– reversal of force-time curves to align with IEC 60068-2-69 (see Figure 2 and Figure B.1);
– modification to the test requirement for progress of wetting (see Clause 9).

This bilingual version (2013-07) corresponds to the monolingual English version, published in 2006-04.

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

FDIS	Report on voting
91/576/FDIS	91/587/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.

IEC 60068 consists of the following parts, under the general title *Environmental testing:*

Part 1: General and guidance

Part 2: Tests

Part 3: Supporting documentation and guidance

Part 4: Information for specification writers - Test summaries

Part 5: Guide to drafting of test methods

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- withdrawn,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.

ENVIRONMENTAL TESTING –

Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method

1 Scope

This part of IEC 60068 outlines Test Ta, solder bath wetting balance method applicable for any shape of component terminations to determine the solderability. It is especially suitable for reference testing and for components that cannot be quantitatively tested by other methods. For surface mounting devices (SMD), IEC 60068-2-69 should be applied if it is suitable.

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 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests – Test T: Soldering*

IEC 61190-1-3, *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*

3 Terms and definitions

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

4 General description of the test

The specimen is suspended from a sensitive balance (typically a spring system) and immersed edgewise to a set depth in a bath of molten solder at a controlled temperature. The resultant of the vertical forces of buoyancy and surface tension acting upon the immersed specimen is detected by a transducer and converted into a signal which is continuously recorded as a function of time on a high-speed chart recorder. The trace may be compared with that derived from a perfectly wetted specimen of the same nature and dimensions.

Two modes of testing exist:

– The stationary mode, intended to study the solderability of a particular place on the specimen. It is this mode which is standardized in this standard.

– The scanning mode, intended to study the homogeneity of the solderability of an extended region of the surface of the specimen. The standardization of this mode is still under consideration.

5 Description of the test apparatus

5.1 Test system

A diagram of an arrangement suitable for the test is shown in Figure 1.

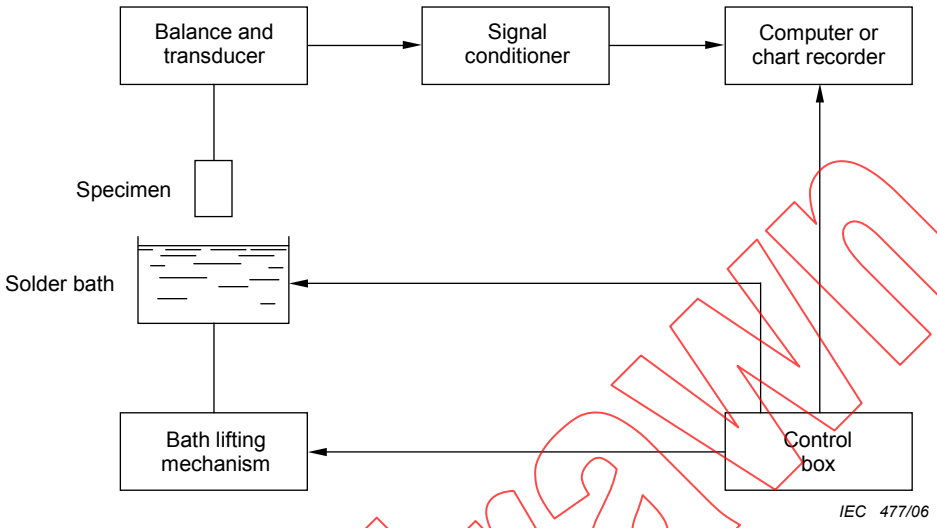

Figure 1 – Test arrangement

Any other system capable of measuring the vertical forces acting on the specimen is admissible, provided that the system has the characteristics given in Annex A.

5.2 Solder bath

The solder bath dimensions shall comply with the requirements of Clause A.7. The material of the solder bath container shall be resistant to the relevant liquid solder alloy.

6 Preconditioning

6.1 Preparation of specimens

The specimen shall be tested in the “as-received“ condition unless otherwise specified by the relevant specification. Care should be taken that no contamination, by contact with the fingers or by other means, occurs.

The specimen may be cleaned by immersion in a neutral organic solvent at room temperature, but only if required by the relevant specification; no other cleaning is permitted.

6.2 Ageing

When accelerated ageing is prescribed by the relevant specification, one of the methods of 4.5 of IEC 60068-2-20 shall be used.

7 Materials

7.1 Solder

7.1.1 General

Solder composition shall be specified in the relevant specification.

7.1.2 Solder alloy containing lead

The solder composition shall be either 60 % by mass (wt %) Sn(tin) and 40 wt % Pb(lead) according to Appendix B of IEC 60068-2-20 (Sn60Pb40A, according to IEC 61190-1-3) or 63 wt % Sn (tin) and 37 wt % Pb(lead) (Sn63Pb37A, according to IEC 61190-1-3).

7.1.3 Lead-free solder alloy

Unless otherwise specified in the relevant specification, the solder composition shall be either 3,0 wt % Ag(silver), 0,5 wt % Cu(copper) and the remainder of Sn(tin), Sn96,5Ag3,0Cu0,5, or 0,7 wt % Cu(copper) and the remainder of Sn(tin), Sn99,3Cu0,7, is preferred.

NOTE 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 Sn96,5Ag3,0Cu0,5. The solder alloys consist of 0,45 wt % to 0,9 wt % Cu and the remainder of Sn may be used instead of Sn99,3Cu0,7.

7.2 Flux

The flux to be used shall be either rosin based non-activated or rosin based activated as follows:

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

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

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

8 Procedure

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, solder temperature prior to test and during test shall be 245 °C ± 3 °C for Sn96,5Ag3,0Cu0,5 alloy and 250 °C ± 3 °C for Sn99,3Cu0,7 alloy respectively.

8.2 Fluxing

After mounting the specimen in a suitable holder, the portion of the surface specified shall be immersed in flux at room temperature. Excess flux is immediately drained off by standing the specimen vertically on clean filter paper for 1 s to 5 s.

8.3 Flux drying

The temperature of the solder prior to test shall be as specified in 8.1. The specimen is then suspended vertically with lower edge 20 mm ± 5 mm above the bath for 30 s ± 15 s to allow most of the flux solvent to evaporate, before initiating the test. During this drying period the suspension and the chart recorder trace shall be adjusted to the desired zero position, and immediately before starting the test, the surface of the solder bath is scraped with a blade of suitable material to remove oxides.

8.4 Test

The specimen is then immersed at a speed of 5 mm/s ± 1 mm/s to 20 mm/s ± 1 mm/s to the specified depth in the molten solder and held in this position for a specified time and then withdrawn. The relevant part of the recorder trace of force versus time is obtained when the specimen is held stationary in the immersed position.

NOTE The specimen should be immersed to the required depth within 0,2 s.

The trace shall be recorded starting immediately before immersion into molten solder and throughout test period.

Table 1 – Time sequence of the test

Procedure	Time s	Duration s
1) Immersion in flux	0	≈5
2) Flux drain	≈10	1 to 5
3) Hang the specimen on the apparatus	≈15	--
4) Preheat	≈20	30 ± 15
5) Wipe the oxide from the solder surface	≈60	
6) Start test	≈65	1 to 5
7) Solder immersion	70 max.	5
NOTE Time is elapsed time from immersion in flux. Duration is time for relevant procedure.		

9 Presentation of results

9.1 Form of chart-recorder trace

The trace may be recorded in two forms, the only difference being the polarity of the force readings.

In Figure 2, upward forces (non-wetting) are shown as negative and downward forces (wetting) are positive. Usually, force at *E* is equal to force at *D* indicating stable wetting conditions. If force at *E* is less than at *D*, some instability in wetting is present (see B.6.1.3).

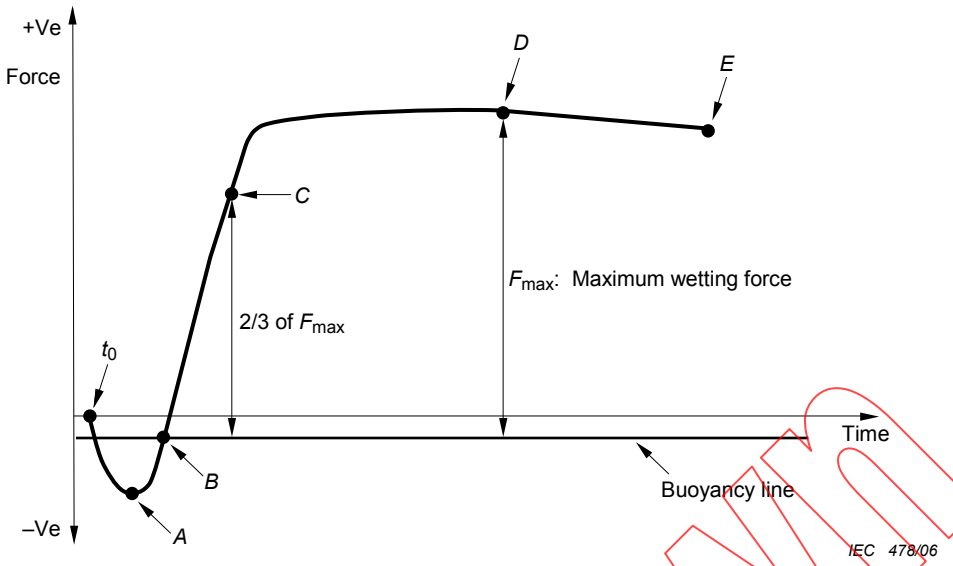

Figure 2 – Wetting conditions

9.2 Points of significance

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

9.2.2 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.

9.2.3 At point *B* the contact angle is 90°. The measured force is that due to the buoyancy of the component.

9.2.4 At point *C* the wetting force reaches two-thirds of the maximum value of the resultant wetting force. At point *C*, the wetting force shall exceed a specified value within a specified time.

9.2.5 Point *D* is the maximum value of the resultant wetting force is reached during the specified immersion period.

9.2.6 Point *E* is the point at the end of the specified immersion period. Points *D* and *E* may have the same force value on the same specimen (see B.6.1.3).

9.2.7 Interpretation of the trace formed during the withdrawal of the specimen is not considered in the stationary mode.

9.3 Reference wetting force

In order to obtain a practical reference against which to compare experimental results, the following procedure shall be carried out for each kind of component to be tested.

A specimen is taken from the sample to be tested and is pre-tinned under optimum conditions using the activated flux (refer to 7.2). This pre-tinning can be done on the wetting balance, set at the same conditions as are used for the wetting test. The procedure of pre-tinning shall be repeated on the same specimen till the maximum force reading does not further increase. The reference wetting force is this maximum force.

In order to investigate the general suitability for soldering of a certain material, the reference wetting force can be compared with the theoretical wetting force obtained by calculation under the assumptions of an appropriate surface tension constant and density of the solder alloy, together with the occurrence of "perfect" wetting.

The theoretical wetting force is obtained from the formula:

$$F = -g\rho v + \gamma P$$

where

g is the acceleration of gravity

ρ is the density of the solder

γ is the surface constant of the solder; and

F is obtained in mN, if

v the volume of the immersed part of the specimen, is given in cubic millimetres

P the perimeter of the immersed part of the specimen, is given in millimetres.

NOTE The formula is appropriate only if the cross-section of the specimen in the vicinity of the meniscus is constant through the length of the specimen. The constants are applicable only to the conditions described in the test. It is dependent on the alloy, temperature and flux (see B.6.2).

9.4 Test requirements

Requirements for solderability shall be expressed in terms of one or more of the following parameters:

– For the onset of wetting:
a maximum value for the time interval (t_0 to B)

– For the progress of wetting:
a maximum value of the time interval (t_0 to C)

– For the stability of the wetting:
a minimum value for the fraction: $\frac{\text{force at } E}{\text{force at } D}$.

10 Information to be given in the relevant specification

When a solderability test by the wetting balance method is specified the following details shall be defined:

Subclause

a) whether degreasing is required 6.1
b) ageing method, if required 6.2
c) solder alloy composition to be used 7.1
d) the type of flux to be used 7.2
e) test temperature 8.1
f) the portion of the specimen to be tested 8.2
g) the immersion depth 8.4
h) the duration of immersion 8.4
i) the immersion speed 8.4
j) the parameters to be measured from the trace 9.4
k) the acceptable values for these parameters 9.4