BS EN 60068-2-83:2011

BSI Standards Publication

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

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 60068-2-83:2011. It is idenitical to IEC 60068-2-83:2011.

The UK participation in its preparation was entrusted to Technical Committee EPL/501, Electronic assembly technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 58835 8

ICS 19.040; 31.190

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60068-2-83

October 2011

ICS 19.040; 31.190

English version

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

(IEC 60068-2-83:2011)

Essais d'environnement -
Partie 2-83: Essais -
Essais Tf: Essai de brasabilité des composants électroniques pour les composants pour montage en surface (CMS) par la méthode de la balance de mouillage utilisant de la pâte à braser
(CEI 60068-2-83:2011)

Umweltprüfungen -
Teil 2-83: Prüfungen -
Prüfung Tf: Prüfung der Lötbarkeit von Bauelementen der Elektronik für Oberflächenmontage (SMD) mit der Benetzungswaage unter Verwendung von Lotpaste
(IEC 60068-2-83:2011)

This European Standard was approved by CENELEC on 2011-10-12. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 91/975/FDIS, future edition 1 of IEC 60068-2-83, prepared by IEC/TC 91 "Electronics assembly technology" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60068-2-83:2011.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-07-12
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2014-10-12

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60068-2-83:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-69	NOTE	Harmonized as EN 60068-2-69.
IEC 61189-5	NOTE	Harmonized as EN 61189-5.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	-	Environmental testing - Part 1: General and guidance	EN 60068-1	-
IEC 60068-2-20	2008	Environmental testing - Part 2-20: Tests - Test T: Test methods for solderability and resistance to soldering heat of devices with leads	EN 60068-2-20	2008
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)	EN 60068-2-58	-
IEC 60194	-	Printed board design, manufacture and assembly - Terms and definitions	EN 60194	-
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	EN 61190-1-3	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

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

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

FDIS	Report on voting
91/975/FDIS	91/992/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.

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

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

INTRODUCTION

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents as indicated below.

IEC takes no position concerning the evidence, validity and scope of patent rights.

The holders of the patent rights have assured the IEC that they are willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained as indicated below.

a) EU patent 0920488.4 “Synchronous test method for assessing soldering pastes”[1]

Gen3 Systems LTD

Unit B2

Armstrong Mall

Farnborough GU14 0NR

United Kingdom

b) JP Patent 2630712 “Testing method of characteristics of solder paste and the equipment for the test”

Malcom Co., Ltd

4-15-10 Honmachi, Shibuya-ku

Tokyo, 151-0071

Japan

c) Patent JP 3789041 “Solderability measuring apparatus”

Patent JP 3552061 “Solderability tester and solderability test method”

Patent JP 3498100 “Method and device for testing solderability and microcrucible for testing”

Patent JP 3153884 “Measuring device for soldering performance of cream solder”

Tarutin Kester Co., Ltd.

2-20-11 Yokokawa,

Sumida-ku

Tokyo, 130-0003

Japan

d) Sony Corporation

1-7-1 Konan Minato-ku

Tokyo 108-0075

Japan

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

---

1 Status of patent: Pending.

ISO (www.iso.org/patents) and IEC (http://patents.iec.ch) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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 pastes.

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 prescribes visual evaluation using solder bath and reflow method, IEC 60068-2-69 prescribes wetting balance evaluation using solder bath and solder globule method.

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 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: 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, *Printed board design, manufacture and assembly – Terms and definitions*

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 given in IEC 60068-1, IEC 60068-2-20:2008, IEC 60068-2-58, IEC 60194, and IEC 61190-1-3 and the following apply.

3.1
wettability
ease with which a metal or metal alloy can be wetted by molten solder

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
starting point of heating
time of the start of temperature rise by heating the solder paste applied to a testing jig

3.4
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) may 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 not specified in this standard.

5 Preconditioning

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

When accelerated ageing is prescribed by the relevant specification, one of the methods of 4.1.4 (Ageing 1) of IEC 60068-2-20:2008 shall be used. The aging condition shall be specified in the relevant specification.

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, it is important to prepare the solder paste properly.

a) The solder paste shall be allowed to achieve ambient conditions that shall be nominally 25 °C ± 5 °C and 50 % RH ± 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 paste adhering to the lid(s), internal covers, and the container walls; and add this material to the paste in the supply container(s).

c) Using a spatula, stir the paste gently for 1 min to 2 min to homogenize it; taking care to avoid the introduction of air.

   If necessary, gently transfer the paste to a test container of sufficient volume, taking care to avoid the introduction of air.

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 desirable to use ultrasonic agitation in cleaning.

7 Quick heating method

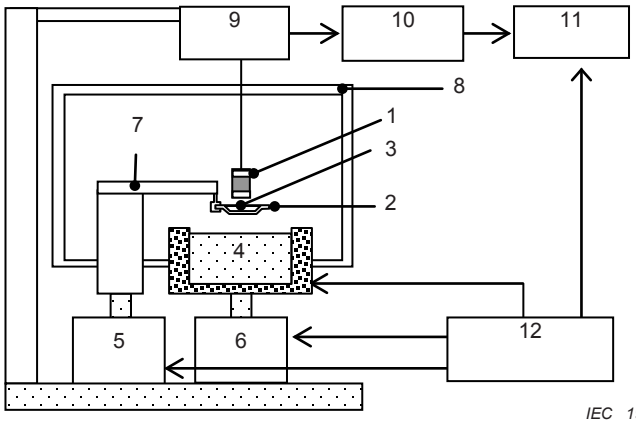
7.1 Equipment

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.

a) The measuring system consists of the force sensor that can measure the force vertically acted on a specimen, signal transducer and a recorder.

b) The heating system shall be capable of controlling the determined set temperature within ± 3 °C.

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	7	Holding jig of a test jig plate
2	Test jig plate	8	Housing
3	Solder paste	9	Sensor
4	Heating bath	10	Transducer
5	Lift for test jig plate	11	Recorder
6	Lift for heating bath	12	Controller

Figure 1 – Examples of the quick heating method test equipment

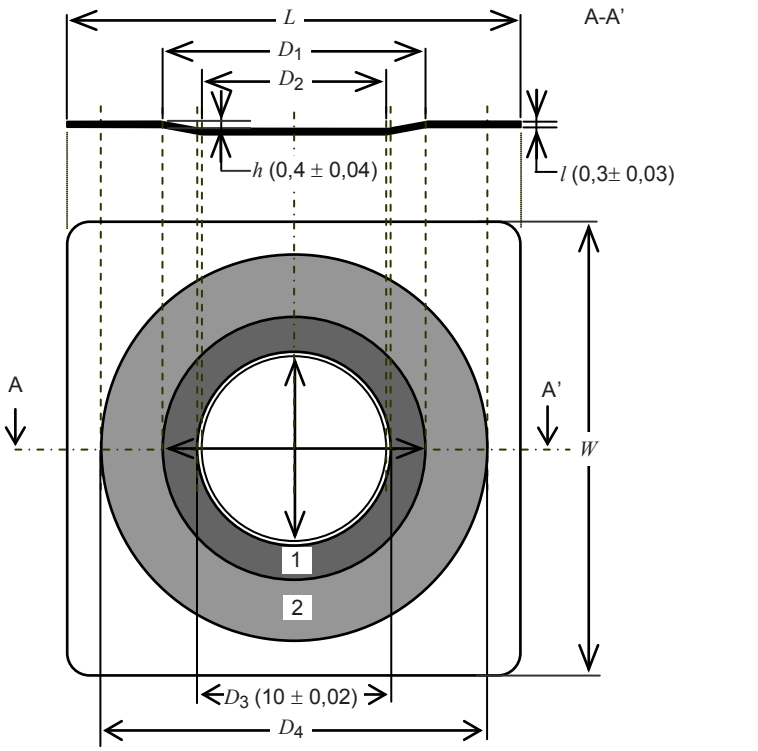
7.2 Test jig plate

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 one the side, or less than a total area of 900 mm^2
Thickness (l)	0,3 mm ± 0,03 mm
Drawn diameter (D_1, D_2)	9 mm to 10 mm at the bottom, 13 mm to 14 mm at the top
Drawn depth (h)	0,4 mm ± 0,04 mm
Solder resist (D_3, D_4)	Inner diameter of 10 mm ± 0,02 mm, and over 20 mm for the outer diameter
Resist coat thickness	0,035 mm ± 0,01 mm
Warp	± 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	h	Drawing depth
2	Solder resist	l	Thickness
L, W	Outer dimension		
D_1	Outer diameter of drawing	D_3	Inner diameter of solder resist
D_2	Inner diameter of drawing	D_4	Outer diameter of solder resist

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

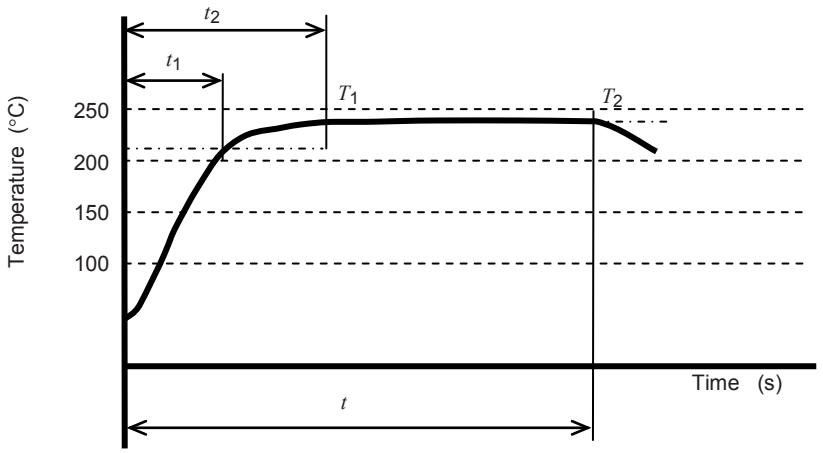
7.3 Preparation

See Clause 6 for details.

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	SAC type	Sn-Pb type
T_1	217 °C	183 °C
T_2	245 °C ± 3 °C	235 °C ± 3°C

Key

T_1 Solder melting temperature

T_2 Test temperature

t Test duration (5 s to15 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 less.

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.

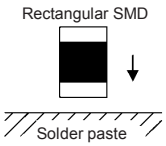
The ramp down rate is not specified.

Figure 3 – Example of the 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]	Angle and direction of specimen immersing into solder paste
Resistors	1005 (0402)	0,15 mm	Horizontal 
	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. In parentheses, dimensions are expressed in Imperial.

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

c The immersion depth is the target values.

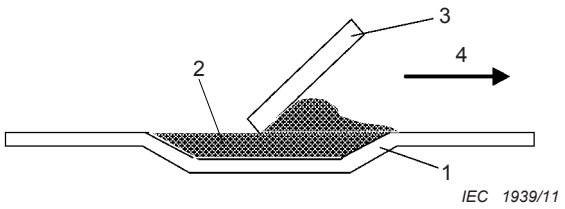
7.4.3 Immersion and withdrawal conditions for test specimen

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.

7.5 Test procedure

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 applying solder paste to a test jig plate

b) Mount a specimen into the clip until the angle specified in 7.4.2 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) 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.

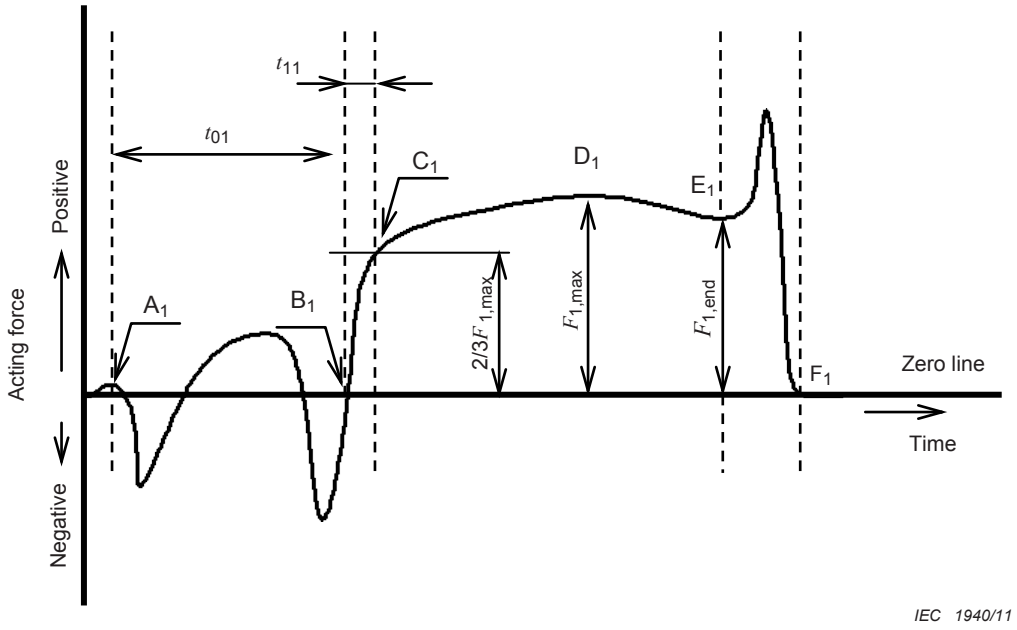
NOTE The specimen may need to be immersed into the solder paste to the depth of twice or more the specified depth, and then the specified depth. The purpose of this procedure is to apply flux on the portion of the specimen which corresponds to the immersion depth, before heating.

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 to the upper direction (pushing force or buoyancy) is recorded as a negative value, and the force acted downward to the specimen (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.



Key

A_1	Reference point to start time measurement.
	NOTE 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 to 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. The time duration from point B_1 to point C_1.
$F_{1,max}$	Maximum wetting force. The maximum force obtained (the value from the zero line) in the measurement.
$F_{1,end}$	Final wetting force. The 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

7.7 Characterisation parameter examples

a) The time to start wetting: t_{01}

b) Wetting time: t_{11}

c) Maximum wetting force: $F_{1,max}$

d) Wetting stability: Sb_1; The ratio of the final wetting force ($F_{1,end}$) and the maximum wetting force ($F_{1,max}$).

NOTE Wetting stability is calculated from $Sb_1 = F_{1,end}/F_{1,max}$.

8 Synchronous method

8.1 Equipment

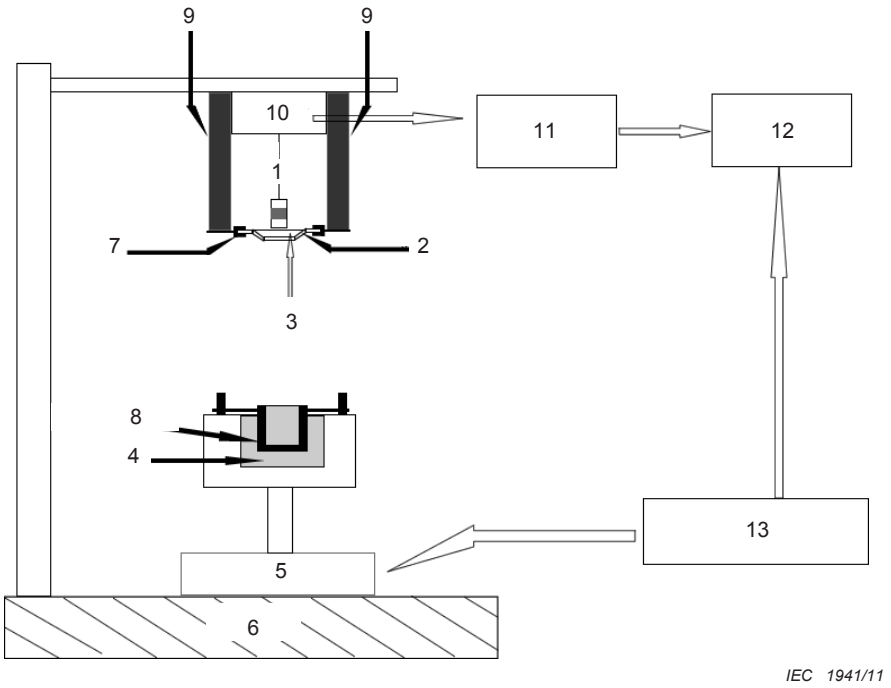
The equipment used for the synchronous method consists of measurement, heating and lift system as shown in Figure 6. The detailed requirements to the equipment are specified in Annex A.

a) The measuring system consists of the force sensor that can measure the force vertically acted on a specimen, signal transducer and a recorder.

b) The heating system shall be capable of controlling the set temperature within the preset tolerances specified in 8.5.1.

c) The lift system shall be capable of carrying out immersion and withdrawal of the specimen as specified in 8.5.3.

d) The synchronous fixturing system shall be capable of permitting the simultaneous immersion and heating of the specimen as specified in 8.6.



Key

1	Specimen	8	Mini crucible
2	Test jig plate	9	Support bars with spring
3	Solder paste	10	Sensor
4	Heating bath	11	Transducer
5	Lift	12	Recorder
6	Base	13	Controller
7	Test jig plate holder		

Figure 6 – Example of synchronous method test equipment

8.2 Test jig plate

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

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

8.3 Synchronous fixture

An example of the synchronous fixture is shown below in Figure 7.

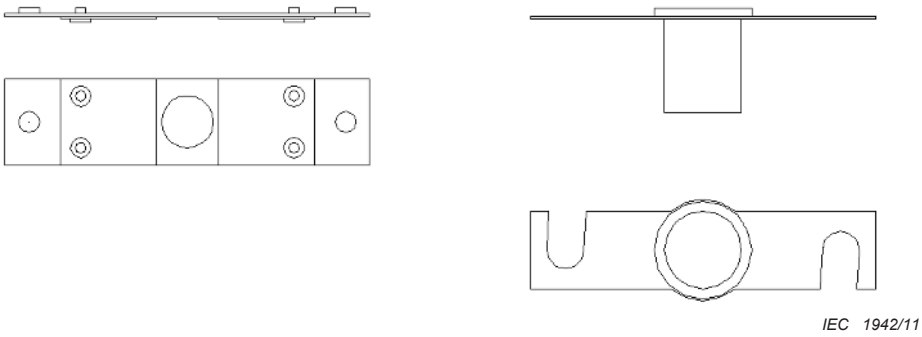


Figure 7a – Test jig plate holder **Figure 7b – Mini crucible**

Figure 7 – Example of synchronous fixture

8.4 Preparation

See Clause 6 for details.

8.5 Test condition

8.5.1 Test temperature

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

8.5.2 Feed of solder paste and immersion condition

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

8.5.3 Immersion and withdrawal conditions for the test specimen

The immersion speed of the specimen into the solder paste shall be 0,5 mm/s to 1 mm/s, and that of the mini crucible shall be 1 mm/s to 5 mm/s.

8.6 Test procedure

Test procedure shall be as follows.

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

b) Mount a specimen into the clip until the angle specified in 7.4.2 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.

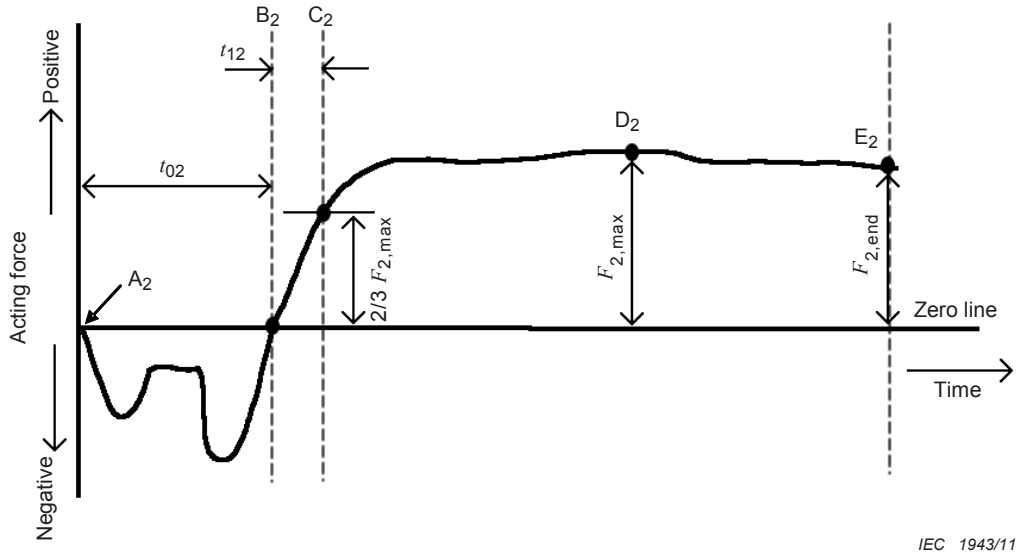
d) Mount the jig plate holder onto the supporting bars, adjust the supporting bars' height just above the surface of the solder paste close to the bottom edge of the electrode. Then, heat the jig plate to melt the solder paste in accordance with the temperature profile, as specified in Figure 3, and the specimen and the solder paste are then brought into contact synchronously. The immersion speed shall be as specified in 8.5.3.

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

8.7 Presentation of the results

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

A typical shape of the output signal obtained is shown in Figure 8.



Key

A_2	Instance when the measurement starts. The specimen is brought in contact with solder paste that is melting.
B_2	Instance when the output crosses the zero line. The downward force of the surface tension is exactly equal to the buoyancy force.
C_2	Instance when the wetting force reaches 2/3 of the maximum wetting force.
D_2	Instance when the maximum wetting force is obtained in the measurement.
E_2	Instance when the specimen is withdrawn and the measurement is completed.
t_{02}	Time to start wetting. Time duration from point A_2 to point B_2.
t_{12}	Wetting time. The time duration from point B_2 to C_2.
$F_{2,max}$	Maximum wetting force. The maximum force optained (the value from the zero line) in the measurement.
2/3 $F_{2,max}$	2/3 of the maximum wetting force.
$F_{2,end}$	Final wetting force. The force obtained (the value from the zero line) at the end of the test.

NOTE Certain solder pastes may cause an initial wetting (pull) force that may be attributed to the wetting agents contained in some solder pastes (see Annex E).

Figure 8 – Typical output shape of signal in the synchronous method

8.8 Characterisation parameter examples

a) The time to start wetting: t_{02}

b) Wetting time: t_{12}

c) Maximum wetting force: $F_{2,max}$

d) Wetting stability: Sb_2; The ratio of the final wetting force ($F_{2,end}$) and the maximum wetting force ($F_{2,max}$).

NOTE Wetting stability is calculated from $Sb_2 = F_{2,end}/F_{2,max}$.

9 Temperature profile method

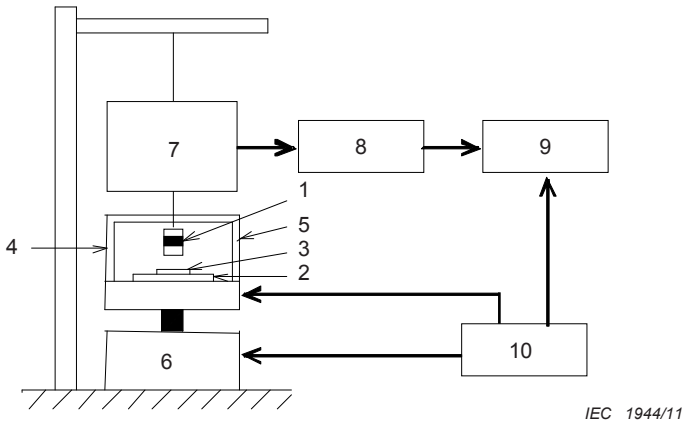
9.1 Equipment

The equipment for the temperature profile method consists of systems of measurement, heating, and mechanical lift. An example of the measurement system is shown in Figure 9. Requirements to the system are given in Annex C.

a) The measuring system shall consist of a force sensor that can measure a force generated in the vertical direction to the specimen, mechanical-electrical signal converter, and recording equipment.

b) The heating system shall realize the temperature profile specified in 9.4.1.

c) The lift system shall consist of a lift mechanism which can ascend and descend with the conditions specified in 9.4.3.



Key

1	Specimen	6	Lift
2	Test jig plate	7	Sensor
3	Solder paste	8	Transducer
4	Heating unit	9	Recorder
5	Housing	10	Controller

Figure 9 – Example of the system for temperature profile method test equipment

9.2 Test jig plate

The test jig plate shall be as specified in Table 3.

Table 3 – Specification of the test jig plate of the temperature profile method

Item	Specification of the test jig plate
Material	oxygen-free phosphate copper
Shape	square or rectangular plate
Size	15 mm to 35 mm for each side
Thickness	0,3 mm ± 0,03 mm
Warp	±0,05 mm (the longer side for a rectangular shape)

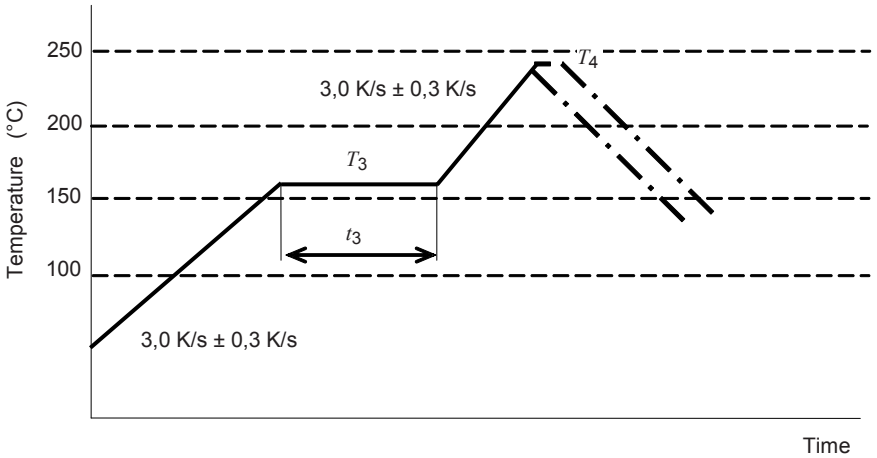
9.3 Preparation

See Clause 6 for details.

9.4 Test condition

9.4.1 Test temperature

The test temperature is the temperature of the jig used in the test. The test jig plate shall be processed using the temperature profile as specified. Figure 10 shows a typical example.



Symbol	SAC type [a]	Sn-Pb type [a]
T_3	160 °C ± 5 °C	150 °C ± 5 °C
t_3	80 s ± 5 s	80 s ± 5 s
T_4 [b]	245 °C ± 3 °C	220 °C ± 3 °C

[a] For example: SAC type (Sn96,5Ag3Cu,5), Sn-Pb type (Sn63Pb37)

[b] T_4 is the preset temperature of the heating unit. The jig temperature may not reach the preset temperature.

Key

T_3 Pre-heating temperature t_3 Pre-heating duration

T_4 Peak temperature

The measurement starts at a temperature of 50 °C or less.

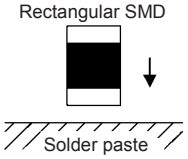
The ramp down rate is not specified.

Figure 10 – Example of the temperature profile

9.4.2 Feed of solder paste and immersion condition

The recommended amount of solder paste and the condition of immersion of a specimen into the solder paste used in the soldering test are given in Table 4. For component not specified in Table 4, test conditions shall be specified in the relevant specification or agreed upon between the trading partners.

Table 4 – Recommended test conditions of the temperature profile method for rectangular SMD

Types and sizes of specimens [a]		Amount of solder paste applied [b, c]		Immersion depth [c]	Angle and direction of specimen immersing into solder paste
		Diameter mm	Thickness mm	mm	
Capacitors	1005 (0402)	3	0,20	0,05	Horizontal Rectangular SMD 
	1608 (0603)				
Resistors	1005 (0402)				
	1608 (0402)				
Capacitors	2012 (0805)	5	0,30		
	3216 (1206)				
Resistors	2012 (0805)				
	3216 (1206)				

[a] Designation of the size, for example 1005, means a specimen with a length of 1,0 mm and a width of 0,5 mm. In parentheses, dimensions are expressed in Imperial.

[b] The amount of applied solder paste is specified according to the size of a specimen.

[c] The amount of solder paste and immersion depth are the target values.

9.4.3 Immersion and withdrawal conditions for test specimen

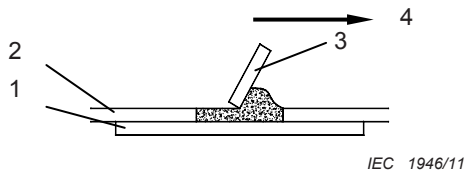
The specimen is immersed in the unfused solder paste to cover the test area with the paste. The specimen is then withdrawn from the solder paste during temperature ramp-up to separate the cohesion force of the solder paste and wetting force of the specimen to solder. The timing of separation shall be 0,5 s prior to the time that the acting force becomes zero expected from the gradient after the acting force reached a peak. After 0,5 s, the specimen is separated from the solder paste, and then the specimen shall be immersed again into the solder paste, returned to the previous position.

The speed of withdrawal and re-immersion of the specimen to and from the solder paste shall be 5 mm/s ± 0,5 mm/s.

9.5 Test procedure

Test procedure shall be as follows.

a) Apply a specified amount of solder paste in 9.4.2 to a test jig plate whose surface is cleaned. Use a stainless steel mask and a stainless steel or urethane squeegee to apply the solder paste to a jig plate as shown below in Figure 11.



Key

1 Test jig plate
2 Metal mask
3 Squeegee
4 Direction of squeeze movement

Figure 11 – Example of applying solder paste to a test jig plate

b) Fix the specimen on the holder designed to realize the immersion angle specified in 9.4.2. Place the holder on the test jig plate at the centre of the plate.

c) Adjust the output of the force sensor to zero before the specimen is immersed into the solder paste. Immerse the specimen into the solder paste. The condition of immersion of the specimen shall be as specified in 9.4.2.

d) Heat the jig plate to melt the solder paste in accordance with the temperature profile specified in Figure 10. The specimen is then withdrawn from the solder paste during temperature ramp-up.

e) Immerse the specimen again into the solder paste immediately before the temperature of solder reaches to the liquidus temperature (approximately 217 °C for SAC type solder paste and approximately 183 °C for Sn-Pb type solder paste).

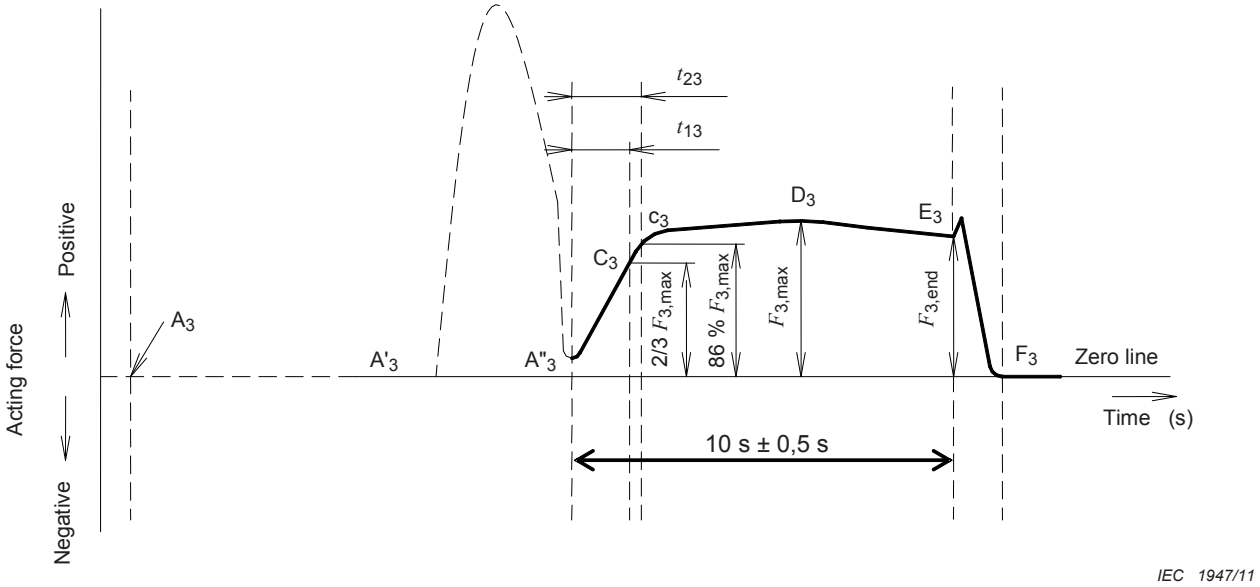
f) Withdraw the specimen from the molten solder paste when the measurement is finished. The recorder shall record the signal of the force from the transducer from A''_3 to F_3 as specified in Figure 12. Measurement finishes when the force reaches to a stable state or specified duration.

9.6 Presentation of the result

A typical shape of the output signal obtained as the sample temperature is raised according to the specified temperature profile, is shown in Figure 12. The meaning and correction of the data different from the shape shown in Figure 12 are given in Annex C.

The data for the period between A_3 and A''_3 are not used in the evaluation of wetting force of the specimen.

NOTE The upward force as shown in Figure 12 with a dotted line between A'_3 and A''_3 is the coagulation force when the solder paste melts.



Key

A_3 The instance the test jig starts to heat.

A'_3 Instance when the flux in the solder starts to melt.

A''_3 Instance when the wetting of the solder to the specimen starts.

C_3 Instance when the wetting force reaches 2/3 of the maximum wetting force.

c_3 Instance when the wetting force reaches 86 % of the maximum wetting force.

D_3 Instance when the maximum wetting force is obtained in the measurement.

E_3 Instance when the specimen is withdrawn after the measurement is completed.

F_3 Instance when the force reaches stable state after the specimen is withdrawn from the jig plate.

t_{13} Wetting time (2/3). Time duration between point C_3 and point A''_3.

t_{23} Wetting time (86 %). Time duration between point c_3 and point A''_3.

$F_{3,max}$ Maximum wetting force. The maximum force obtained (the value from the zero line) in the measurement.

$F_{3,end}$ Final wetting force. The force obtained (the value from the zero line) at the end of the test.

Figure 12 – Typical output shape of signal in the temperature profile method

9.7 Characterisation parameter examples

a) Wetting time: t_{13} and/or t_{23}

b) Maximum wetting force: $F_{3,max}$

c) Wetting stability: Sb_3; The ratio of the final wetting force ($F_{3,end}$) and the maximum wetting force ($F_{3,max}$).

NOTE Wetting stability is calculated from: $Sb_3 = F_{3,end} / F_{3,max}$.

Annex A
(normative)

Equipment for the quick heating and synchronous method

A.1 General

This annex specifies the details of the test equipment for the quick heating and synchronous method.

A.2 Test equipment

A.2.1 General

The details of the test equipment are specified as follows.

A.2.2 Measuring system

The measuring system shall satisfy the following requirements.

a) The range of measurement of the wetting force shall be −10 mN to +10 mN.

b) The displacement sensitivity of the force sensor shall be better than 0,5 mN/μm.

c) The resolution of the force sensor shall be better than 0,01 mN.

d) The continuous recording of the output signal shall cover A_1 to F_1 of the data shown in Figure 5 and A_2 to E_2 of the data shown in Figure 8.

e) The recorder shall be able to record the output data on a recording sheet, or shall be able to display the data by means of, e.g., a personal computer.

f) The time resolution of the record shall be better than 0,1 s.

g) The response time of the recording tip of the recorder used shall be better than 0,3 s to return from the maximum output to the zero center of recording and the overshoot shall be less than 1 % of the reading on the record.

h) The electrical and mechanical noises of the system shall not exceed 10 % of the signal.

A.2.3 Heating system

The heating system shall comply with the following requirements.

a) The heating section of the system shall realize the temperature profile as specified in Figure 3.

b) The size of the heating bath shall be of a diameter larger than 50 mm and of a depth deeper than 15 mm.

c) The inner diameter of the mini crucible for synchronous method shall be 25 mm.

A.2.4 Lift system

The lift system shall comply with the following requirements.

a) The immersion depth of the specimen into the solder paste on the test jig plate can be adjusted by 0,05 mm increment with the maximum depth equal to the drawing depth of the test jig plate.

b) The position resolution shall be controllable better than 0,02 mm.

c) The system shall be capable of immersing a specimen in solder paste and the test jig into the heating bath, as specified in 7.4.3.

Annex B
(informative)

Reading of the output data and correction of the result in the quick heating test

B.1 General

This annex specifies the reading of the output data and correction of the result other than as shown Figure 5.

B.2 Reading of the output form in the quick heating test

Typical examples other than as shown in Figure 5 are given in Figure B.1. The bold line shows the force applied to a specimen as a function of time, and the horizontal fine line shows the zero line.

a) The time the force line crosses the zero line, B_1:

   B_1 cannot be obtained in a case the force line does not cross the zero line, and the start of wetting, t_{01} , and the wetting time, t_{11}, cannot be attained neither. A virtual B_1 should be obtained in the chart from the crossing point of an extended supplemental line and the zero line.

   B_1 for the cases a) to c) and g) is the B_1 as given in the figures. The correction for the cases of d) to f) in Figure B.1 shall be made in accordance with B.3.

   B_1 for case h) in Figure B.1 cannot be obtained

b) Maximum wetting force, $F_{1,max}$:

   $F_{1,max}$ for the cases a) to d) is the $F_{1,max}$ as given in the figures. The correction for the cases of e) to g) in Figure B.1 shall be made in accordance with B.3.

   $F_{1,max}$ for the case h) in Figure B.1 cannot be obtained.

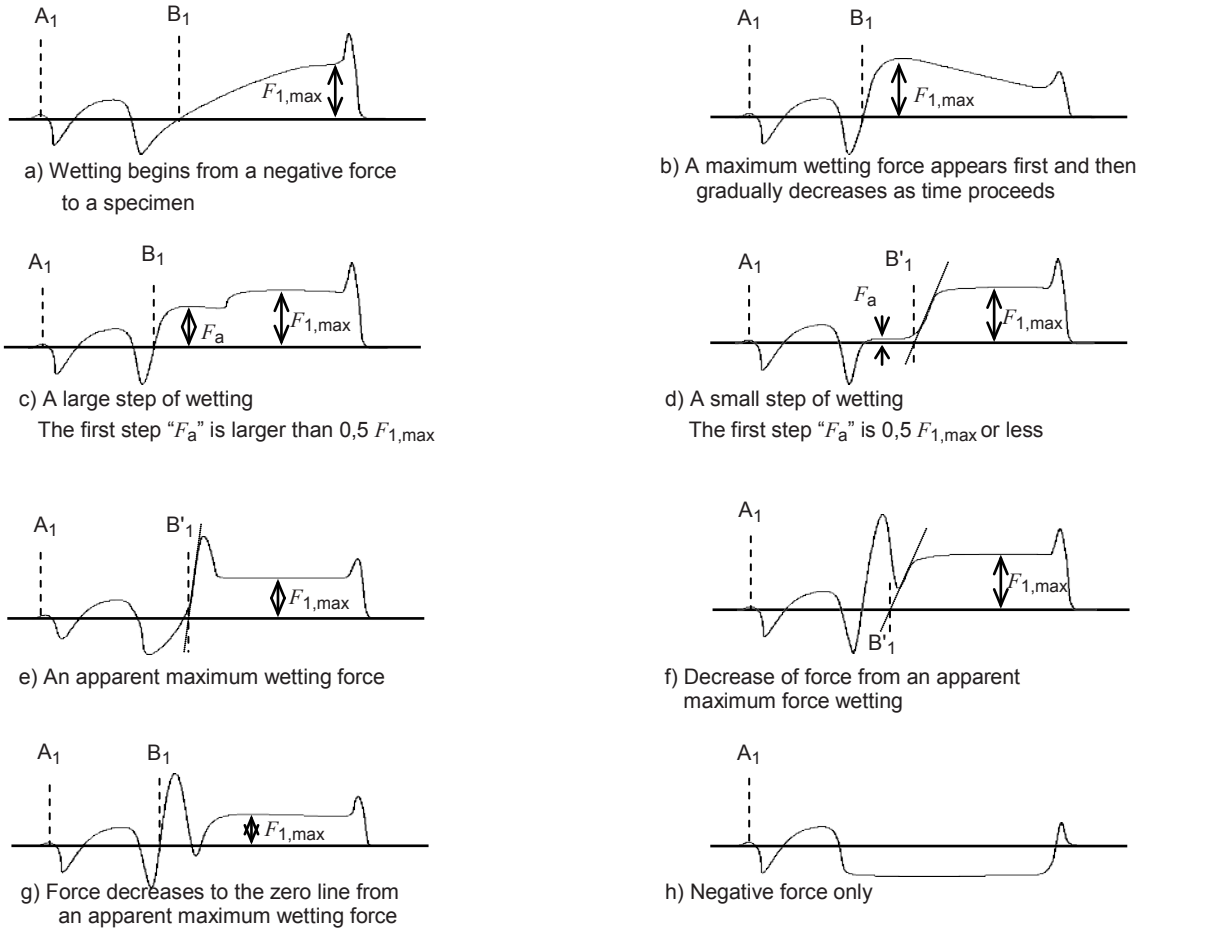


Figure B.1 – Typical wetting force changes in quick heating method

B.3 Correction to the typical data attained by the quick heating method

Corrections to the experimentally obtained data are made in the following cases.

a) Correction to the initial wetting time applicable to cases where the wetting force changes in a step-wise (Figures B.1c and B.1d): When the wetting force is in a step-wise state, the correction is made according to either Figure B.2 or Figure B.3 to determine the initial wetting time, t_{01}, depending on whether the value of wetting force is larger or smaller than 1/2 of the maximum wetting force.

   1) The wetting force at the first step, F_a, is larger than 0,5 $F_{1,max}$ (applicable to Figure B.1c).

      The start of wetting of the first step is taken as the initial time of wetting, B_1.

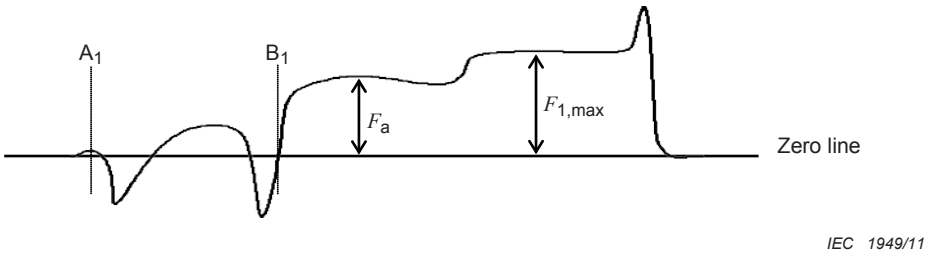


Figure B.2 – Example of correction of the initial time of wetting (F_a is larger than 0,5$F_{1,max}$)

2) The wetting force at the first step, F_a, is 0,5$F_{1,max}$ or less (applicable to Figure B.1, d))

Draw a tangential line to the wetting curve and obtain the crossing of this tangential line and the zero line to obtain the initial time of wetting, B'$_1$.

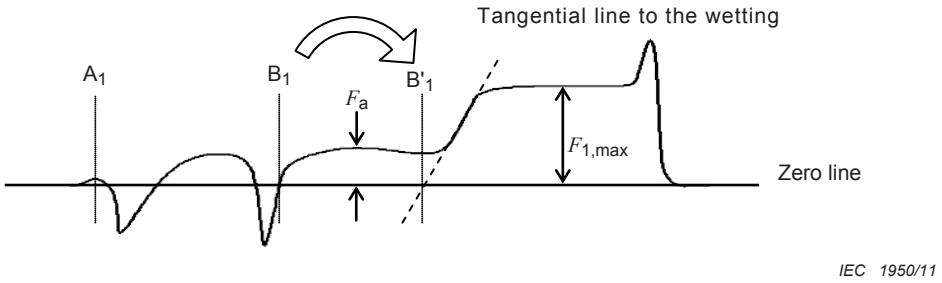


Figure B.3 – Example of correction of the initial time of wetting (F_a is 0,5$F_{1,max}$ or less)

b) Correction to the initial wetting time applicable to cases where a sharp positive peak appears in the wetting Figure B.1e to g:

1) Correction to the initial time of wetting (applicable to Figure B.1, e) to f).

Draw a tangential line to the wetting curve (refer to Figure B.3) and obtain the crossing of this tangential line and the zero line to obtain the initial time of wetting, B'$_1$.

2) Correction to the maximum wetting force (applicable to Figure B.1, e) to g)

The maximum wetting force is the force when wetting has reached stable state.

The time to reach 2/3 of the maximum wetting force (refer to C_1 in Figure 5) is obtained from the corrected maximum wetting force.

Annex C
(normative)

Test equipment for the temperature profile method

C.1 General

This annex specifies the details of the test equipment for the temperature profile method.

C.2 Test equipment

C.2.1 General

The details of the test equipment are specified as follows.

C.2.2 Measuring systems

The measuring system shall satisfy the following requirements.

a) The range of measurement of the wetting force shall be −10 mN to +10 mN.

b) The displacement sensitivity of the force sensor shall be better than 0,5 mN/μm.

c) The resolution of the force sensor shall be better than 0,01 mN.

d) The continuous recording of the output signal shall cover A''_3 to F_3 of the data shown in Figure 12.

e) The recorder shall be able to record the output data on a recording sheet, or shall be able to display the data by means of, e.g., a personal computer.

f) The time resolution of the record shall be better than 0,1 s.

g) The response time of the recording tip of the recorder used shall be better than 0,3 s to return from the maximum output to the zero center of recording and the overshoot shall be less than 1 % of the reading on the record.

h) The electrical and mechanical noises of the system shall not exceed 10 % of the signal.

C.2.3 Heating system

The heating system shall comply with the following requirements.

a) The heating section of the system shall realize the temperature profile as specified in Figure 10.

b) The temperature difference between the solder paste and the electrodes of testing specimen shall be less than 5 °C for the temperature of solder paste of 212 °C to 222 °C (SAC) or 178 °C to 188 °C (Sn-Pb). The temperature difference may be within 10 °C when the temperature of the solder paste is outside of this temperature range. The temperature difference caused by the latent heat of solder paste is not specified in this standard.

C.2.4 Lift system

The lift system shall comply with the following requirements.

a) The speed of immersion and withdrawal shall be 0,5 mm/s to 5 mm/s.

b) The position resolution shall be controllable better than 0,01 mm.

c) The system shall be capable of immersing a specimen in solder paste until the withdrawal of the specimen from the solder paste, as specified in 9.5.

Annex D
(informative)

Reading of the output data and correction of the result in the temperature profile test

D.1 General

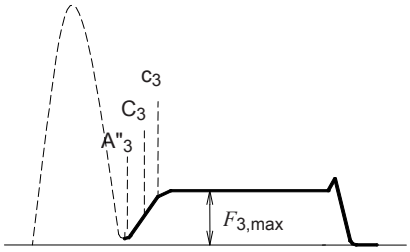
This annex specifies the reading of the output data and correction of the result other than as shown in Figure 12.

D.2 Reading of the output form in the temperature profile test

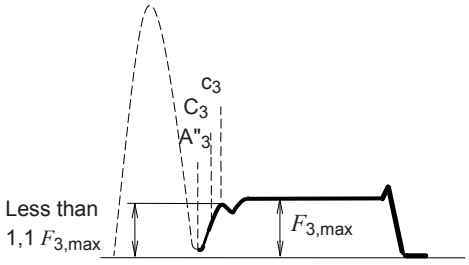
Typical examples other than as shown in Figure 12 are given in Figure D.1. The bold line shows the force acted to a specimen as a function of time, and the horizontal fine line shows the zero line. The wetting time and the value of $F_{3,max}$ are used as they are for the cases a), b) and e) to f) as shown in Figure D.1.

The correction for the case of c) in Figure D.1 shall be made in accordance with Clause D.3.

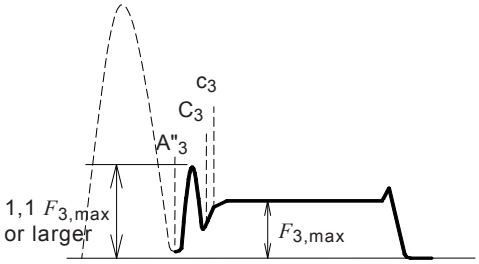
The result cannot be obtained in the case of d) in Figure D.1.



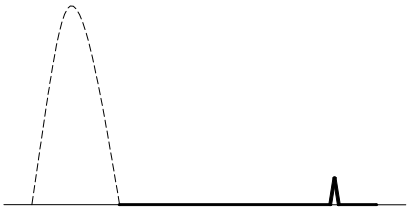
a) Wetting starts immediately



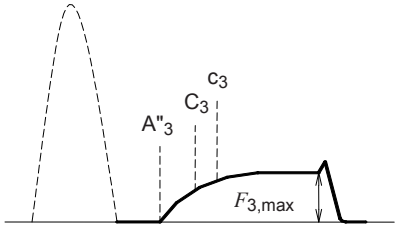
b) An extruding acting force is experienced immediately after start of wetting (less than 1,1 $F_{3,max}$)



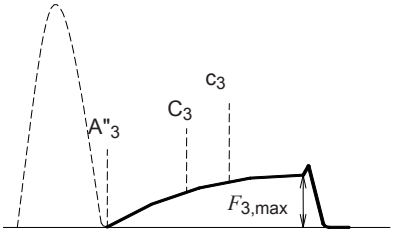
c) An extruding acting force is experienced immediately after start of wetting (1,1 $F_{3,max}$ or larger)



d) No wetting



e) Retarded wetting



f) No complete wetting during the test

IEC 1951/11

Figure D.1 – Typical output forms for profile temperature test

D.3 Correction to the typical data attained by the temperature profile method

Data for the wettability are obtained from the experimental data when a chart as shown in Figure D.1c is attained from the obtained chart using the illustration given in Figure D.2. In the case an extruding force larger than 1,1 times the maximum wetting force, $F_{3,max}$, is applied to a specimen after a coagulation force is generated due to the melting of solder paste (A''$_3$ to C_3 in Figure 12), the wetting time t_{13} and t_{23}, the maximum wetting force $F_{3,max}$ and the final wetting force $F_{3,end}$ are obtained as shown in the Figure D.2.

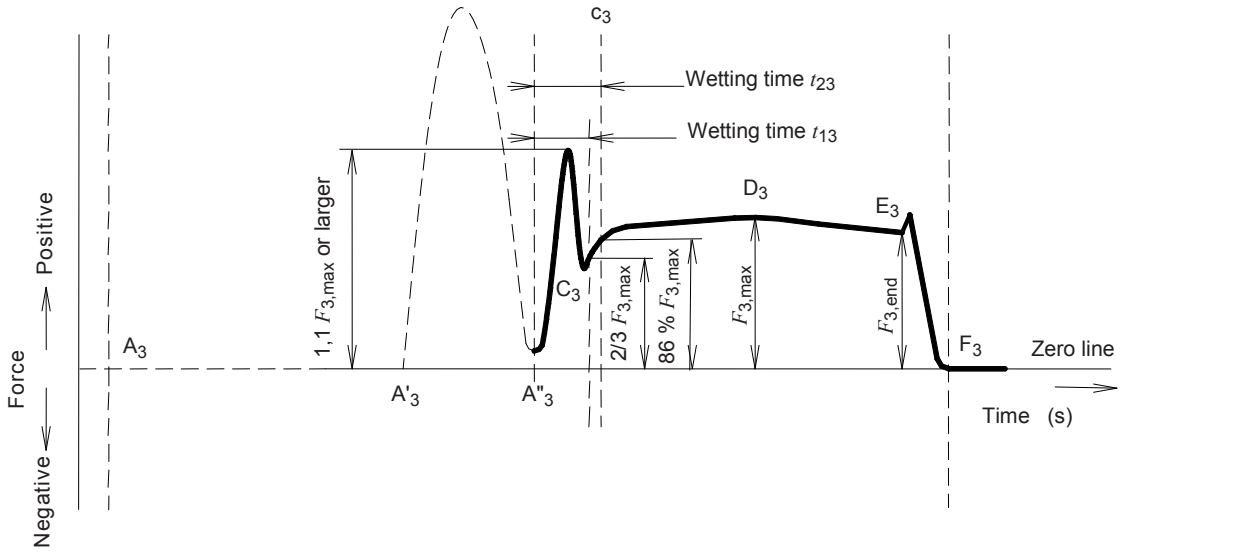


Figure D.2 – The case when an extruding force (1,1F_{max} or larger) is generated immediately after the beginning of wetting

Annex E
(informative)

Caveats / Notes

E.1 General

The test methods described in 4.2 are not to be used for pass/fail interpretations due to the poor gauge of repeatability and reproducibility that these methods may generate.

One of the primary reasons for this is that the presence of flux, and other ingredients in the solder paste, can cause explosive boiling as the solder paste reaches the molten state.

Also the buoyancy of the component cannot be incorporated into the result. The main reason for this is that different solder pastes have different densities.

E.2 Influences

E.2.1 Solder pastes

Solder pastes have many variables that influence the interpretation of the test results including:

a) thixotropy;
b) rheology;
c) viscosity;
d) slump;
e) tackiness.

This is due to the fact that pastes have to fulfil a variety of different functions as demanded by users who may be either high or low volume producers.

The solder pastes should be tested in compliance with IEC 61189-5 test methods.

E.2.2 Components

Samples from the same test batch should be tested in compliance with IEC 60068-2-69 to verify that the terminations under test are not an influencing factor in the test results.

E.3 Interpreting results – Examples

E.3.1 Quick heating method

An explanation diagram of the test procedure is shown in Figure E.1.

For the correction of output data, refer to Annex B.

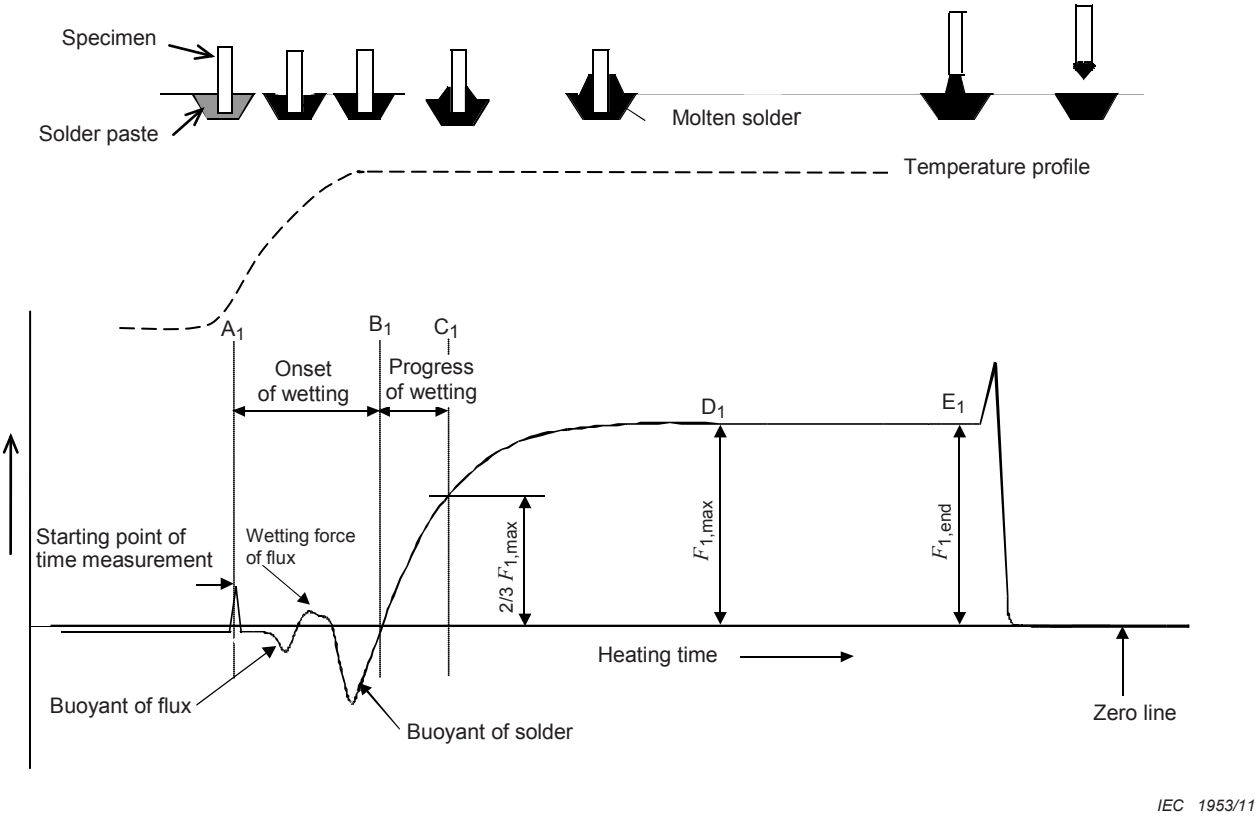


Figure E.1 – Explanation diagram of test procedure for the quick heating method

E.3.2 Synchronous method

An explanation diagram of the test procedure is shown in Figure E.2.

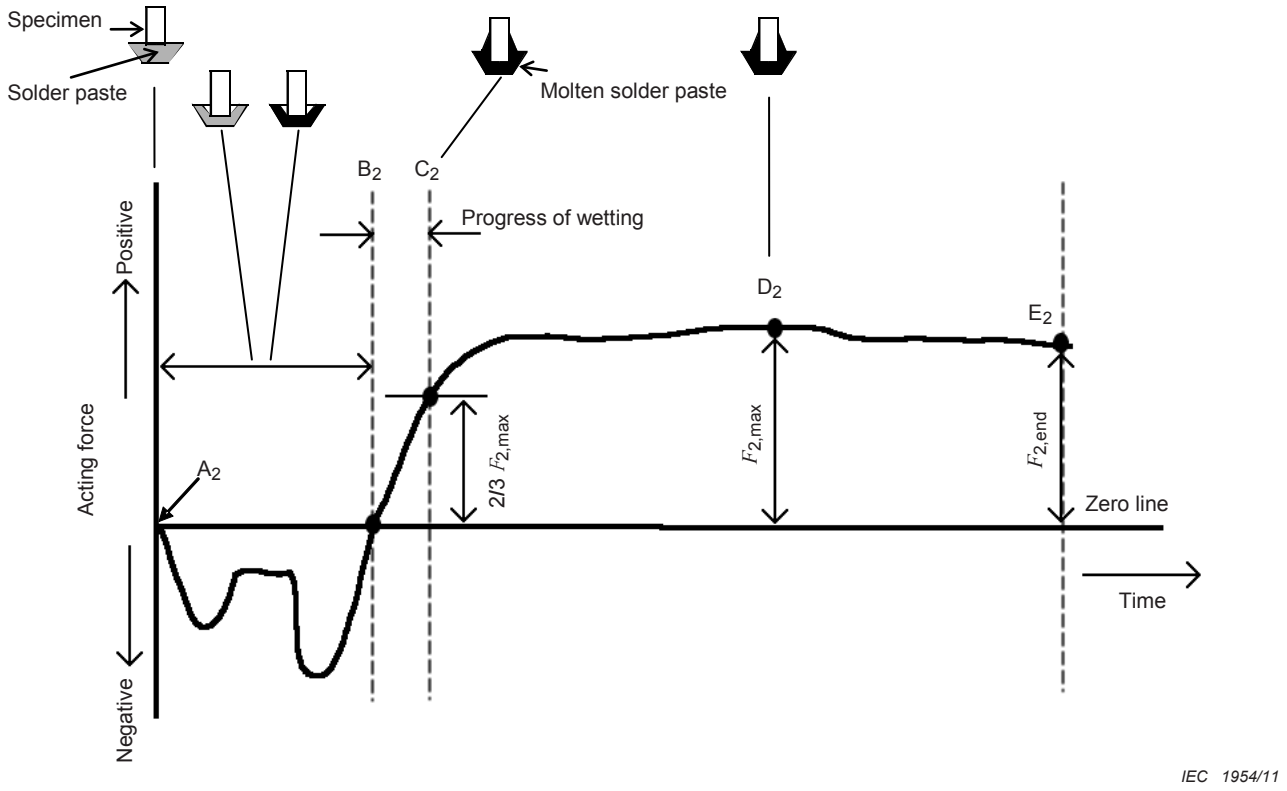


Figure E.2 – Explanation diagram of test procedure for synchronous method

Here we can see that the solder paste has generated an initial wetting (pull) force that is followed by a push force prior to component immersion and the subsequent return to the zero line (see Figure E.3).

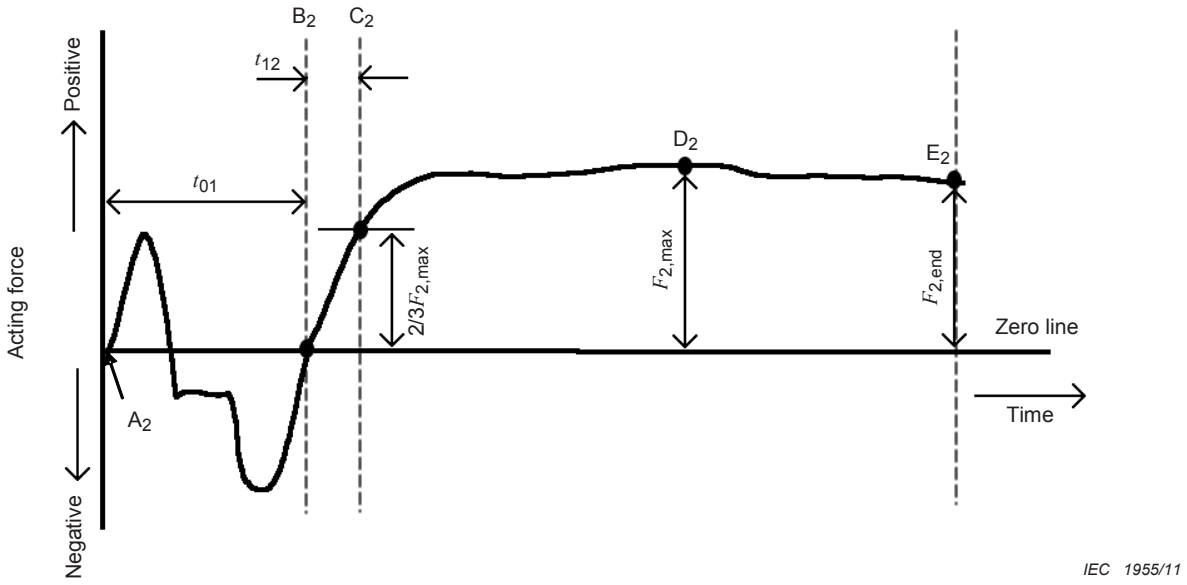


Figure E.3 – Showing the wetting force (pull) of some solder pastes

E.3.3 Temperature profile method

An explanation diagram of the test procedure is shown in Figure E.4.

For the correction of output data, refer to Annex D.

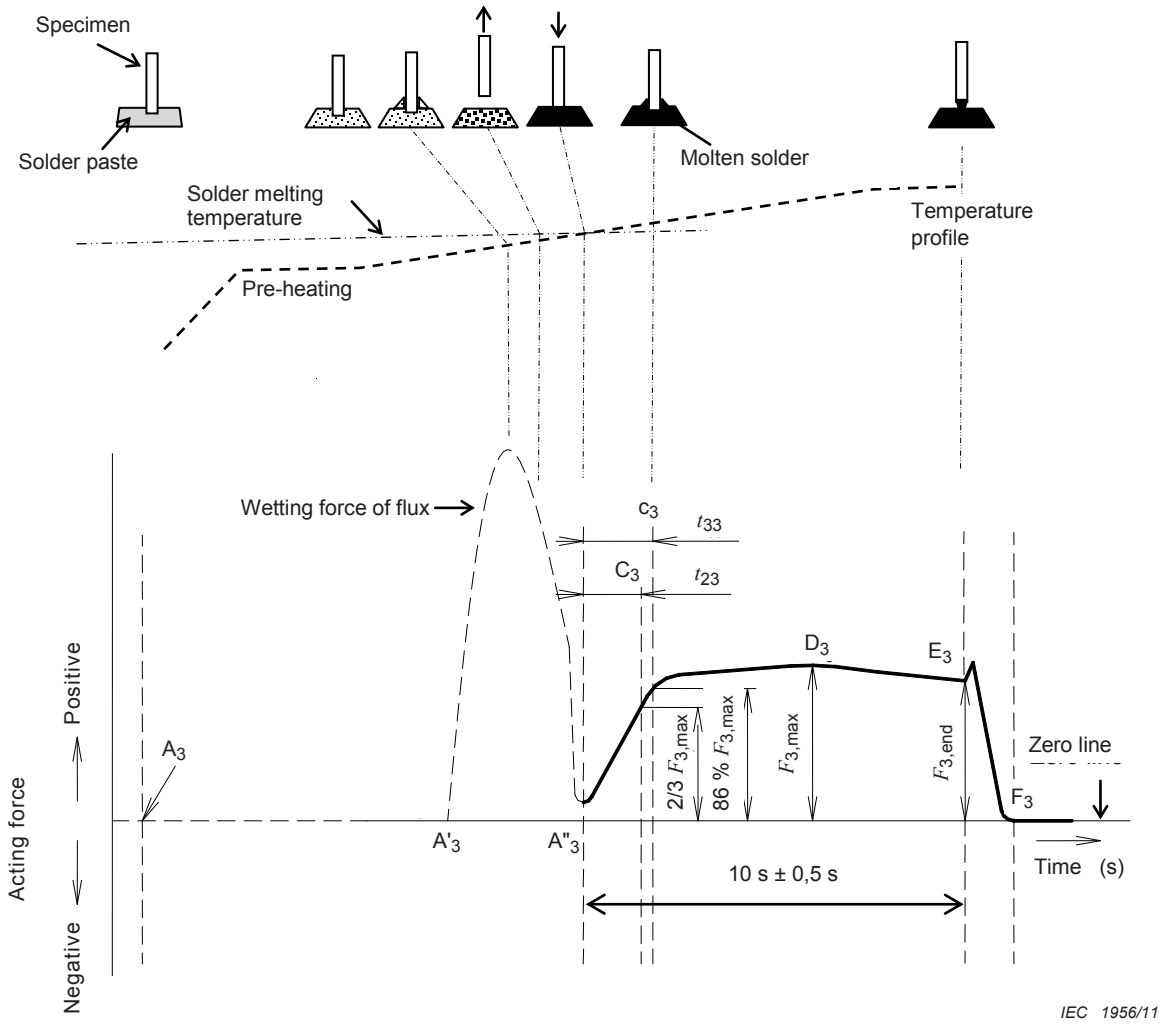


Figure E.4 – Explanation diagram of the test procedure for the temperature profile method

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™