INTERNATIONAL STANDARD

IEC 60068-2-58

Second edition
1999-01

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)

Essais d'environnement –

Partie 2-58:
Essais – Essai Td – Méthodes d'essai de la soudabilité, de la résistance de la métallisation à la dissolution et de la résistance à la chaleur de soudage des composants pour montage en surface

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CONTENTS

Clause Page

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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)

FOREWORD

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International Standard IEC 60068-2-58 has been prepared by IEC technical committee 50: Environmental testing, and is published by IEC technical committee 91: Surface mounting technology.

This second edition cancels and replaces the first edition, published in 1989, and constitutes a technical revision.

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

FDIS	Report on voting
91/157/FDIS	91/164/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.

Annex A forms an integral part of this standard.

Annex B is for information only.

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)

1 Scope

This part of IEC 60068 outlines test Td, applicable to surface mounting devices (SMD). Soldering tests applicable to SMD in IEC 60068-2-69 and to other electrotechnical products are in IEC 60068-2-20 and IEC 60068-2-54, for which guidance is given in IEC 60068-2-44.

This standard provides standard procedures for determining the solderability, resistance to dissolution of metallization and resistance to soldering heat of surface mounting devices (SMD) (hereinafter referred to as specimens).

The procedures use either a solder bath or reflow method and are applicable only to specimens or products designed to withstand short term immersion in molten solder or limited exposure to reflow systems.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60068. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60068 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

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

IEC 60068-2-44:1995, *Environmental testing – Part 2: Tests – Guidance on test T: Soldering*

IEC 60068-2-54:1985, *Environmental testing – Part 2: Tests – Test Ta: Soldering – Solderability testing by the wetting balance method*

IEC 60068-2-69:1995, *Environmental testing – Part 2: Tests – Test Te: Solderability testing of electronic components for surface mount technology by the wetting balance method*

IEC 60249-2-4:1987, *Base materials for printed circuits – Part 2: Specifications – Specification No. 4: Epoxide woven, glass fabric, copper-clad laminated sheet, general purpose grade*

IEC 60749:1996, *Semiconductor devices – Mechanical and climatic test methods*

3 Terms and definitions

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

4 Preconditioning

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

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

4.3 Prior to the resistance to soldering heat test, specimens of semiconductor SMDs in plastic encapsulation shall be soaked and/or baked in accordance with the relevant specification of IEC 60749.

5 Solder bath method

5.1 Test apparatus and materials for the solder bath method

5.1.1 Solder bath

The solder bath dimensions shall comply with the requirements of 4.6.1 of IEC 60068-2-20.

5.1.2 Flux

The flux shall comply with the requirements of 4.6.2, 6.6.1 or 6.6.2 of IEC 60068-2-20 as prescribed by the relevant specification.

5.1.3 Solder

The solder composition shall be 60 % tin and 40 % lead according to appendix B of IEC 60068-2-20.

6 Procedure

6.1 Number of specimens

A specimen shall not be used for more than one test.

6.2 Clamping

The specimen shall be placed in a stainless steel clip as shown in figure 1. No part of the clip jaws shall make contact with the areas to be examined. The specimen shall remain in the clip while being fluxed and dipped in the solder.

6.3 Fluxing

The specimen shall be completely immersed in flux and withdrawn slowly. Any excess flux shall be removed by contact with absorbent paper.

6.4 Solder immersion

When preheating is prescribed by the relevant specification, the specified duration and temperature shall be applied immediately prior to the immersion of the specimen in the solder bath.

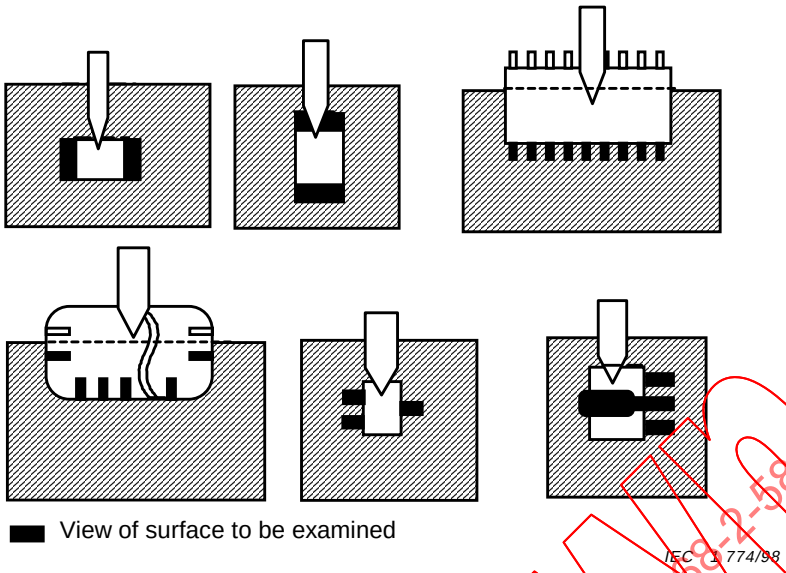

Figure 1 – Examples of immersion

6.4.1 Severities

The duration and temperature of immersion shall be selected from table 1, unless otherwise prescribed by the relevant specification. Guidance on the choice of severities, including those for lower grades of resistance to soldering heat and dissolution of metallization, is given in annex B.

Table 1 – Severities (duration and temperature)

Property tested	Severity								
	(215 ± 3) °C			(235 ± 5) °C			(260 ± 5) °C		
	(3 ± 0,3) s	(10 ± 1) s	(40 ± 1) s	(2 ± 0,2) s	(5 ± 0,5) s	(10 ± 1) s	(5 ± 0,5) s	(10 ± 1) s	(30 ± 1) s
Wetting	X	X		X	X				
Dewetting							X		
Resistance to dissolution of metallization									X
Resistance to soldering heat			X			X	X	X	

The oxide film on the solder bath shall be skimmed off immediately before immersion.

The immersion and withdrawal speed shall be between 20 mm/s and 25 mm/s.

6.4.2 Attitude

Two attitudes of immersion are standardized:

Attitude A: For most specimens, the areas to be examined shall be immersed not less than 2 mm below the solder meniscus (but not to a greater depth than necessary; see figure 1) with the seating plane vertical.

Attitude B: For certain specimens (see B.3.4), the specimen may be floated on the solder, but only when testing resistance to soldering heat.

If the relevant specification does not mention the attitude, *attitude A* shall be adopted.

7 Solder reflow methods

7.1 Test apparatus and materials

The following two methods may be used to determine the suitability of SMDs for reflow soldering or when they are only designed for reflow soldering processes and when the solder bath (dipping) method is not appropriate.

Where the characteristics of an SMD are such that both reflow methods are applicable, then infrared, forced gas or vapour phase shall take precedence over hot plate reflow. The applicable test method shall be stated in the relevant specification.

7.1.1 Solder paste

The particle mesh size of the solder paste shall be 160 or finer.

The metal composition shall be in accordance with the solder specification in B.1 of IEC 60068-2-20.

The composition of the flux shall comply with the flux specification in annex C of IEC 60068-2-20.

The viscosity range and method of measurement shall be specified in the relevant specification.

7.1.2 Test substrates

7.1.2.1 Test substrates for infrared, forced gas or vapour phase solder reflow

The test substrate shall consist of an unmetallized (no tracks or lands) piece of ceramic (alumina 90 % to 98 %) or glass epoxy (see IEC 60249-2-4).

Dimensional details shall be given in the relevant specification.

7.1.2.2 Test substrate for hot plate solder reflow

The test substrate shall consist of an unmetallized (no tracks or lands) piece of ceramic (alumina 90 % to 98 %).

Dimensional details shall be given in the relevant specification.

8 Test procedure

8.1 Number of specimens

A specimen shall not be used for more than one test.

8.2 Application of solder paste

The solder paste shall be applied to the test substrate by screen or stencil printing, dispensing or pin transfer.

The thickness of the solder deposit shall be between 100 µm and 250 µm and shall be specified in the relevant specification.

The area (size) to be printed, and thus the amount of solder paste deposit, shall be specified in the relevant specification.

When semiconductor SMDs are examined, solder paste shall not be applied as specified in IEC 60749.

8.3 Placement of specimens

After printing, the terminations of the specimen shall be placed on the solder paste.

The placement procedure (for example depth of penetration) shall be prescribed in the relevant specification.

8.4 Preheating

Unless otherwise specified in the relevant specification, the specimen and test substrate shall be preheated to a temperature of (150 ± 10) °C and maintained for 60 s to 120 s in the reflow system.

8.5 Solder reflow

8.5.1 Reflow procedure for wetting

8.5.1.1 Reflow method 1: infrared, forced gas or vapour phase

As long as the test conditions prescribed in 8.4 are fulfilled, any suitable infrared, forced gas or vapour phase system may be used.

The temperature of the reflow system shall be quickly raised until the specimen has reached (215 ± 3) °C and maintained at this temperature for (10 ± 1) s.

The temperature shall be measured at the specimen termination.

The temperature profile shall be specified in the relevant specification. After cooling, the specimen shall be removed from the substrate for inspection. Details of the removal procedure shall be given in the relevant specification.

8.5.1.2 Reflow method 2: hot plate soldering

As long as the test requirements of 8.4 are fulfilled, any suitable equipment, such as a metallic plate (carrier), floating on a molten solder bath or an electrically heated plate, may be used.

Immediately after preheating, the specimen shall be moved to a second hot plate so that the temperature of the specimen is quickly raised to (215 ± 3) °C and maintained at this temperature for (10 ± 1) s. The temperature of the substrate shall be maintained above 140 °C between preheating and reflow.

The temperature shall be measured at the specimen termination.

The temperature profile shall be specified in the relevant specification. After cooling, the specimen shall be removed from the substrate for inspection. Details of the removal procedure shall be given in the relevant specification.

8.5.2 Reflow procedure for resistance to soldering heat

The following three methods may be used to determine the suitability of SMDs for reflow soldering or when they are only designed for reflow soldering processes and when the solder bath (dipping) method is not appropriate.

Where the characteristics of an SMD are such that both reflow methods 1 and 2 are applicable, the applicable test method shall be stated in the relevant specification.

8.5.2.1 Reflow method 1: vapour phase soldering system

As long as the test conditions prescribed in 8.4 are fulfilled, any suitable vapour phase system may be used.

Unless otherwise specified, the number of test cycles shall be a minimum of one and a maximum of three, and shall be specified in the relevant specification. The recovery period between two successive cycles shall be either 60 min minimum or until the temperature of the specimen drops below 50 °C.

The temperature of the reflow system shall be quickly raised until the specimen has reached (215 ± 3) °C and maintained at this temperature for (40 ± 1) s.

Unless otherwise specified, the temperature shall be measured at the specimen termination. When semiconductor SMDs are examined, the temperature shall be measured at the SMD's body surface, as specified in IEC 60749.

The temperature profile shall be specified in the relevant specification.

The test duration of 40 s is based on only one cycle for the resistance to soldering heat.

The dwell time for more than one cycle shall be given in the relevant specification.

If more than one cycle is specified, both the preheating and the test shall be repeated.

After cooling the specimen shall be removed from the substrate for inspection. Details of the removal procedure shall be given in the relevant specification.

8.5.2.2 Reflow method 2: infrared and forced gas convection soldering systems

As long as the test conditions prescribed in 8.4 are fulfilled, any infrared or forced gas system may be used.

Unless otherwise specified, the number of test cycles shall be a minimum of one and a maximum of three, and shall be specified in the relevant specification. The recovery period between two successive cycles shall be either 60 min minimum or until the temperature of the specimen drops below 50 °C.

The temperature of the reflow system shall be quickly raised until the specimen has reached (235 ± 5) °C and maintained at this temperature for (10 ± 1) s.

Unless otherwise specified, the temperature shall be measured at the specimen termination. When semiconductor SMDs are examined, the temperature shall be measured at the SMD's body surface, as specified in IEC 60749.

The temperature profile shall be specified in the relevant specification.

The test duration of 10 s is based on only one cycle for the resistance to soldering heat.

The dwell time for more than one cycle shall be given in the relevant specification.

If more than one cycle is specified, both the preheating and the test shall be repeated. After cooling, the specimen shall be removed from the substrate for inspection. Details of the removal procedure shall be given in the relevant specification.

8.5.2.3 Reflow method 3: hot plate soldering

As long as the test requirements of 8.4 are fulfilled, any suitable equipment, such as a metallic plate (carrier), floating on a molten solder bath or an electrically heated plate, may be used.

Unless otherwise specified, the number of test cycles shall be a minimum of one and a maximum of three, and shall be specified in the relevant specification. The recovery period between two successive cycles shall be either 60 min minimum or until the temperature of the specimen drops below 50 °C.

Immediately after preheating the specimen shall be moved to a second hot plate so that the temperature of the specimen is quickly raised to (235 ± 5) °C and maintained at this temperature for (30 ± 1) s. The temperature of the substrate shall be maintained above 140 °C between preheating and reflow.

Unless otherwise specified, the temperature shall be measured at the specimen termination. When semiconductor SMDs are examined, the temperature shall be measured at the SMD body surface, as specified in IEC 60749.

The temperature profile shall be specified in the relevant specification.

The test duration of 30 s is based on only one cycle for the resistance to soldering heat.

The dwell time for more than one cycle shall be given in the relevant specification.

If more than one cycle is specified, both the preheating and the test shall be repeated. After cooling the specimen shall be removed from the substrate for inspection. Details of the removal procedure shall be given in the relevant specification.

9 Flux removal

Within 60 min of the test and after the specimen has been allowed to cool to room temperature, the flux residues shall be removed with a suitable solvent.

9.1 Recovery

The recovery conditions shall be prescribed in the relevant specification.

9.2 Evaluation

9.2.1 Wetting

The wetting shall be assessed visually under adequate light with a binocular microscope of magnification in the range between 10× and 25×, using the photographs of component terminations in figure 3 to assist with the evaluation. The areas to be examined shall be prescribed in the relevant specification.

9.2.1.1 Terminations with metallized solder pads

The dipped or reflowed surface shall be covered with a smooth and bright solder coating with no more than small amounts of scattered imperfections, such as pinholes or non-wetted or dewetted areas. These imperfections shall not be concentrated in one area.

9.2.1.2 Metallic terminations shorter than 6 mm (dimension *d* in figure 2)

The following criteria apply where the specimen is tested in the "as-received" condition or after accelerated ageing.

a) Areas that form the joint:

   1) the underside of the termination foot and the convex side of the lower bend;

   2) the side faces of the foot.

   The highest quality is required in these areas. The dipped or reflowed surface shall be covered with a smooth and bright solder coating with no more than small amounts of scattered imperfections such as pinholes, non-wetted or dewetted areas. These imperfections shall not be concentrated in one area.

b) The upper side of the termination:

   After the dipping test, the dipped surface shall show visible evidence of being wettable, as indicated by the presence of fresh solder. A homogeneous coating is not necessary here.

c) Non-coated cut edges at the end of the termination and the termination above the lower bend:

   for these surfaces no criteria are given. These areas are illustrated in figure 2.

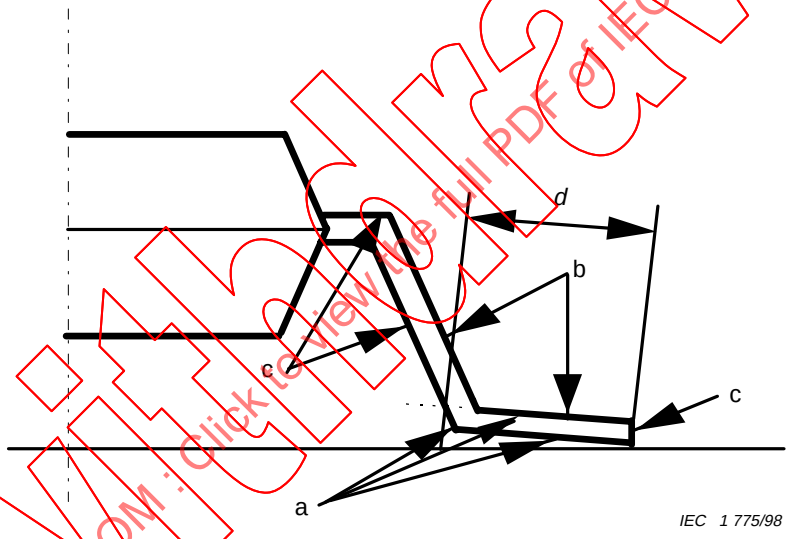

Figure 2 – Identification of areas on metallic termination

9.2.2 Dewetting

The criteria for wetting described in 9.2.1, shall also apply after dipping at 260 °C.

The dewetting shall be assessed visually under adequate light with a binocular microscope of magnification in the range between 10× and 25×.

9.2.3 Resistance to soldering heat

After testing for resistance to soldering heat, the specimen shall be checked and visually examined in accordance with the relevant specification.

9.2.4 Resistance to dissolution of metallization

a) Areas where metallization is lost during immersion shall not individually exceed 5 % of the total electrode area, and collectively shall not exceed 10 % of the total electrode area.

b) The functional connection of the electrode to the interior of the specimen shall not be exposed.

c) Where the metallization of the electrode extends over edges onto adjacent surfaces, loss of metallization on the edges shall not exceed 10 % of their total length.

10 Information to be given in the relevant specification

When this test is included in a specification, the following details shall be given as far as they are applicable. Particular attention should be given to items marked with an asterisk (*) as this information is mandatory.

a) Applicable test method
b) Condition of preconditioning (soak and bake)
c) Flux type
d) Solder temperature for bath tests
e) Dwell time for bath tests
f) Attitude to be used for bath tests
g) Viscosity of solder paste
h) Thickness of solder paste
i) Amount and particle mesh size of solder paste
j) Dimensional details of test substrate
k) Placement procedure (depth of penetration)*
l) Pre-heating temperature and time
m) Temperature profile for reflow
n) Temperature measurement point
o) Number of test cycles for resistance to soldering heat
p) Removal procedure
q) Cleaning method
r) Recovery conditions
s) Final inspection requirements and acceptance criteria
t) Areas of the terminations to be examined.

* Mandatory information.

Annex A
(normative)

Criteria for visual examination

A.1 Wetting

In various specifications, a complete or nearly complete coating with solder is often defined by the so-called 95 % requirement. The application of this requirement is often difficult when assessing specimens with metallized terminations or with short metallic terminations, especially when different parts of the termination are distinguished. Nevertheless, the same approach is followed here. To help in the evaluation of wetting, the photographs in figure A.1 have been reproduced on such a scale that the dimensions are reasonably comparable with the view detained under a microscope, while ensuring that smaller details are still sufficiently clear.

A.2 Evaluation of wetting

Figure A.1 comprises six examples illustrating the criteria for visual examination.

a) Acceptable: ideal coating both on the foot and on the sides; the visible rim is not dewetted because there is no contact angle; the flux residues between body and termination have not been removed.

b) Unacceptable: more than 5 % dewetting on the toe; the bend is well coated.

c) Acceptable: some spots of non-ideal coating on the surface are visible.

d) Unacceptable: more than 5 % dewetting of the foot.

e) Acceptable: a few very small irregularities are visible.

f) Unacceptable: more than 5 % of the area not wetted.

Acceptable

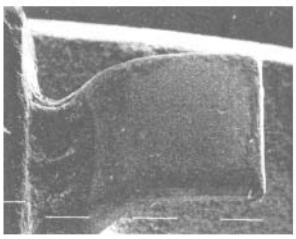

Figure A.1a

Unacceptable

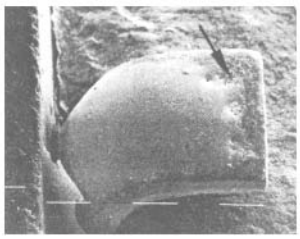

Figure A.1b

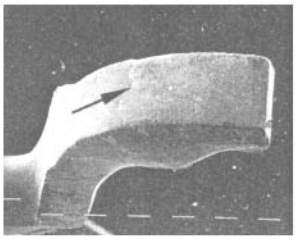

Figure A.1c

Figure A.1d

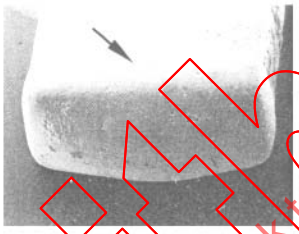

Figure A.1e

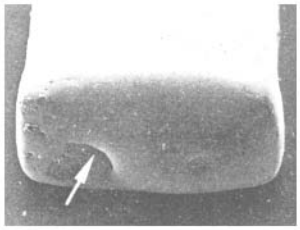

Figure A.1f

IEC 1 776/98

NOTE – The arrows indicate imperfections (acceptable or unacceptable) referred to in A.2 .

Figure A.1 – Evaluation of wetting

Annex B
(informative)

Guidance

B.1 General

In principle, solderability testing should be quantitative and objective. During the preparation of this standard consideration has been given to procedures which meet these requirements and these methods may be found in IEC 60068-2-69.

In choosing these conditions, consideration has been given to procedures established by TC 40, TC 47, CECC*, AIE**, as well as the solder bath dip test conditions already specified in IEC 60068-2-20 and IEC 60749.

The reflow method has been included for SMDs that are intended for reflow process only, or to determine the suitability of an SMD for reflow.

B.2 Limitations

In the case of specimens having terminations plated with pure tin, there might be a mismatch between the results of the dip test, and the performance in practice using methods operating below the melting point of tin (for example vapour phase). The solution to this problem is not yet known; in such cases normal production methods or the reflow method may be used as a test procedure.

B.3 Choice of severity (see 6.4.1)

B.3.1 Immersion for 40 s at 215 °C, 2 s at 235 °C, 5 s at 235 °C, 10 s at 235 °C, 5 s at 260 °C, and 10 s at 260 °C

These conditions are the normal conditions for testing wetting (2 s and 5 s at 235 °C) and resistance to soldering heat respectively.

It should be noted that, as the wetting is assessed after immersion, the method gives no measurement of the speed of wetting; it does however indicate whether adequate wetting can be achieved within the specified time.

Longer immersion times should be used for SMDs with large heat capacities, to ensure the terminations reach the soldering temperature.

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* CECC: CENELEC electronic components committee.

** AIE: International association of electrical contractors.

The relevant specification may prescribe a lower grade of resistance to soldering heat by specifying an immersion time of 5 s at 260 °C.

B.3.2 Immersion for 3 s and 10 s at 215 °C

This condition is provided to allow testing at the relatively low temperature normally used for vapour-phase soldering, as a result obtained at 235 °C is not necessarily relevant to soldering behaviour at 215 °C. A somewhat longer immersion time is specified, as the wetting reaction, even on a readily-wetted surface, can be expected to be slower. A correlation between bath soldering and vapour-phase soldering does not always exist.

B.3.3 Immersion for 30 s at 260 °C

In wave-soldering, the speed of dissolution of metallization is much greater than in a static dip. With wave, reflow or vapour-phase soldering, the specimen may be subjected to subsequent iron-soldering for touch-up or repair. A rather long immersion at high temperature can therefore be specified for testing the resistance of the metallization to dissolution in molten solder.

B.3.4 Immersion attitude

When testing resistance to soldering heat, certain large flat specimens (for example ceramic chip carriers), if immersed with the seating plane vertical, will not experience the thermal gradient across their thickness that they would in practical soldering. In such cases, attitude B (the floating attitude) should be chosen by the specification writer. Discrimination between different sizes of specimen by varying the immersion time is not considered desirable.