

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

Surface mounting technology – Environmental and endurance test methods for surface mount solder joint – Part 1-4: Cyclic bending test

Technologie de montage en surface – Méthodes d'essais d'environnement et d'endurance des joints brasés montés en surface – Partie 1-4: Essai de flexion cyclique



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IEC 62137-1-4

Edition 1.0 2009-01

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

M

ICS 31.190

ISBN 978-2-88910-627-1

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SURFACE MOUNTING TECHNOLOGY –  
ENVIRONMENTAL AND ENDURANCE TEST METHODS  
FOR SURFACE MOUNT SOLDER JOINT –**

**Part 1-4: Cyclic bending test**

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

FDIS	Report on voting
91/815/FDIS	91/835/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.

A list of all parts of the IEC 62137 series, under the general title *Surface mounting technology – Environmental and endurance test methods for surface mount solder joint*, can be found on the IEC website.

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

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# SURFACE MOUNTING TECHNOLOGY – ENVIRONMENTAL AND ENDURANCE TEST METHODS FOR SURFACE MOUNT SOLDER JOINT –

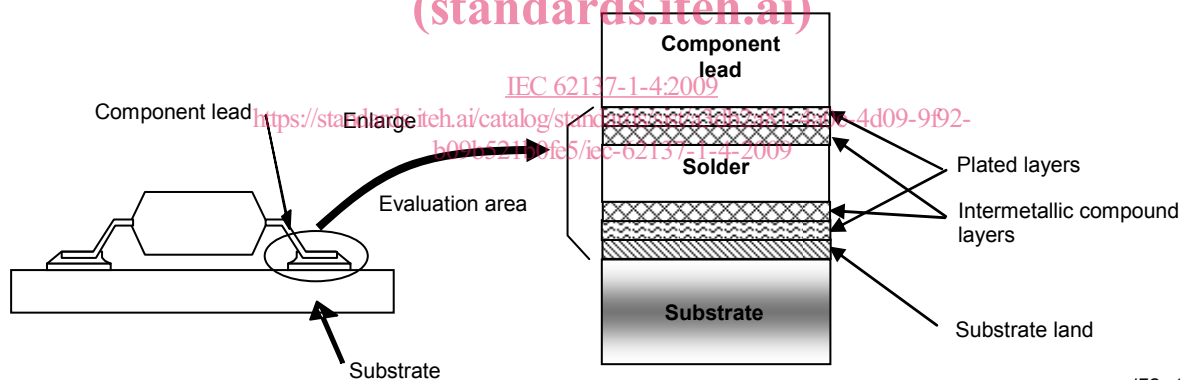
## Part 1-4: Cyclic bending test

### 1 Scope

The test method described in this part of IEC 62137 applies to surface mount components with a thin and wide basal plane, such as QFP and BGA. This test method evaluates the endurance of the solder joints between component leads and lands on a substrate by cyclic bending of substrate.

This test also evaluates the effects of repeated mechanical stress, such as key pushing in cell phones, the strength of the solder joint between component terminals and lands on a substrate.

In this test method, the evaluation requires first to mount the surface mount component on the substrate by reflow soldering, then cyclically bend the substrate to a certain degree of depth until fracture of the solder joints occurs. The properties of the solder joints (e.g, solder alloy, substrate, mounted device or design, etc.) are evaluated to assist in improving the strength of the solder joints.



**Figure 1 – Image drawing on evaluation area of joint strength**

## 2 Normative references

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

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

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

IEC 61188-5 (all parts 5), *Printed boards and printed board assemblies – Design and use – Part 5: Attachment (land-joint) considerations*

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

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

IEC 61249-2-7, *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, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

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## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194, IEC 60068-1 and IEC 61249-2-7 as well as the following apply.

### 3.1

#### **cyclic bending strength**

intensity of the strength, which is expressed in the number of cycles to attain the joint fracture between surface mount component terminals mounted on the printed board and the copper land of the substrate after bending the substrate cyclically to a certain degree to allow the surface of the component side of the board to become a convex shape

### 3.2

#### **displacement rate**

moving velocities of the indenter when cyclically bending the substrate

### 3.3

#### **displacement range**

distance from the initial test position at the centre of the substrate to the maximum indentation caused by pushing the indenter down and by pulling it back

## 4 Test equipment and materials

### 4.1 Test equipment for cyclic bending

The equipment for cyclic bending tests consists of a tension compression testing machine, substrate bending jigs, a resistance measuring instrument and a recorder. The specifications shall comply with those of the cyclic bending test equipment described in Annex A.



## 4.2 Test substrate

Unless otherwise prescribed by the relevant product specifications, the test substrate shall meet the following conditions:

- a) **Material:** Epoxide woven, glass fabric, copper-clad laminated sheet, general purpose grade (see IEC 61249–2-7), with foil bonded to one side and a nominal thickness of the sheet, including the metal foil, of 1,6 mm with a tolerance of  $\pm 0,20$  mm. The copper foil should have a thickness of  $0,035 \text{ mm} \pm 0,010 \text{ mm}$ .
- b) **Size:** The size of the substrate depends on the size and shape of a surface mount device soldered on the substrate. The substrate shall be able to be fastened to the pull test equipment.
- c) **Land geometry:** The shape and size of a land shall comply with the IEC 61188-5 series or the pad geometry recommended by the respective component supplier.
- d) **Surface protection:** The solderable areas of the substrate (lands) shall be protected against oxidization by suitable means, for example by an organic surface protection layer (OSP). This protective layer shall not adversely effect the solderability of the lands under the soldering conditions of the reflow soldering equipment.

## 4.3 Solder alloy

Unless otherwise specified, the solder alloy shall consist of a ternary composition of Sn, Ag and Cu with the Ag content ranking from 3,0 % to 4,0 % by weight and the Cu content ranking from 0,5 % to 1,0 % by weight with Sn for balance, for example SnAg3,0Cu0,5. The solder alloy shall be in accordance with IEC 61190-1-3.

## 4.4 Solder paste

Unless otherwise stated in the relevant product specifications, solder paste should be chosen from IEC 61190-1-2. However, the solder to be used shall be the one specified in 4.3 above.

## 4.5 Reflow soldering equipment

Unless otherwise prescribed by the relevant product specifications, reflow-soldering equipment should be the one that can realize the temperature profile as shown in Figure 2.

## 4.6 Surface mount component for testing

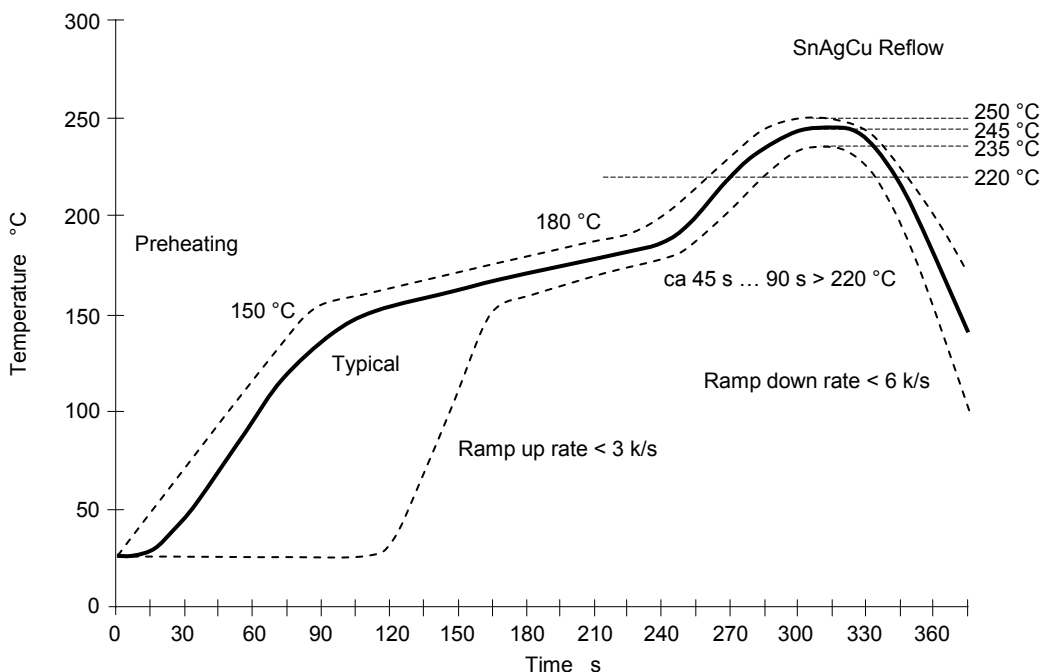
Unless otherwise prescribed by the relevant product specifications, the surface mount component shall have the structure that enables the measurement of electrical resistance (for example, daisy chain).

NOTE In connecting a daisy chain, care should be given to prevent breaking the wiring pattern, such as by drawing the wiring pattern forth from a shorter rather than a longer direction of the board.

## 5 Mounting method

Unless otherwise prescribed by the relevant product specifications, the surface mount component shall be mounted on the substrate in the following sequence:

- a) Apply the solder paste specified in 4.4 to the lands of a test substrate as specified in 4.2, using a stainless steel mask that has openings of the same size, shape and configuration as the lands as specified in 4.2 c) with a thickness of  $100 \text{ }\mu\text{m}$  to  $150 \text{ }\mu\text{m}$ .
- b) Mount the test specimen on the test substrate with the printed solder paste.
- c) Perform soldering using the reflow soldering equipment specified in 4.5 and the solder paste specified in 4.4 under the following conditions: typical temperature profile of reflow soldering is given in Figure 2 and as proposed in IEC 61760-1; the temperature shall be measured at the land.



Continuous line: typical process (terminal temperature)

Dotted line: process limits. Bottom process limit (terminal temperature). Upper process limit (top surface temperature)

IEC 1176/07

**Figure 2 – Typical reflow soldering profile**

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## 6 Test conditions

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### 6.1 Pre-treatment

Unless otherwise stated in the relevant product specifications, the specimen shall be left under standard atmospheric conditions, as specified in IEC 60068-1, for 4 h or more.

### 6.2 Test procedures

Unless otherwise stated in the relevant product specifications, the following procedures should be followed:

- a) Fix the test substrate to the substrate bending jig in the following order:
  - 1) First, solder the lead-wires to the terminals (daisy chain) used for monitoring electrical resistance on the substrate, and then connect the wires to a momentary interruption detector.
  - 2) Make sure that the centre of the support jigs is evenly spaced ( $45\text{ mm} \pm 0,5\text{ mm}$ ) apart from the centre of the indenter.
  - 3) Mount the substrate on the support jigs with the face down of the surface mount component side. Adjust the position to allow the indenter to push into the central part of the substrate.
  - 4) Install anti-displacement jigs at both sides of the substrate, leaving no space between in order to prevent the indenter from pushing down off the centre of the substrate.
  - 5) Make sure that the indenter is at the centre position by having it in contact with the substrate.

NOTE To ensure that the indenter is going down to the centre position of the substrate and that the indenter is in contact with the substrate, keep pushing the substrate until a force of  $1\text{ N} \pm 0,1\text{ N}$  is applied.

- b) Displacement rate and allowable displacement range shall be set as follows:

- 1) The displacement rate shall be 0,5 mm/s (30 mm/min) which is the moving rate of the indenter to push the central part of the substrate.
- 2) Allowable displacement range (maximum bending depth) shall be determined by conducting preliminary tests for each type of surface mount component and thereby selecting the conditions in which joint fracture can be initiated with the cyclic number of several thousands. However, the selection should be limited within 1 mm to 4 mm.
- c) Continue cyclic bending strength tests at each level mainly in the selected range until the electrical resistance-measuring instrument can detect occurrence of electric continuity interruption in the specimen. Make a record of the number of cycles when fracture occurs.
- d) Make analytical observations of the fractured part as needed, verify the fracture mode and record it.

### 6.3 Judging criteria

When a momentary interruption detector can detect that electrical continuity interruption has occurred in the specimen, this is judged as a failure.

## 7 Items to be included in the test report

When a test report is required, agreement shall be made between the reporting party and the recipient on the selection of reporting items from the following:

- a) Test date
- b) Location of the test organization
- c) Name of the electronic component, type, size, body dimensions and lead pitch
- d) Base materials of lead on electronic components; with or without plating, and materials of plating
- e) Materials of the test substrate dimensions and layer structure
- f) Measurements of the land on the substrate and materials for the surface treatment
- g) Type of solder and type of solder paste
- h) Temperature profile of reflow soldering and soldering ambience (for the case of a nitrogen ambient atmosphere, oxygen concentration should apply)
- i) Model of the tensile and compression machine
- j) Details of the substrate bending jig (drawing is preferable.)
- k) Specifications of the electrical resistance-measuring instrument
- l) Specifications of the recorder
- m) Displacement rate
- n) Displacement range and the number of cycles to fracture initiation
- o) Fracture mode (photos, etc.)

NOTE Solder joint geometry may affect the performance in this test.

## 8 Items to be given in the product specifications

The following items shall be included:

- a) Test substrate (4.2)
- b) Solder alloy (4.3)
- c) Solder paste (4.4)
- d) Reflow soldering equipment (4.5)
- e) Specimens (4.6)

- f) Mounting method (5.1)
- g) Pre-treatment (6.1)
- h) Test procedures (6.2)

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