# INTERNATIONAL STANDARD

# IEC 60068-2-58

Third edition
2004-07

**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)**



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## Environmental testing –

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## Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)





International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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)

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International Standard IEC 60068-2-58 has been prepared by IEC technical committee 91: Electronics assembly technology.

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

- expansion of the scope so that it includes lead-free solder alloy in addition to the existing tin-lead eutectic or near eutectic solder alloy (the structure of the document has been changed accordingly);
- addition of the definitions of "solderability" and "resistance to soldering heat" for SMDs;
- specification of the reflow temperature profiles for the resistance to soldering heat using lead-free solder;
- addition of an Annex C enabling a quick overview of the test conditions.

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

| FDIS | Report on voting |
|---|---|
| 91/447/FDIS | 91/459/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 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- withdrawn;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.

A bilingual version may be issued at a later date.

# 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 and object

This part of IEC 60068 outlines test Td, applicable to surface mounting devices (SMD), which are intended to mount on substrates. This standard provides the standard procedures for solder alloys containing lead (Pb) and for lead-free solder alloys.

This standard provides standard procedures for determining the solderability and resistance of soldering heat to lead-free solder alloys.

This standard provides standard procedures for determining the solderability, dissolution of metallization (see B.3.3) and resistance of soldering heat to solder alloys which are eutectic or near eutectic tin lead solders.

The procedures in this standard include the solder bath method and reflow method. The solder bath method is applicable to the SMD designed for flow soldering and the SMD designed for reflow soldering when the solder bath (dipping) method is appropriate. The reflow method is applicable to the SMD designed for reflow soldering, to determine the suitability of SMD for reflow soldering and when the solder bath (dipping) method is not appropriate.

The objective of this standard is to ensure that component lead or termination solderability meets the applicable solder joint requirements of IEC 61191-2 using each of the soldering methods specified in IEC 61760-1. In addition, test methods are provided to ensure that the component body can resist against the heat load to which it is exposed during soldering.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

IEC 60194:1999, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 60749-20:2002, *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic-encapsulated SMDs to the combined effect of moisture and soldering heat*

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

IEC 61190-1-2:2002, *Attachment materials for electronic assembly – Part 1-2: Requirements for solder pastes for high-quality interconnections in electronic assembly*

IEC 61190-1-3:2002, *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 61191-2:1998, *Printed board assemblies – Part 2: Sectional specification – Requirements for surface mount soldered assemblies*

IEC 61249-2-7:2002, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

IEC 61760-1:1998, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions as defined in IEC 60068-1, IEC 60068-2-20, IEC 60194, as well as the following apply.

**3.1**
**solderability**
ability of the termination or electrode of SMD to be wetted by solder at the temperature of the termination or electrode which is assumed to be the lowest temperature in the soldering process within solderable temperature of solder alloy

**3.2**
**resistance to soldering heat**
ability of SMD to withstand the highest temperature of the termination or electrode in soldering process, within applicable temperature range of solder alloy

## 4 Grouping of soldering processes using lead-free solder alloys

The melting temperatures of lead-free solder alloys selected currently for industrial processes are significantly different from those for Sn-Pb solder alloy. Moreover, the melting temperatures of lead-free solder alloys are different from each other but can be clustered in groups.

According to the ability of the SMD to withstand the typical temperature and dwell time conditions that match the exposure to the processes using the selected lead-free alloys, the following groups of soldering processes outlined in Table 1 are given as a a guideline for selecting the severities for the wetting and resistance tests against the specified soldering heat:

**Table 1 – Grouping of soldering processes related to lead-free solder alloys**

| Group | Typical process temperature | | Alloys (examples) |
|---|---|---|---|
| | Flow soldering | Reflow soldering | |
| **1 Low temperature** | --------- | 170 °C – 210 °C | Sn-Bi |
| **2 Medium temperature** | --------- | 210 °C – 235 °C | Sn-Zn-Bi<br>Sn-Zn |
| **3 Medium-high temperature** | 245 °C – 255 °C | 235 °C – 250 °C | Sn-Ag<br>Sn-Ag-Cu<br>Sn-Ag-Bi |
| **4 High temperature** | 250 °C – 260 °C | --------- | Sn-Cu |

NOTE 1 Flow soldering applies to both wave soldering and dip soldering.

NOTE 2 Typical process temperatures for flow soldering are identical to the solder temperature. Typical process temperatures for reflow soldering are the terminal and top surface temperature of the SMDs.

NOTE 3 In Group 2 reflow soldering under inert atmosphere (e.g. nitrogen) is required.

NOTE 4 The basic solder alloys listed in this table represent compositions that are currently preferred for lead-free soldering processes. However, other solder alloys when matching with the specified group should not be excluded.

## 5 Preconditioning

**5.1** 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.

**5.2** When accelerated ageing is prescribed by the relevant specification, one of the methods of 4.5 of IEC 60068-2-20 shall be used or, when appropriate, 4 h/155 °C dry heat shall be used.

**5.3** The preconditioning and resistance to soldering heat test of semiconductor SMDs in plastic encapsulation shall be done conform the test procedure as described in IEC 60749-20.

## 6 Solder bath method

### 6.1 Test apparatus and materials for the solder bath method

#### 6.1.1 Solder bath

The solder bath dimensions shall comply with the requirements of 4.6.1 of IEC 60068-2-20. The material of the solder bath container shall be resistant to the liquid solder alloy.

#### 6.1.2 Flux

The flux shall consist of 25 % by weight of colophony in 75 % by weight of 2-propanol (isopropanol) or ethyl alcohol (as specified in Appendix C of IEC 60068-2-20). Preferably the flux activity should conform with the "Low (0)" level, corresponding to a halide content of <0,01 wt % (Cl, Br, F) (see IEC 61190-1-1). When non-activated flux is inappropriate, the above flux with the addition of diethylammonium chloride (analytical reagent grade), up to an amount of 0,5 % chloride (expressed as free chlorine based on the colophony content), may be used. Information concerning the used flux type shall be given in the product detail specification.

### 6.1.3 Solder

#### 6.1.3.1 Lead-free solder alloys

When testing solderability, the solder composition shall be as defined in Table 2. For the resistance to soldering heat test, any alloys may be used, provided they are completely liquid at the required temperature.

#### 6.1.3.2 Solder alloys containing lead

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

### 6.2 Test procedure for solder bath method

#### 6.2.1 Specimens

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

#### 6.2.2 Clamping

Unless otherwise specified in the relevant specification, 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.

#### 6.2.3 Fluxing

Unless otherwise specified in the relevant specification, the specimen shall be completely immersed in flux and withdrawn slowly. Any excess flux shall be removed by contact with absorbent paper.

#### 6.2.4 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.

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.

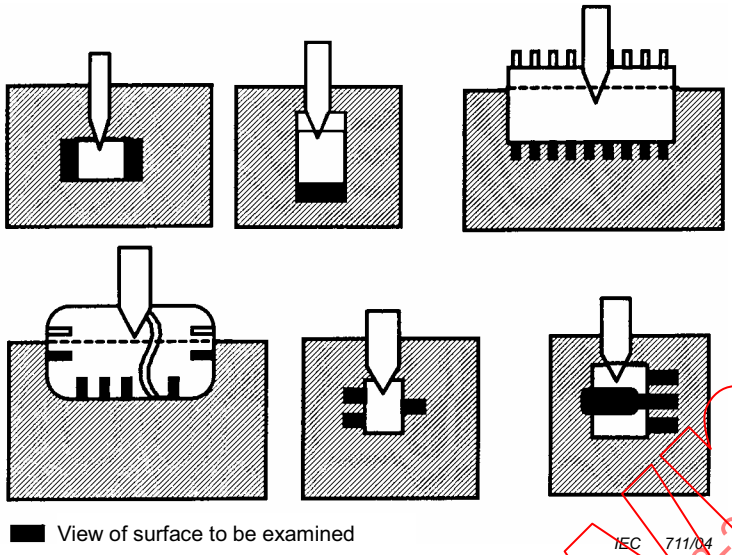


**Figure 1 – Examples of immersion**

### 6.2.5 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 for solder reflow methods

#### 7.1.1 Reflow equipment

As long as the test conditions are fulfilled, any reflow equipment may be used:

a) forced gas convection;

b) infrared;

c) vapour phase;

d) hot plate soldering; metallic plate (carrier), floating on a molten solder bath or an electrically heated plate.

NOTE 1 Forced gas convection is preferred; including infrared assistance.

NOTE 2 Infrared reflow equipments are known to have variations of peak reflow temperature (PRT) of 30 °C or more across the board in a PC board.

NOTE 3 In case of vapour phase soldering, a specific liquid is necessary for each test temperature.

NOTE 4 Hot plate soldering is a method which at times may have large PRT variations in the order of 40 °C.

### 7.1.2 Solder paste for solder reflow

#### 7.1.2.1 Lead-free solder paste

Unless otherwise specified in the relevant specification, solder paste shall be as shown below. For the resistance to soldering heat test, any alloys may be used, provided they are completely liquid at the required temperature.

a) Solder paste for group 1:

- Alloy composition

  The alloy composition to be used shall consist of 58 wt % of Bi (bismuth) and the remainder of Sn (tin), Sn42Bi58. The solder alloy shall consist of 57 wt % to 58 wt % Bi and the remainder of Sn may be used.

- Solder powder

  Under consideration.

- Flux composition

  Under consideration.

- Solder paste composition

  Under consideration.

b) Solder paste for group 2:

- Alloy composition

  Under consideration.

- Solder powder

  Under consideration.

- Flux composition

  Under consideration.

- Solder paste composition

  Under consideration.

c) Solder paste for group 3:

- Alloy composition

  The alloy composition to be used shall consist of 3,0 wt % Ag (silver), 0,5 wt % Cu (copper) and the remainder of Sn (tin); Sn96.5Ag3.0Cu0.5 is preferred. The solder alloys shall consist of 3,0 wt % to 4,0 wt % Ag, 0,5 wt % to 1,0 wt % Cu, and the remainder of Sn may be used instead of Sn96.5Ag3.0Cu0.5.

- Solder powder

  The powder size shall be symbol 3, specified in Table 2 of 4.3.2 of IEC 61190-1-2.

  The shape of the solder powder shall be spherical.

- Flux composition

  The flux to be used shall consist of 30 wt % polymerization rosin (softening point approximately 95 °C), 30 wt % dibasic acid degeneration rosin (softening point approximately 140 °C), 34,7 wt % diethylene glycol monobutyl ether, 0,8 wt % 1,3-diphenylguanidine- HBr, 0,5 wt % adipic acid (chlorine content less than 0,1 %) and 4 wt % stiffening castor oil.

- Solder paste composition

  The solder paste to be used shall consist of 88 wt % solder powder and 12 wt % flux. The viscosity range shall be (180 ± 50) Pa·s.

#### 7.1.2.2 Lead containing solder paste

– Alloy composition

  The solder composition shall be as specified in 6.1.3.2.

– Solder powder

  Unless otherwise specified in the relevant specification, the particle size of the solder paste shall be 20 µm to 45 µm.

– Flux composition

  The composition of the flux shall be as specified in 6.1.2.

– Solder paste composition

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

### 7.1.3 Test substrates

The test substrate shall consist of an unmetallized (no tracks or lands) piece of ceramic (alumina 90 % to 98 %) for all reflow equipments or glass epoxy (see IEC 61249-2-7) except for hot plate soldering.

Dimensional details and number of sample(s) to be tested shall be given in the relevant specification.

## 7.2 Test procedure for the solder reflow method

### 7.2.1 Specimens

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

### 7.2.2 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 solder paste is applied by dispensing or pin transfer, the volume shall be adjusted so that a comparable solder volume can be achieved.

When the resistance to soldering heat of semiconductor SMDs is found to conform to IEC 60749-20, then no solder paste shall be applied.

### 7.2.3 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.

### 7.2.4 Reflow temperature profile

#### 7.2.4.1 Parameters for reflow temperature profile

As a minimum, the following parameters shown in Figure 2 shall be specified for reflow temperature profile.

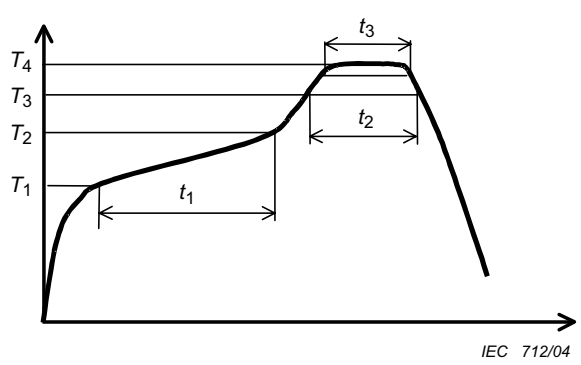


**Figure 2a – "Hat" type**

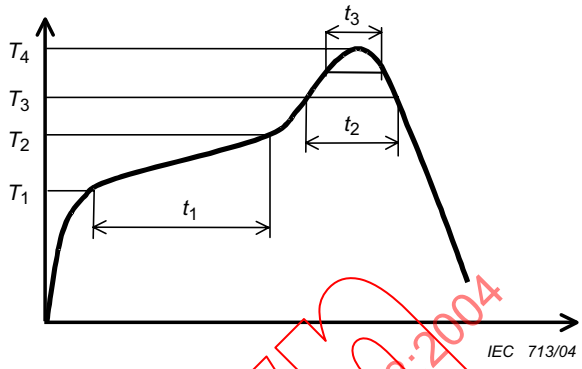


**Figure 2b – "Angle" type**

**Key**

| | |
|---|---|
| $T_1$ | Minimum preheating temperature |
| $T_2$ | Maximum preheating temperature |
| $T_3$ | Soldering temperature |
| $T_4$ | Peak temperature |
| $t_1$ | Preheating duration |
| $t_2$ | Soldering duration |
| $t_3$ | Peak temperature duration |

NOTE The ramp for heating and cooling in the soldering zone has a certain impact to the soldering results (damage to components, oxidization, cracking of flux).

**Figure 2 – Reflow temperature profile**

#### 7.2.4.2 Reflow temperature profile for wetting

Unless otherwise specified in the relevant specification, the temperature shall be measured at the specimen termination. When semiconductor SMDs are examined, the temperature shall be measured at the SMD's top body surface, as specified in IEC 60749-20.

#### 7.2.4.3 Reflow temperature profile for resistance to soldering heat

Unless otherwise specified in the relevant specification, the temperature shall be measured at the specimen's top body surface.

## 8 Test conditions

### 8.1 Test conditions for lead-free solder alloys

#### 8.1.1 Solder bath method (wetting and resistance to soldering heat)

Unless otherwise specified in the relevant specification, the duration and temperature of immersion shall be selected from Table 2.

**Table 2 – Severities (duration and temperatures) – Solder bath method – Lead-free solder alloys**

| Property tested | Alloy composition | Severity | | | |
|---|---|---|---|---|---|
| | | Group 3 | | Group 4 | |
| | | (245 ± 5) °C<br>(3 ± 0,3) s | (255 ± 5) °C<br>(10 ± 1) s | (250± 5) °C<br>(3 ± 0,3) s | (260 ± 5) °C<br>(10 ± 1) s |
| **Wetting** | Sn96,5Ag3,0Cu0,5<br>Sn99,3Cu0,7 | X | | X | |
| **Resistance to soldering heat** | See 6.1.3.1 | | X | | X |

Alloy composition for test purposes only. The solder alloys consist of 3,0 wt % to 4,0 wt % Ag, 0,5 wt % to 1,0 wt % Cu, and the remainder of Sn may be used instead of Sn96.5Ag3.0Cu0.5. The solder alloys consist of 0,45 wt % to 0,9 wt % Cu and the remainder of Sn may be used instead of Sn99.3Cu0.7.

NOTE 1 "X" denotes 'applicable'.

NOTE 2 For groups 3 and 4, refer to Table 1.

NOTE 3 Refer to 3.1 of IEC 61190-1-3 to identify alloy composition.

NOTE 4 If solder alloys other than those listed here are used, it has to be verified that the given severities are applicable, refer to Note 4 of Table 1.

### 8.1.2 Solder reflow method (wetting and resistance to soldering heat)

#### 8.1.2.1 Reflow temperature profile for wetting

The reflow temperature profile shall be as shown in Figure 2b. Unless otherwise specified in the relevant specification, reflow temperature profile for wetting shall be as specified in Table 3.

**Table 3 – Reflow temperature profile for wetting – Lead-free solder alloys**

| Group | $T_1$ °C | $T_2$ °C | $t_1$ s | $T_3$ °C | $t_2$ s | $T_4$ °C | $t_3$ s |
|---|---|---|---|---|---|---|---|
| **1** | 100 ± 5 | 100 ± 5 | 60 to 120 | 160 | 30 ± 5 | 170 | -- |
| **2** [a] | Under consideration | | | | | | |
| **3** | 150 ± 5 | 180 ± 5 | 60 to 120 | 225 | 20 ± 5 | 235 | -- |

[a] Under inert atmosphere (e.g. nitrogen).

#### 8.1.2.2 Reflow temperature profile for resistance to soldering heat

Unless otherwise specified in the relevant specification, the reflow temperature profile for resistance to soldering heat shall be as specified in Table 4.

NOTE 1 This standard assumes that reflow soldering using group 3 solder and a small size specimen is an acceptable upper limit of severity. A lower peak temperature may be specified by the relevant specification if

a) in the case of a large specimen, due to its thermal capacity, the peak temperature of SMD dose not reach the specified temperature in reflow soldering process;

b) the SMDs cannot withstand the specified temperature. For example, some types of switches, quartz oscillators, aluminium electrolytic capacitors, connectors, etc.

NOTE 2 A forced gas convection oven is recommended to ensure reproducibility of the reflow temperature profile.

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 the time it takes until the temperature of the specimen drops below 50 °C.

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

**Table 4 – Reflow temperature profile for resistance to soldering heat – Lead-free solder alloys**

| Test | Reflow profile | $T_1$ °C | $T_2$ °C | $t_1$ s | $T_3$ °C | $t_2$ s | $T_4$ °C | $t_3$ s |
|---|---|---|---|---|---|---|---|---|
| 1 | Figure 2a | 150 ± 5 | 180 ± 5 | 120 ± 5 | 220 | 60 to 90 | 250 | 20 – 40 @ $T_4$ – 5 °C |
| 2 | Figure 2b | 150 ± 5 | 180 ± 5 | 120 ± 5 | 220 | ≤ 60 | 255 | ≤ 20 @ $T_4$ -10 °C |
| NOTE 1 Test 2 may be specified by agreement between trading partners. | | | | | | | | |
| NOTE 2 There is no test result correlation between Test 1 and Test 2. | | | | | | | | |

## 8.2 Test conditions for lead containing solder alloy

### 8.2.1 Solder bath method (wetting, dewetting, resistance to soldering heat and resistance to dissolution of metallization)

The duration and temperature of immersion shall be selected from Table 5, unless otherwise prescribed by the relevant specification. Guidance on the choice of severities, including those for lower grades of dissolution of metallization, is given in B.3.

**Table 5 – 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 | |
| NOTE “X” denotes ‘applicable’. | | | | | | | | | |

### 8.2.2 Test conditions for solder reflow method (wetting and resistance to soldering heat)

#### 8.2.2.1 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.

#### 8.2.2.2 Solder reflow

The temperature profile shall be specified in the relevant specification, except for hot plate soldering. For hot plate soldering, the temperature of the substrate shall be maintained above 140 °C between preheating and reflow.

### 8.2.3 Solder reflow method for wetting

#### 8.2.3.1 General

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

#### 8.2.3.2 Reflow method 1 (preferred): infrared, forced gas convection or vapour phase

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.

#### 8.2.3.3 Reflow method 2: hot plate soldering

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.

**Table 6 – Reflow temperature profile for wetting – Lead containing solder alloys**

| Reflow method | $T_1$ °C | $T_2$ °C | $t_1$ s | $T_3$ °C | $t_2$ s | $T_4$ °C | $t_3$ s |
|---|---|---|---|---|---|---|---|
| 1 | 150 ± 10 | 150 ± 10 | 60 -120 | -- | -- | 215 ± 3 | 10 ± 1 @ $T_4$ |
| 2 | 150 ± 10 | 150 ± 10 | 60 -120 | -- | -- | 215 ± 3 | 10 ± 1 @ $T_4$ |

### 8.2.4 Solder reflow method for resistance to soldering heat

#### 8.2.4.1 General

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.

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 the time it takes until the temperature of the specimen drops below 50 °C.

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.

#### 8.2.4.2 Reflow method 1: vapour phase soldering system

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.

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

#### 8.2.4.3 Reflow method 2: infrared and forced gas convection soldering system

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.

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

#### 8.2.4.4 Reflow method 3: hot plate soldering

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 specified duration. The temperature of the substrate shall be maintained above 140 °C between preheating and reflow.

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

**Table 7 – Reflow temperature profile for resistance to soldering heat – Lead containing solder alloys**

| Reflow method | $T_1$ °C | $T_2$ °C | $t_1$ s | $T_3$ °C | $t_2$ s | $T_4$ °C | $t_3$ s |
|---|---|---|---|---|---|---|---|
| 1 | 150 ± 10 | 150 ± 10 | 60 -120 | -- | -- | 215 ± 3 | 40 ± 1 @ $T_4$ |
| 2 | 150 ± 10 | 150 ± 10 | 60 -120 | | | 235 ± 5 | 10 ± 1 @ $T_4$ |
| 3 | 150 ± 10 | 150 ± 10 | 60 -120 | -- | -- | 235 ± 5 | 30 ± 1 @ $T_4$ |

## 9 Final measurements

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

### 9.2 Recovery conditions

The recovery conditions shall be prescribed in the relevant specification.

### 9.3 Evaluation

#### 9.3.1 Wetting

The wetting shall be assessed visually under adequate light with a binocular microscope of a magnification in the range of 10x and 25x, using the photographs of component terminations in Clause A.1 to assist with the evaluation. The areas to be examined shall be prescribed in the relevant specification.

##### 9.3.1.1 Metallized end cap terminations (rectangular or circular configuration)

The dipped or reflowed surface shall be covered with 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. For solder alloy containing lead, solder coating shall be smooth and bright.

##### 9.3.1.2 Metallic terminations shorter than 6 mm (dimension "*d*" in Figure 3)

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

a) Areas that form the joint (area "a" in Figure 3):

   1) the underside of the termination foot (area "*d*" in Figure 3) 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 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. For solder alloy containing lead, solder coating shall be smooth and bright.

b) The upper side of the termination (area “b” in Figure 3):

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 (area “c” in Figure 3):

For these surfaces no criteria are given.

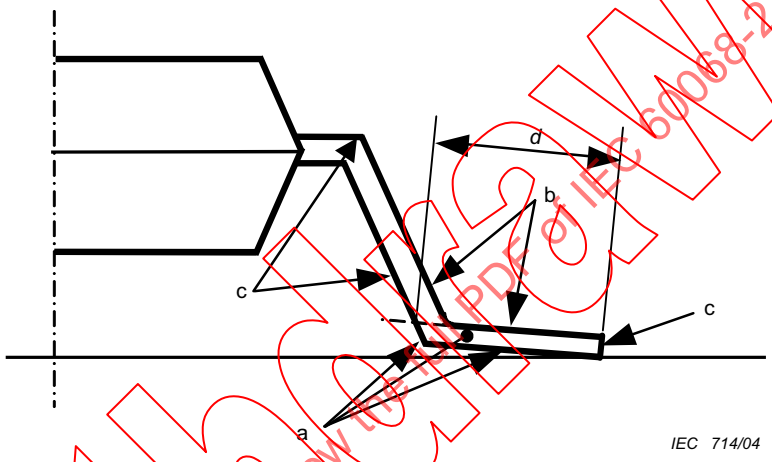


**Figure 3 – Identification of areas on metallic termination**

### 9.3.2 **Dewetting** (if applicable)

The criteria for wetting described in 9.3.1 shall also apply.

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

### 9.3.3 Resistance to soldering heat

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

### 9.3.4 **Resistance to dissolution of metallization** (if applicable)

The following criteria shall apply. If these criteria cannot be applied, criteria shall be prescribed in the relevant specification.

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 insofar as they are applicable. Particular attention shall be given to items marked with and asterisk (*) as this information is mandatory.

| | Subclause reference | |
|---|---|---|
| | **Lead free solder alloy** | **Solder alloy containing lead** |
| a) Property to be tested* | Clause 1 | Clause 1 |
| b) Applicable test method* | Clause 1 | |
| c) Condition of preconditioning | Clause 5 | |
| d) Selected solder alloy* (solder bath method) | 6.1.3.1 | 6.1.3.2 |
| e) Flux type (solder bath method) | 6.1.2 | |
| f) Clamping, fluxing and solder immersion | 6.2 | |
| g) Preheating for solder bath method* | 6.2.4 | |
| h) Attitude to be used for bath test | 6.2.5 | |
| i) Solder temperature and duration* | 8.1.1 | 8.2.1 |
| j) Solder paste | 7.1.2.1 | 7.1.2.2 |
| k) Dimensional details of test substrate* | 7.1.3 | |
| l) Thickness of solder paste* | 7.2.2 | |
| m) Amount of solder paste* | 7.2.2 | |
| n) Placement procedure* | 7.2.3 | |
| o) Pre-heating for solder reflow | | 8.2.2.1 |
| p) Temperature profile* | 8.1.2.1, 8.1.2.2 | 8.2.2.2 |
| q) Temperature measurement point | 7.2.4.2, 7.2.4.3 | |
| r) Number of test cycles for resistance to soldering heat if other than 1 cycle | 8.1.2.2 | 8.2.4.1 |
| s) Removal procedure* | 9.1 | |
| t) Cleaning method* | 9.1 | |
| u) Recovery conditions* | 9.2 | |
| v) Areas of the terminations to be examined* | 9.3.1 | |
| w) Final inspection requirements and acceptance criteria | 9.3.1, 9.3.2, 9.3.3, 9.3.4 | |
| | | |
| * 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 obtained 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

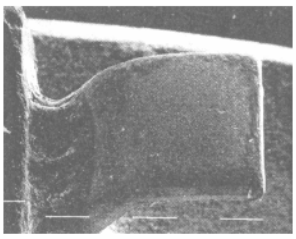

Figure A.1a

Unacceptable

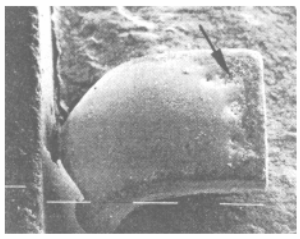

Figure A.1b

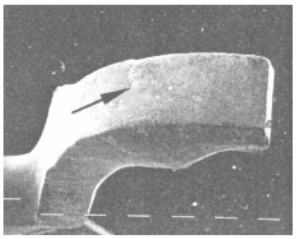

Figure A.1c

Figure A.1d

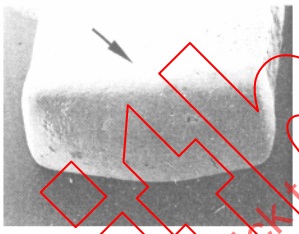

Figure A.1e

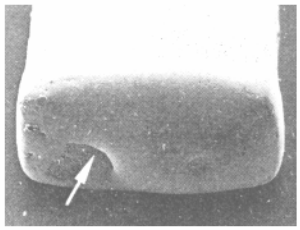

Figure A.1f

IEC 1 776/98

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

**Figure A.1 – Evaluation of wetting**

# Annex B
(informative)

# Guidance

## B.1 General

The following considerations are primarily relating to solder alloys containing lead. For lead-free solder alloys comparable guidance should be developed as when more experience is available.

Soldering tests applicable to SMD are in IEC 60068-2-69 and for other electrotechnical products are in IEC 60068-2-20 and IEC 60068-2-54, for which guidance is given in IEC 60068-2-44.

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 or solder reflow test conditions already specified in IEC 60068-2-20 and IEC 60749-20.

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

If full body solder dipping of the part is to be used to test for capability to bottom side full body immersion using wavesolder attach, correlation between the static solder dip conditions and the dynamic wavesolder conditions must be considered.

Some parts get damaged with reflow temperature profile. Therefore caution should be exercised when choosing solder reflow profiles and peak reflow temperatures. For example, a semiconductor device to ensure that the moisture sensitivity level (MSL) ratings of these parts is not exceeded (see IEC 60749-20).

## B.2 Limitations

**B.2.1** In the case of specimens having terminations plated with pure tin, or another lead-free plating, there might be a mismatch between the results of the dip test in lead-tin solder bath, 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.2.2** Excessive peak reflow temperatures initiate failures, which cause equipment failures under normal use conditions.

Hot plate solder reflow is a method subject to large variations of the peak reflow temperature. If this method is to be used, strict process controls are required to ensure that the appropriate peak reflow temperature is not exceeded and that abnormal latent field failures are not initiated.

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* CECC: CENELEC Electronic Components Committee.

** AIE: International Association Of Electrical Contractors.

Solder dipping should only be used if data exists showing that correlation between the part junction temperature under wave solder and dipping is equivalent. In addition, data should exist showing the proper preheating for the correlation.

Preheating is extremely important to prevent damage to parts, especially to large volume packages. Preheating is part of a good process set-up.

## B.3 Choice of severity (see Table 5)

### B.3.1 Immersion for the different specified temperatures and durations

These conditions are the conditions for testing wetting 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 SMD with large heat capacities to ensure the terminations reach the soldering temperature.

The relevant specification may prescribe a lower grade of resistance to soldering heat by specifying a shorter immersion time.

### 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, because 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 (see 6.2.5)

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 experience 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.

# Annex C
(informative)

# Overview of test conditions

## C.1 General

This annex shows the many different temperature and duration conditions of the several tests mentioned in this standard:

– solder alloys: lead-free and containing lead;
– test method: solder bath and solder reflow;
– test property: wetting, dewetting, resistance to dissolution of metallization and resistance to soldering heat.

In order to have a rapid overview of the temperature and duration conditions of the different tests, Table C.1 shows the main temperature and conditions of all the methods covered in this standard.