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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 lead-free solder paste

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JP Patent 2630712 Testing method of characteristics of solder paste and the equipment for the test.

name of holder of patent right : Malcom Co., Ltd

address: 4-15-10 Honmachi, Shibuya-ku, Tokyo, 151-0071,Japan

JP Patent 3027441 High temperature solders.

name of holder of patent right : Senju Metal Industry Co., Ltd.

address: Senju Hashido-cho 23, Adachi-ku, Tokyo 120-8555, Japan

name of holder of patent right : Matsushita Electric Industrial Co., Ltd.

address: 1006, Kadoma, Kadoma City, Osaka 571-8501, Japan

JP Patent 3153884 Soldering equipment for solder paste.
name of holder of patent right : Sony Corporation
address: 6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo 141-0001, Japan
name of holder of patent right : Tarutin Kester Co., Ltd.
address: 2-20-11 Yokokawa, Sumida-ku, Tokyo, 130-0003, Japan

JP Patent 3552061 Equipment for solderability test.
name of holder of patent right : Sony Corporation
address: 6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo 141-0001, Japan
name of holder of patent right : Tarutin Kester Co., Ltd.
address: 2-20-11 Yokokawa, Sumida-ku, Tokyo, 130-0003, Japan

JP Pat. Appl. No. Heisei-5-256383 3498100
Testing method of solderability and the equipment used for the test, and the micro-furnace used for the test.
Patent applicant: Sony Corporation
Address: 6-7-35 Kitashinagawa, Shinagawa-ku, Tokyo 141-0001, Japan
Patent applicant: Tarutin Kester Co., Ltd.
Address: 2-20-11 Yokokawa, Sumida-ku, Tokyo, 130-0003, Japan

International Standard IEC 60068-2-83 has been prepared by IEC technical committee 91:

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/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 maintenance result date[1)] 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.

1) The National Committees are requested to note that for this publication the maintenance result date is ....

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

1 General

1.1 Scope

This part of IEC 60068 outlines test Tf, solderability test for surface mounting devices (SMD) by wetting balance method using solder paste.

This standard provides two (2) methods for quantitatively evaluation of the wettability of the metallic terminations or metallized terminations of SMD, the temperature profile method and the quick heating method.

Comment [□□□□1]: UK1

Note that the test results are depening on the size, shape and thermal mass of the specimens.

Note1 – This Standard is applicable to the components shown in Table 3 and Table 5, but may be applicable to the other components which are not evaluated.

Note2 - 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.

Comment [□□□□2]: UK2

1.2 Objective

Test methods are intended for evaluation purpose. The result may be used for acceptance/rejection upon agreement between the trading partners.

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 – Electricity and Electronics – General rules*

IEC 60068-2-20(91/764/FDIS), *Environmental testing - Part 2-20: Tests - Test T: Test methods for solderability and resistance to soldering heat of leaded devices*

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

IEC 60068-2-58:2004, *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 Definition*

IEC 61190-1-1:2002, *Attachment materials for electronic assemblies: Part 1-1: Requirements for soldering fluxes for high quality interconnections in electronic assembly*

IEC 61190-1-2:2007, *Attachment materials for electronic assembly - Part 1-2: Requirements for soldering paste for high-quality interconnects in electronics assembly*

IEC 61190-1-3:2007, *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*

IEC 61189-5:2006, *Test methods for electrical materials, interconnection structures and assemblies - Part 5: Test methods for printed board assemblies*

3 Terms and definitions

For the purpose of this standard, in addition to the definitions given in IEC 60068-1, IEC 60068-2-20, IEC 60068-2-58, IEC 60194, and IEC 61190-1-3 the following principal definitions apply.

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

3.2
solder paste
finely divided particles of solder, with additives to promote wetting and to control viscosity, tackiness, slumping, drying rate, etc, that are suspended in a cream flux.

3.3
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.

3.4
starting point of heating
time of the start of temperature rise by heating the solder paste applied to a testing jig

3.5
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 end of measurement.

Comment [□□□□3]: DE2:

4 Test

4.1 General description

Comment [□□□□4]: UK4

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 past is heated to melt. The resultant of the vertical forces of buoyancy and surface tension (here after, referred 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. The evaluation of the wetting force is made by comparison of the forces experienced by specimens of the same shape and sizes.

4.2 Test methods

Comment [□□□□5]: UK5

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

a) 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.

b) Quick heating method: The wettability of electrodes of a component is evaluated while the solder paste is melted in a rapid temperature rise.

5 Solder paste

The solder paste used in this test is given in Table 1. The detailed specification of the flux is given in Table A.1.

Table 1 - Solder paste description

Type	Alloy designation [a]	Flux classification [b]	Powder size type [c]	Nominal metal content (wt%)	Viscosity [d] (Pa-s)
SAC	Sn96,5Ag3Cu0,5	ROM1	3	88	180 ± 50
Sn-Pb	Sn63Pb37	ROM1	3	90	200 ± 50
Shape of the solder powder shall be spherical.					

a See IEC 61190-1-3, Annex B.
b See IEC 61190-1-1, Table 1.
c See IEC 61190-1-2, Table 3.
d The viscosity of the paste flux shall be evaluated in accordance with IEC 61189-5 test method 5X02.

6 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 shall be used. The aging condition shall be specified in the relevant specification.

7 Temperature profile method

7.1 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 1. Requirements to the system are given in Annex B.

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 7.4.1.

c) The lift system shall consist of a lift mechanism which can ascend and descend with the conditions specified in 7.4.3.

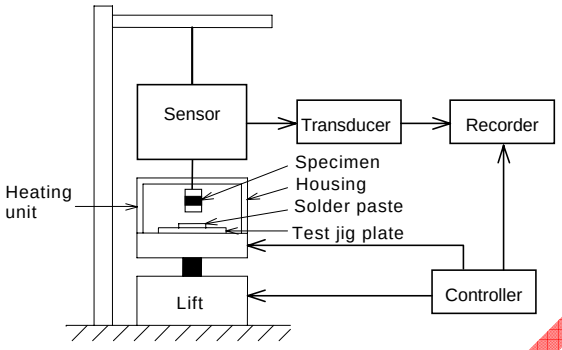


Figure 1- Example of the system for temperature profile method test equipment

7.2 Test jig plate

The test jig plate shall be as specified in Table 2.

Table 2 - Specification of the test jig plate of 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 rectangular shape)

7.3 Preparation

7.3.1 Solder Paste

Use solder paste that has been stored in a sealed container and stored in an environment of dark place and below 10 °C. The procedure of the use of solder paste shall be in the following way.

a) Confirm the limiting date of use of the solder paste.

b) Take the solder paste from the dark and cool storage place and leave it in the testing environment until the temperature of the solder paste reaches to nearly room temperature.

c) Open the cap of the container of the solder paste and confirm that the solder and solvent are not separated or observable change in quality.

d) Stir the solder paste thoroughly until the colour tone of the solder paste becomes uniform on the surface and inside of the paste.

e) Take a required amount of solder paste from the container and then return the container to the dark and cool storage place.

7.3.2 Test jig plate

The test jig plate used in the test shall be the plate stored in a sealed container after cleaning the plate using acid, or plate cleaned using acid immediately before the test. The plates taken out by opening a sealed container shall be used for tests on the day of opening of the sealed container but shall not be carried over to the next day. A new jig plate shall be used for each test.

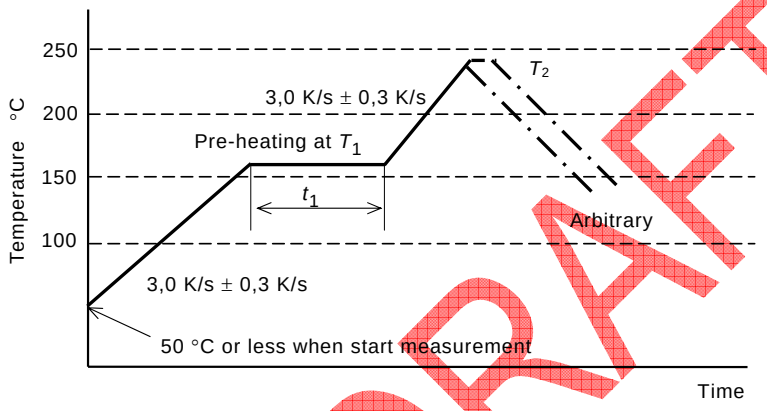
7.3.3 Specimen Holder

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

7.4 Test condition

7.4.1 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 given in Figure 2.



Symbol	SAC type *	Sn-Pb type *
T_1	160 °C ± 5 °C	150 °C ± 5 °C
t_1	80 s ± 5 s	80 s ± 5 s
T_2**	245 °C ± 3 °C	220 °C ± 3 °C

* Refer to Table 1

** T_2 is the preset temperature of the heating unit. Jig temperature may not reach the preset temperature.

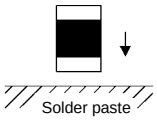
Figure 2 – The temperature profile of the temperature profile method.

7.4.2 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 3. The component not specified in Table 3, test conditions shall be specified in the relevant specification or agreed upon between the trading partners.

Table 3 – Recommended test conditions of the temperature profile method for rectangular SMD

Comment [□□□□6]: DE3

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	thickness		
Capacitors	1005 (0402)	3 mm	0,20 mm	0,05 mm	Horizontal Rectangular SMD  Solder paste
	1608 (0603)				
Resistors	1005 (0402)				
	1608 (0402)				
Capacitors	2012 (0805)	5 mm	0,30 mm		
	3216 (1206)				
Resistors	2012 (0805)				
	3216 (1206)				

[a] Designation of the size is, for example, 1005 means a specimen with a length of 1,0 mm and 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.

Comment [□□□□7]: UK9

7.4.3 Conditions for ascend and descend of the test equipment

The specimen is once 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 acting force reached to a peak. After 0,5 s, the specimen separated from the solder paste, and then the specimen shall be immersed again to the solder paste returned to the previous position.

Comment [□□□□8]: DE4

a) 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.

b) The duration for the second immersion of the specimen to the withdrawal of the specimen from the solder shall be 10 s ± 0,5 s.

Comment [□□□□9]: UK14

7.5 Test procedure

a) Apply a specified amount of solder paste in 7.4.2 to a test jig plate whose surface is cleaned. Use a metal mask and a squeegee to apply solder paste to a jig plate as shown in Figure 3.

Comment [□□□□10]: UK15

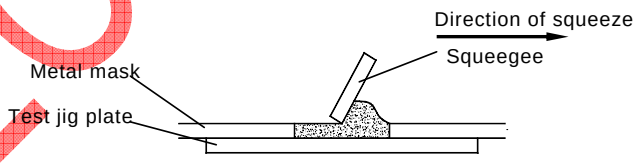


Figure 3 - Example of applying solder paste to a test jig plate

b) Fix the specimen on the holder designed to realize the immersion angle specified in 7.4.2. Place the holder on the test jig plate at the centre of the plate.

c) Immerse the specimen into the solder paste. The condition of immersion of the specimen is specified in 7.4.2.

Comment [□□□□11]: UK16

d) Adjust the output of the force sensor to zero before the specimen is immersed into the solder paste

Comment [□□□□12]: UK17

e) Heat the jig plate to melt the solder paste in accordance with the temperature profile specified in Figure 2.

f) The specimen shall be withdrawn from the solder paste to separate the cohesion force of the solder paste and wetting force of the specimen to the solder. 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).

Comment [□□□□13]: UK18

g) Withdraw the specimen from the molten solder paste when measurement is finished. The recorder shall record the signal of the force from the transducer from t_1 to t_4 as specified in Figure 4. Measurement finishes when the force reaches to a stable state.

7.6 Presentation of the result

Comment [□□□□14]: UK19

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 to downward to the specimen (wetting force) is recorded as a positive value.

A typical shape of the output signal obtained as the sample temperature is raised according to the specified temperature profile is shown in Figure 4. The meaning and correction of the data different from the shape shown in Figure 4 are given in Annex C.

The data for the period between t_0 and t_1 are not used in the evaluation of wetting force of the specimen.

NOTE - The upward force as shown in Figure 4 with a dotted line between A' and B is the coagulation force when the solder paste melts.

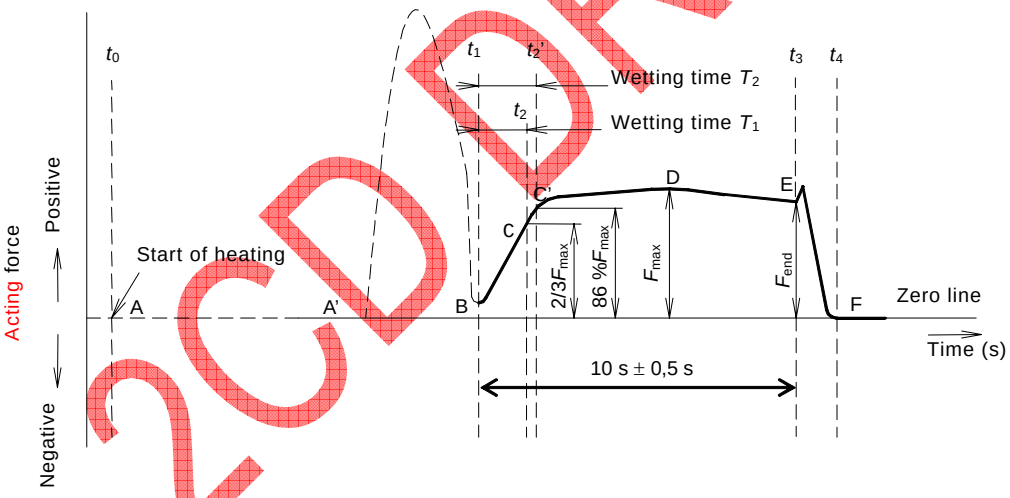


Figure 4-Typical output shape of signal in the temperature profile method

Where:

t_0: Time to start to heat the test jig (A in Figure 4).

t_1: Time to start wetting of solder to the specimen (B in Figure 4).

t_2: The time the wetting force reaches to 2/3 of the maximum wetting force (C in Figure 4).

t_2': The time the wetting force reaches to 86 % of the maximum wetting force (C' in Figure 4).

t_3: The time to withdraw the specimen after measurement is complete (E in Figure 4).

t_4: The time the force reaches to a stable state after the specimen is withdrawn from the jig plate (F in Figure 4).

T_1: $T1$ is calculated from $T_1 = t_2 - t_1$, that is the time the wetting force reaches to 2/3 of the maximum wetting force minus the time to start wetting of the specimen.

T_2: T_2 is the wetting time. $T_2 = t_2' - t_1$, that is the time the wetting force reaches to 86 % of the maximum wetting force minus the time to start wetting of the specimen.

F_{max}: The maximum wetting force. The maximum force obtained in the measurement, the value from the zero line (D in Figure 4).

F_{end}: The wetting force obtained at the end of the test, the value from the zero line (*E* in Figure 4).

7.7 Required items of the test

The requirement for the wetting force in the temperature profile method is to specify at least one of the following items.

a) Wetting time: T_1 and/or T_2

b) Maximum wetting force: F_{max}

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

NOTE - Wetting stability is calculate from $S_b = F_{end}/F_{max}$.

8 Quick heating Method

8.1 Equipment

The equipment used for the quick heating method consists of measurement, heating and lift system as shown in Figure 5. The detailed requirements to the equipment are specified in Annex D.

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 realizing the control of the temperature profile as specified in 8.4.1.

c) The lift system shall be capable of carrying out immersion and withdraw of the specimen as specified in 8.4.3.

Comment [□□□□15]: UK21

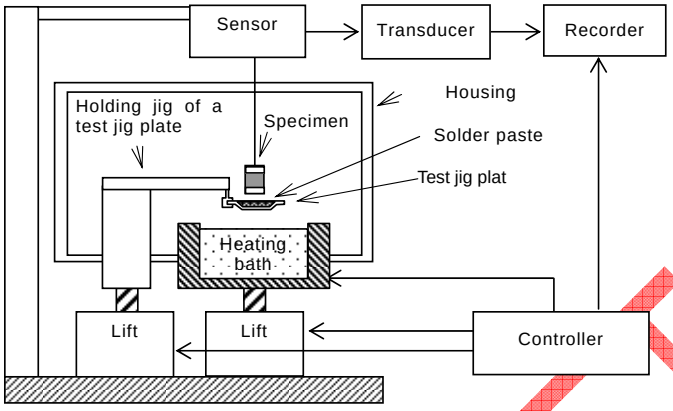


Figure 5 - Example of the system for quick heating method test equipment

8.2 Test jig plate

The test jig plate shall be as specified in Table 4.

Table 4 - Specification of the test jig plate of quick heating method

Item	Specification of the test jig
Material	Oxygen-free phosphate copper
Shape	Drawed rectangular plate
Dimensions	Less than 30 mm one side, or less than total area of 900 mm^2
Thickness	0,3 mm ± 0,03mm
Drawing diameter	9 mm to 10 mm at the bottom, 13 mm to 14 mm at the top
Drawing depth	0,4 mm ± 0,04 mm
Solder resist	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)

Comment [□□□□16]: UK23

Comment [□□□□17]: UK22

An example of the test jig plate used in the quick heating method is shown in Figure 6.

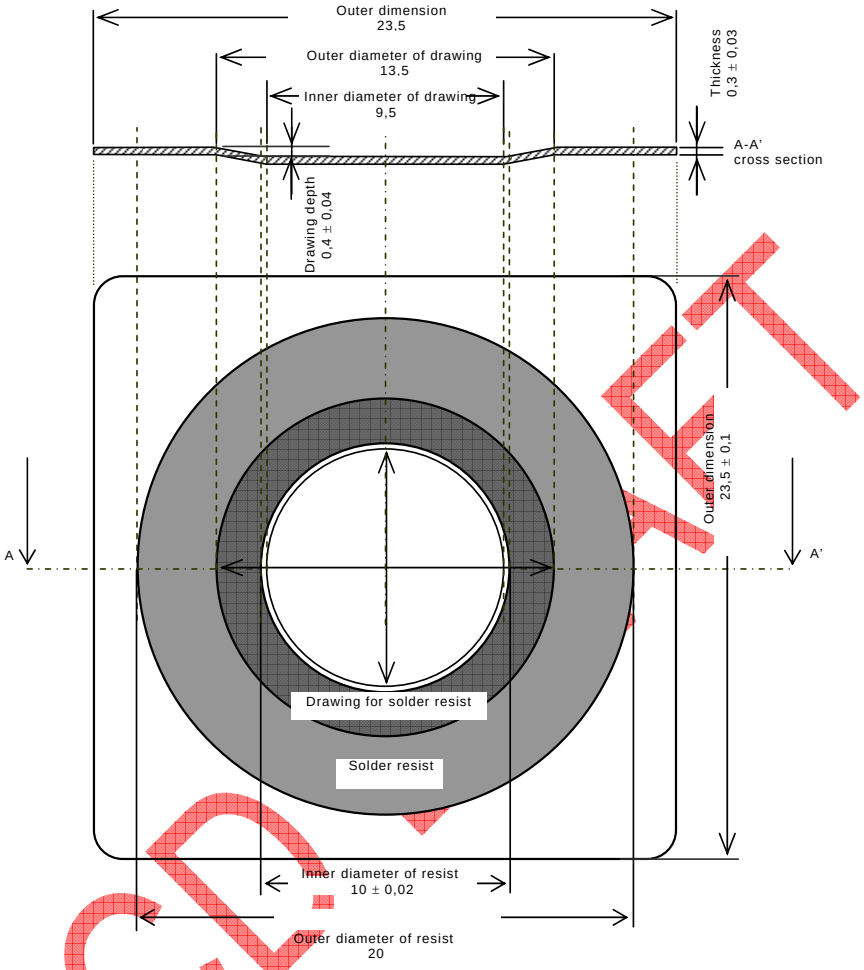


Figure 6 - Example of test jig plate for the quick heating method

8.3 Preparation

8.3.1 Solder paste

Refer to 7.3.1.

8.3.2 Test jig plate

Refer to 7.3.2.

8.3.3 Specimen Holder

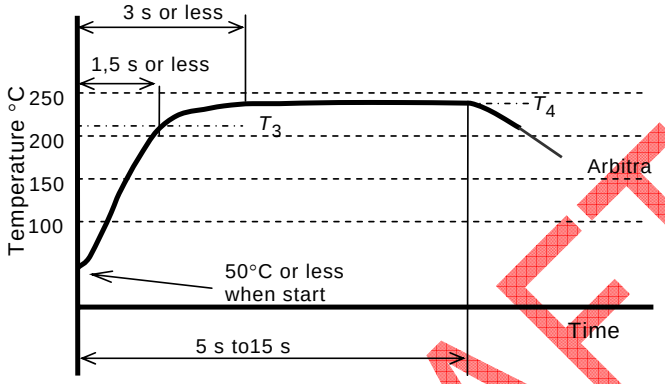
Use a clean specimen holder on the surface and exchange for each measurement.

8.4 Test Condition

8.4.1 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 given in Figure 7.

Comment [□□□□18]: UK24



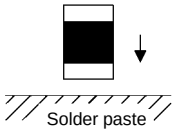
Symbol	SAC type *	Sn-Pb type *
T_3	217 °C	183 °C
T_4	245 °C ± 3 °C	235 °C ± 3 °C
* Refer to Table 1		

Figure 7 - The temperature profile of the quick heating method

8.4.2 Feed of Solder Paste and Immersion Condition

The recommended condition of immersing a specimen into the solder paste is given in Table 5. The component not specified in Table 5, test conditions shall be specified in the relevant specification or agreed upon between the trading partners.

Table 5 - Recommended test conditions of the quick heating 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 Rectangular SMD 
	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 is, for example, 1005 means a specimen with a length of 1,0 mm and width of 0,5 mm. In parentheses, dimensions are expressed in Imperial.

[b] The immersion depths specified in this table are recommended due to the buoyancy force is different depending upon the electrode configuration.

[c] The immersion depth is the target values.

8.4.3 Conditions for ascend and descend of the test equipment

Comment [□□□□19]: UK27

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

8.5 Procedure

a) Apply solder paste to the drawn section of a test jig plate using a squeegee as shown in Figure 8. Excess solder paste is scraped off using the squeegee.

Comment [□□□□20]: DE6 &UK28

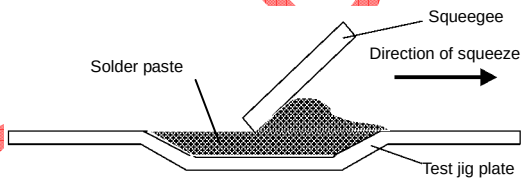


Figure 8 - Example of applying solder paste to a test jig plate.

b) Mount a specimen on a holder as to the immersion angle specified in 8.4.2 is realized. The holder shall be installed on the centre of upper surface of a test jig plate with solder paste applied.

c) The specimen shall be immersed into the solder paste to the depth of twice or more the specified depth, and then the specified depth. The immersion attitude and the immersion depth are given in 8.4.2.

Comment [□□□□21]: UK29

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

d) Adjust the output of the force sensor and the recorder to zero before the specimen is immersed into the solder paste.

e) Heat the jig plate to melt the solder paste in accordance with the temperature profile specified in Figure 7.

f) The specimen shall be withdrawn from the solder to separate the coagulation force of the solder and wetting force of the specimen to the solder.

g) 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.

8.6 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 to downward to the specimen (wetting force) is recorded as a positive value.

A typical shape of the output signal obtained the sample temperature is raised as the specified temperature profile is shown in Figure 9. The meaning and correction of the data different from the shape shown in Figure 9 are given in Annex E.

Comment [□□□□22]: UK30 &UK31

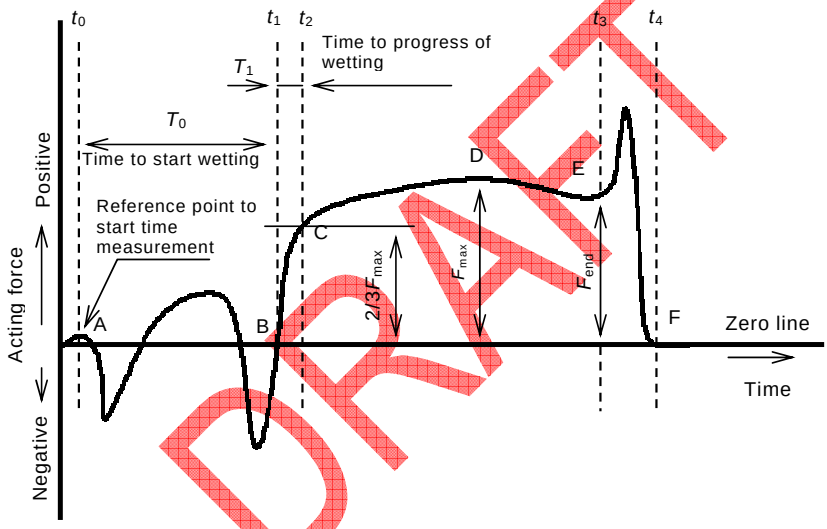


Figure 9 - Typical output shape of signal in the quick heating method

Where: t_0: Reference point to start time measurement (A in Figure 9).

Note- Point A is the fist positive force peak during the test.

t_1: Time to cross the output form and the zero line (B in Figure 9).

t_2: The time the wetting force reaches to 2/3 of the maximum wetting force (C in Figure 9).

t_3: The time to withdraw the specimen after measurement is complete (E in Figure 9).

t_4: The time the force reached to a stable state after the specimen is withdrawn from the jig plate (F in Figure 9).

T_0 : The time to start wetting. The time from point A to point B. $T_0 = t_1 - t_0$.

T_1: Time to wetting. The time from point B to point C. $T_1 = t_2 - t_1$

F_{max}: The maximum wetting force. The maximum force obtained in the measurement, the value from the zero line (D in Figure 9).

F_{end}: The final wetting force. The wetting force obtained at the end of the test, the value from the zero line (E in Figure 9).

8.7 Required test items

The requirement for the wetting force in the quick heating test is to specify at least one of the following items.

a) The time to start wetting: T_0

b) Wetting time: T_1

c) Maximum wetting force: F_{max}

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

NOTE - Wetting stability is calculate from $S_b=F_{end}/F_{max}$.

9 Items to be specified in the relevant specification

The relevant specification of a component shall specify the following items.

a)	Test method (Temperature profile method, or the quick heating method) *	4.2
b)	Preconditioning	6
c)	Amount of solder paste used and the immersion condition for the temperature profile method	7.4.2
d)	Required test items in the temperature profile method *	7.7
e)	Immersion condition in the quick heating method	8.4.2
f)	Required test items in the quick heating method *	8.7

* These items shall be included in the detailed specification.

Comment [□□□□23]: UK32

Comment [□□□□24]: UK33

Annex A
(Normative)
Specifications of the flux

A.1 Scope

This Annex specified the composition and materials of the flux used for the solder paste as described in clause 5.

A.2 Specification of the flux

The flux used for solder paste in this test shall have the component satisfying the composition, items and their specified values as given in Table A.1.

Table A.1-Specification of flux for solder paste

Component	Composition	Content (wt%)		Characteristic	Specification
		SAC *	Sn-Pb *		
Rosin	Polymerized rosin	30,0	52,5	Softening point	93 °C to 115 °C
				Acid value	145 mgKOH/g to 165 mgKOH/g
	Modified rosin	30,0	—	Softening point	113 °C to 139 °C
				Acid value	160 mgKOH/g or more
Solvent	Diethylene glycol Monobutyl ether	34,7	—	Specific gravity	0.953 to 0.958
				Water content	0,2 wt% or less
				Boiling point	220 °C to 236 °C
	2-METHYL-2,4-PENTANEDIOL	—	42,2	Specific gravity	0.922 to0.925
				Water content	0,1 wt% or less
				Boiling point	197.1 to 198.3 °C
Activator	1,3-Diphenyl guanidine Hydrobromide	0,8	0,8	Halide content	11,6wt% to 12,6wt%
				Acid value	170 mgKOH/g to 230 mgKOH/g
Organic acid	Adipic acid	0,5	0,5	Purity	99,6 wt% or more
				Water content	0,3 wt% or less
				Ash content	0,02 wt% or less
				Melting point	151 °C or above
Thixotropic agent	Hydrogenated castor oil	4,0	4,0	Acid value	2 mgKOH/g or less
				Melting point	85 °C to 87 °C
				Saponification value	175 mgKOH/g to 185 mgKOH/g

* Solder flux type, refer to Table 1

Comment [□□□□25]: UK34

Annex B
(Normative)
Test equipment for the temperature profile method

B.1 Scope

This Annex specified the details of the test equipment for the temperature profile method.

B.2 Test equipment

The details of the test equipment are specified as follow.

B.2.1 Measuring system

The measuring system shall satisfy the following requirements

a) The range of measurement of the wetting force shall be –50 mN to +50 mN.
b) The deviation 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 t_1 to t_4 of the data shown in 7.6, Figure 3 of the main text.
e) The recorder shall be able to record the output data on 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.

Comment [□□□□26]: DE7

B.2.2 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 7.4.1, Figure 2.
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 ~ 222 °C. 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 document.

B.2.3 Lift system

The lift system shall comply with the following requirements.

a) The speed of immersion and withdraw 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 time to withdraw the specimen from the solder paste as specified in 7.5 g).

Annex C
(Normative)
Reading of the output data and correction of the result
in the temperature profile test

C.1 Scope

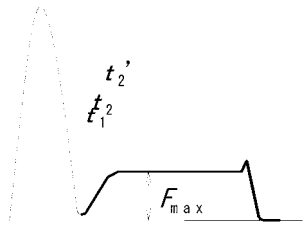
This annex specifies the reading of the output data and correction of the result other than as shown in 7.6, Figure 4.

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

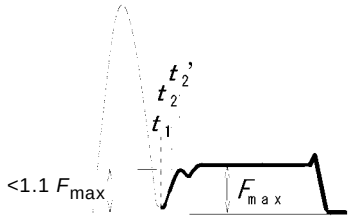
Typical examples other than as shown in 7.6, Figure 4 are given in Figure C.1. The bold line shows the force acted to a specimen as a function of time, and the horizontal fine line shows the zero line. The wetting time and the value of F_{max} are used as they are for the cases a), b) and e) to f) as shown in Figure C.1.

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

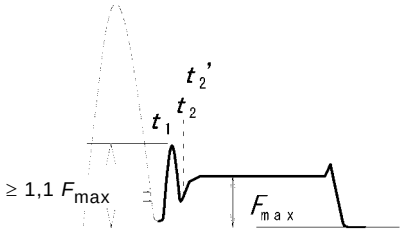
The result cannot be obtained in the case of d) in Figure C.1.



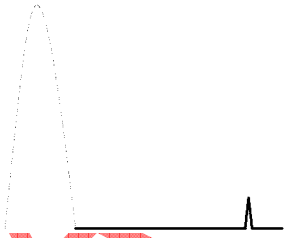
a) Wetting starts immediately



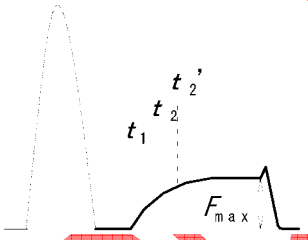
b) An extruding acting force is experienced immediately after start of wetting (less than 1,1 F_{max})



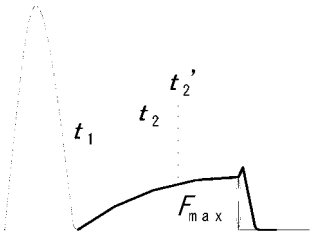
c) An extruding acting force is experienced immediately after start of wetting (1,1 F_{max} or lager)



d) No wetting



e) Retarded wetting



f) No complete wetting during the test

Figure C.1 - Typical output forms for profile temperature test

C.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 C.1, c) is attained from the obtained chart using the illustration given in Figure C.2. In the case an extruding force larger than 1,1 times the maximum wetting force, F_{max}, is applied to a specimen after a coagulation force is generated due to the melting of solder paste (B to C in the Figure 4), the wetting time T_1, wetting time T_2, the maximum wetting force F_{max} and the final wetting force F_{end} are obtained as shown in the figure.

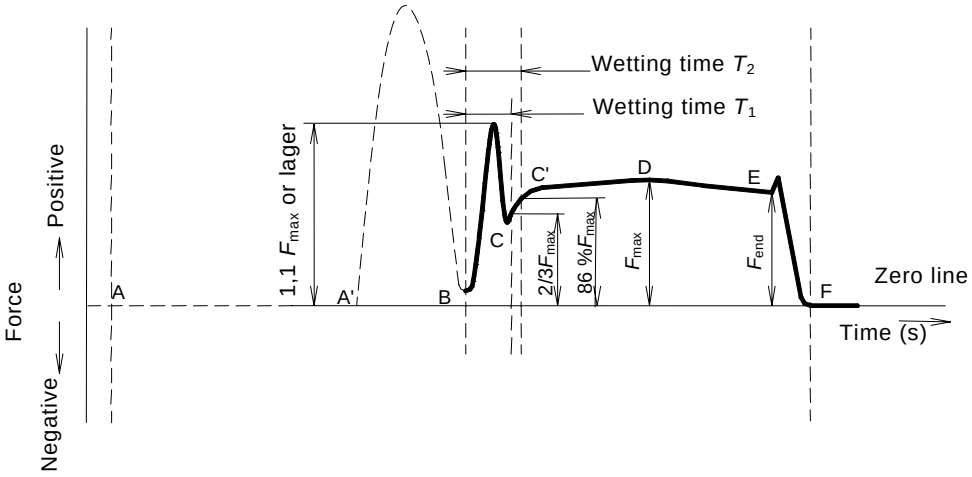


Figure C.2 - The case an extruding force (1,1F_{max} or lager) is generated immediately after beginning of wetting.

Annex D
(Normative)
Equipment for the quick heating method

D.1 Scope

This Annex specified the details of the test equipment for the quick heating method

D.2 Test equipment

The details of the test equipment are specified as follow.

D.2.1 Measuring system

The measuring system shall satisfy the following requirements

a) The range of measurement of the wetting force shall be –40 mN to +40 mN.

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

c) The resolution of the force sensor shall be better than 0,02 mN.

d) The continuous recording of the output signal shall cover t_0 to t_4 of the data shown in 8.6, Figure 9 of the main text.

e) The recorder shall be able to record the output data on 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.

D.2.2 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 8.4.1, Figure 7.

b) The size of the heating bath shall be of a diameter larger than 40 mm and of a depth deeper than 15 mm.

D.2.3 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 speed of immersion shall be 0,5 mm/s to 5 mm/s.

d) The duration of the test jig plate being contacted with the heating bath shall be adjustable from 5 s to 15 s.

Comment [□□□□27]: UK36

Comment [□□□□28]: UK37

Annex E
(Normative)
Reading of the output data and correction of the result
in the quick heating test

E.1 Scope

This annex specifies the reading of the output data and correction of the result other than as shown in 8.6, Figure 9.

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

Typical examples other than as shown in 8.6, Figure 9 are given in Figure E.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.

a) The time the force line crosses the zero line, t_1:

t_1 cannot be obtained in a case the force line does not cross the zero line, and the start of wetting, T_0 , and the wetting time, T_1, cannot be attained neither. A virtual t_1 should be obtained in the chart from the crossing point of an extended supplemental line and the zero line.

t_1 for the cases a) to c) and g) is the t_1 as given in the figure. The correction for the cases of d) to g) in Figure E.1 shall be made in accordance with E.3.

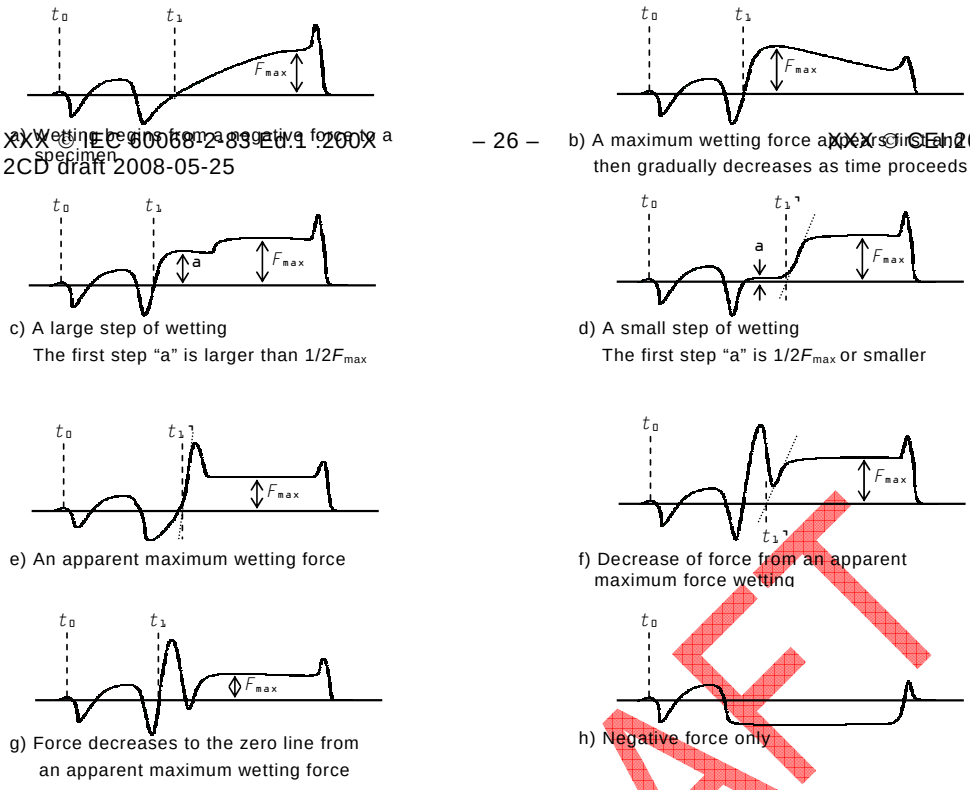
t_1 for the case h) in Figure E.1 cannot be obtained

b) Maximum wetting force, F_{max}:

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

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

Comment [□□□□29]: DE8



a) Wetting begins from a negative force to a specimen

b) A maximum wetting force appears first and then gradually decreases as time proceeds

c) A large step of wetting
The first step “a” is larger than 1/2F_{max}

d) A small step of wetting
The first step “a” is 1/2F_{max} or smaller

e) An apparent maximum wetting force

f) Decrease of force from an apparent maximum force wetting

g) Force decreases to the zero line from an apparent maximum wetting force

h) Negative force only

Figure E.1 - Typical wetting force changes in quick heating method

E.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 (Figure E.1, c) and d)): When the wetting force is in a step-wise state, the correction is made according to either Figure E.2 or Figure E.3 to determine the initial wetting time, t_1, depending on 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, Fa, is 1/2F_{max} or less

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, t_1.

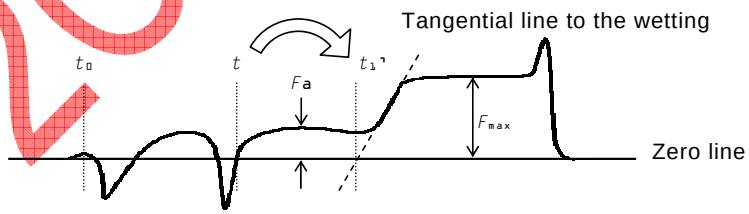


Figure E.2 - Example of correction of the initial time of wetting (Fa is 1/2F_{max} or less).

2) The wetting force at the first step, Fa, is larger than 1/2F_{max}

The start of wetting of the first step is taken as the initial time of wetting, t_1.

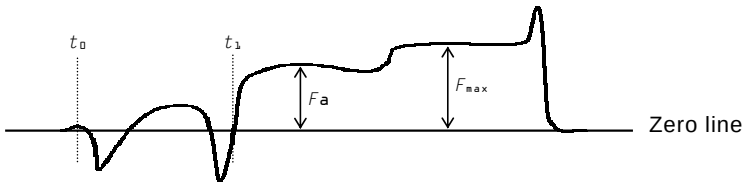


Figure E.3 - Example of correction of the initial time of wetting (Fa is larger than 1/2F_{max}).

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

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

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, t_1.

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

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

The time to reach 2/3 of the maximum wetting force (t_2) is obtained from the corrected maximum wetting force.