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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-601: General test methods for materials and assemblies – Reflow soldering ability test for solder joint, and reflow heat resistance test for printed boards

Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 5-601: Méthodes d'essai générales pour les matériaux et les assemblages – Essai d'aptitude au brasage par refusion pour un joint brasé, et essai de résistance à la chaleur de refusion pour les cartes imprimées

IEC 61189-5-601:2021-02(en-fr)

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FOREWORD

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IEC 61189-5-601 has been prepared by IEC technical committee 91: Electronics assembly technology. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
91/1601/CDV	91/1674/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61189 series, published under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARDS AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

Part 5-601: General test methods for materials and assemblies – Reflow soldering ability test for solder joint, and reflow heat resistance test for printed boards

1 Scope

This part of IEC 61189 specifies the reflow soldering ability test method for components mounted on organic rigid printed boards, the reflow heat resistance test method for organic rigid printed boards, and the reflow soldering ability test method for the lands of organic rigid printed boards in applications using solder alloys, which are eutectic or near-eutectic tin-lead (Pb), or lead-free alloys.

The printed boards materials for this organic rigid printed boards are epoxide woven E-glass laminated sheets that are specified in IEC 61249-2 (all parts).

The objective of this document is to ensure the soldering ability of the solder joint and of the lands of the printed boards. In addition, test methods are provided to ensure that the printed boards can resist the heat load to which they are exposed during soldering.

This document covers tests Tg_1, Tg_2, Tg_3, Tg_4, Tg_5, and Tg_6 listed in Table 1:

Table 1 – Test items defined in this document

Number of test method	Test	Method
Tg_1	Solder joint initial quality after reflow	Reflow
Tg_2	Warpage of component and printed boards in reflow process	
Tg_3	Resistance to soldering heat of printed boards	
Tg_4	Wetting and dewetting of printed board land	
Tg_5	Resistance to dissolution of printed board land	
Tg_6	Pull strength of the test substrate land	

NOTE The test methods do not apply to the solder bath method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2 (all parts), *Environmental testing*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60191-6-2, *Mechanical standardization of semiconductor devices – Part 6-2: General rules for the preparation of outline drawings of surface mounted semiconductor devices packages – Design guide for 1,50 mm, 1,27 mm and 1,00 mm pitch ball and column terminal packages*

IEC 60191-6-5, *Mechanical standardization of semiconductor devices – Part 6-5: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for fine-pitch ball grid array (FBGA)*

IEC 60191-6-19, *Mechanical standardization of semiconductor devices – Part 6-19: Measurement methods of the package warpage at elevated temperature and the maximum permissible warpage*

IEC 60194-1[1], *Printed boards design, manufacture and assembly – Vocabulary – Part 1: Common usage in printed board and electronic assembly technologies*

IEC 60194-2, *Printed boards design, manufacture and assembly – Vocabulary – Part 2: Common usage in electronic technologies as well as printed board and electronic assembly technologies*

IEC 61190-1-3, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solder for electronic soldering applications*

IEC 62137-3, *Electronics assembly technology – Part 3: Selection guidance of environmental and endurance test methods for solder joints*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60191-6-2, IEC 60191-6-5, IEC 60194-1 and IEC 60194-2, as well as the following, apply.

For the purposes of this document, the following terms and definitions apply.

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3.1
solderability
ability of the lead or termination of a component or electrode of a component or printed board to be wetted by solder at the temperature of the lead, termination or electrode, which is assumed to be the lowest temperature in the soldering process, within the applicable temperature range of the solder alloy

Note 1 to entry: The term "solderability" is often used in combination with the term "test", indicating a specific method to evaluate the wettability or ability to be soldered of a surface under worst case conditions (soldering temperature and contact time with solder). It is not to be confused with the concepts "soldering ability" (see 3.3).

3.2
wettability
intrinsic property of the termination material to form an alloy with the solder

[1] Under preparation. Stage at the time of publication: IEC/FDIS 60194-1:2020.

Note 1 to entry: Wettability depends on the base metal used to produce the termination or, in the case of a plated termination, the condition and material used to plate the base metal.

3.3
soldering ability
ability of a specific combination of components to facilitate the formation of a proper solder joint

Note 1 to entry: See 3.2, wettability.

3.4
resistance to soldering heat
ability of the component to withstand the highest temperature in terms of temperature gradient, peak temperature and duration of the soldering process, within the applicable temperature range of the solder alloy

3.5
reflow soldering
joining of surfaces that have been tinned and/or have solder between them, placing them together, heating them until the solder flows, and allowing the surface and the solder to cool in the joined position

3.6
wetting
formation of an adherent coating of solder on a surface indicated by a small contact angle

3.7
dewetting
retraction of molten solder on a solid area that it has initially wetted

Note 1 to entry: In some cases, an extremely thin film of solder may remain. As the solder retracts, the contact angle increases.

3.8
non-wetting
inability to form an adherent coating of solder on a surface indicated by a contact angle greater than 90°

3.9
dissolution of printed-board land
process of dissolving metal, usually by introduction of chemicals

4 Grouping of soldering processes and related test severities

The melting temperatures of lead-free solder alloys selected 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.

The groups of soldering processes indicated in Table 2 are given as a guideline to select the severities for the wetting and resistance tests at a specified soldering heat.

Table 2 – Grouping of soldering processes and typical test severities – Overview

Process temperature group [a]			1	2
Typical solder alloy group			Sn-Pb	Sn-Ag-Cu
Typical process temperature	Reflow peak temperature		210 °C to 240 °C	235 °C to 250 °C
Test method	Test property		Reflow peak temperature/Duration	
Reflow [b]	Solder joint initial quality "Soldering ability"	Maximum profile temperature	235 °C / 20 s or more	245 °C / 30 s or more
		Minimum profile temperature	215 °C / 10 s or less	235 °C / 10 s or less
	Warpage		235 °C / 20 s or more	245 °C / 30 s or more
	Resistance to soldering heat		235 °C / 20 s or more	245 °C / 30 s or more
	Wetting and dewetting		215 °C / 10 s or less	235 °C / 10 s or less
	Resistance to dissolution		235 °C / 20 s or more	245 °C / 30 s or more
	Pull strength		235 °C / 20 s or more	245 °C / 30 s or more

Typical process temperatures for reflow soldering are the land temperatures in device area on printed boards.

The Sn-Ag-Cu alloy listed in this table represents compositions that are currently preferred for lead-free soldering processes. However, other solder alloys when matching with the specified group should not be excluded.

[a] Refer to each appropriate subclauses for the detailed test conditions.

[b] Measured at the solder joint or land of printed boards.

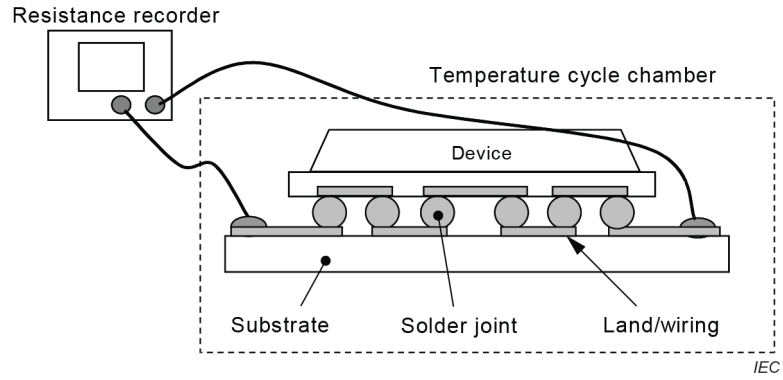
5 Specimens

5.1 Devices

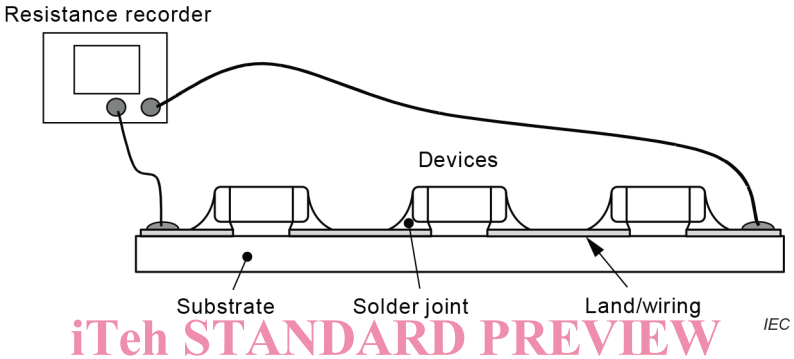
Device specimens for this test are specified in IEC 62137-3.

When the evaluation needs to be conducted, the device used for this test is a dummy device within which the terminations are connected as shown in Figure 1.

When the evaluation for leadless termination type devices needs to be conducted on the resistance device, the device resistance for the test is a low-resistance device [as shown in Figure 1 b)]. The resistance of the low-resistance device should be 50 mΩ or less.



a) Example of area array type packages



b) Example of leadless termination type devices

Figure 1 – Example of a test circuit for the electrical continuity test of a solder joint

The following Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6 show the typical appearance of each package type.

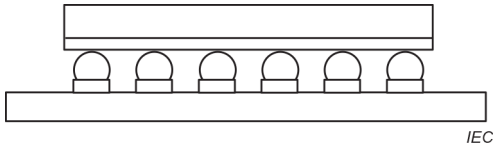


Figure 2 – Example of area array type packages

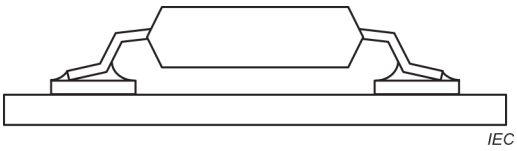


Figure 3 – Example of leaded type devices

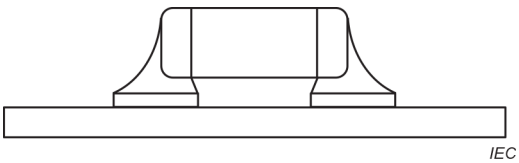


Figure 4 – Example of leadless termination type devices

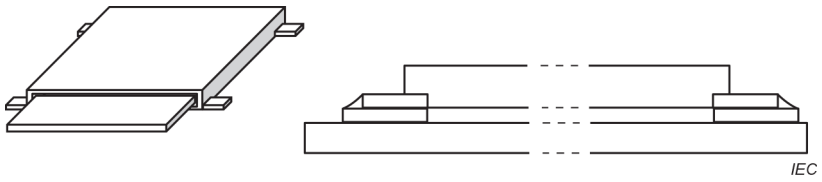


Figure 5 – Example of connector for card type devices

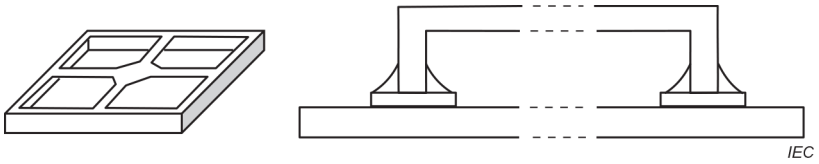


Figure 6 – Example of shielding metal components

5.2 Test substrate

The test substrate material shall be single or double-sided mounting with single-layer, double-layer or multilayer printed boards for material structure used with product. Unless otherwise specified in the product specification, the test substrate shall be as follows.

a) Test substrate material

Test substrate material shall be a single-sided printed board for general use, for example, copper-clad epoxide woven fiberglass reinforced laminated sheets as specified in IEC 61249-2-7 or IEC 61249-2-8. The thickness shall be (1,6 ± 0,2) mm including copper foil. The copper foil thickness shall be (35 ± 10) µm.

b) Test substrate dimensions

The test substrate dimensions depend on the mounted package size and shape. However, the test substrate dimensions shall be able to be fixed on the pull strength test equipment.

c) Land shape and land dimensions

Land shape and land dimensions should be the same specification as used for product design. Land shape and land dimensions should be as specified in IEC 61188-5-8.

Moreover, the test substrate and the test package shall be designed in such a way that their land pattern forms a daisy chain circuit after mounting for the electrical continuity measurement.

d) Surface finish of land pattern

If specified in the product specification, the surface finish treatment (for land pattern of the printed board) shall be the same as specified in the product specification.

EXAMPLE: organic solderability preservative (OSP) or electroless nickel immersion gold (ENIG) plating layer.

5.3 Solder paste

Solder paste is made of flux, finely divided particles of solder, and additives to promote wetting and to control viscosity, tackiness, slumping, drying rate, etc. Unless otherwise specified in the product specification, one of the solder alloys listed below (as specified in IEC 61190-1-3) shall be used. The product specification shall specify details of the solder paste.

The major composition of the solder alloys are as follows:

a) 63 % mass fraction of Sn (tin) and 37 % mass fraction of Pb (lead);

b) from 3,0 % to 4,0 % mass fraction of Ag (silver), from 0,5 % to 1,0 % mass fraction of Cu (copper) and the remainder of Sn (tin).

EXAMPLE: Sn-Ag-Cu ternary alloy such as Sn96,5Ag3Cu,5 alloy is used.