BS EN 62137-1-4:2009

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Surface mounting technology — Environmental and endurance test methods for surface mount solder joint —

Part 1-4: Cyclic bending test

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National foreword

This British Standard is the UK implementation of EN 62137-1-4:2009. It is identical to IEC 62137-1-4:2009.

The UK participation in its preparation was entrusted to Technical Committee EPL/501, Electronic assembly technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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(IEC 62137-1-4:2009)

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 (CEI 62137-1-4:2009)

Oberflächenmontage-Technik - Verfahren zur Prüfung auf Umgebungseinflüsse und zur Prüfung der Haltbarkeit von Oberflächen-Lötverbindungen - Teil 1-4: Zyklische Biegeprüfung (IEC 62137-1-4:2009)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 91/815/FDIS, future edition 1 of IEC 62137-1-4, prepared by IEC TC 91, Electronics assembly technology, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62137-1-4 on 2009-02-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-02-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62137-1-4:2009 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	-[1)]	Environmental testing - Part 1: General and guidance	EN 60068-1	1994[2)]
IEC 60194	-[1)]	Printed board design, manufacture and assembly - Terms and definitions	EN 60194	2006[2)]
IEC 61188-5	Series	Printed boards and printed board assemblies - Design and use - Part 5: Attachment (land/joint) considerations	EN 61188-5	Series
IEC 61190-1-2	-[1)]	Attachment materials for electronic assembly - Part 1-2: Requirements for soldering paste for high-quality interconnects in electronics assembly	EN 61190-1-2	2007[2)]
IEC 61190-1-3	-[1)]	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	EN 61190-1-3	2007[2)]
IEC 61249-2-7	-[1)]	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	EN 61249-2-7 + corr. September	2002[2)] 2005
IEC 61760-1	-[1)]	Surface mounting technology - Part 1: Standard method for the specification of surface mounting components (SMDs)	EN 61760-1	2006[2)]

[1)] Undated reference.

[2)] Valid edition at date of issue.

CONTENTS

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.

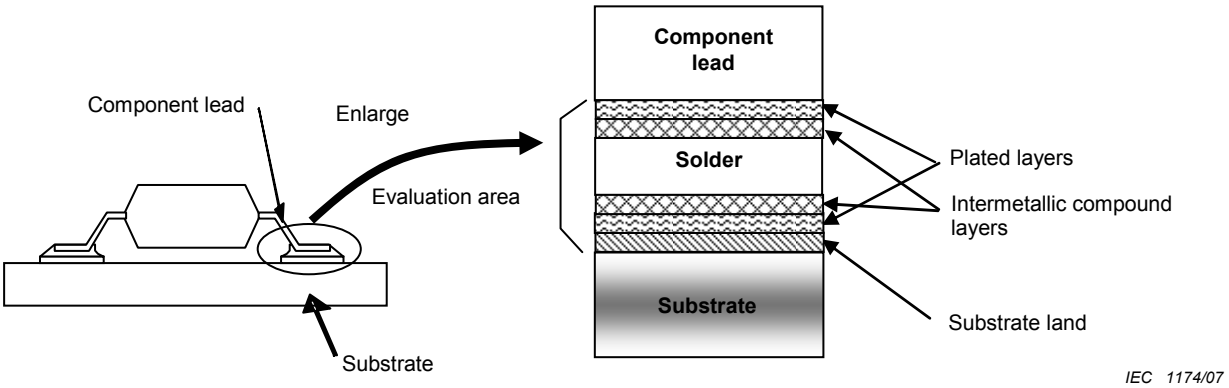


Figure 1 – Image drawing on evaluation area of joint strength

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)*

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 ±0,20 mm. The copper foil should have a thickness of 0,035 mm ± 0,010 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.

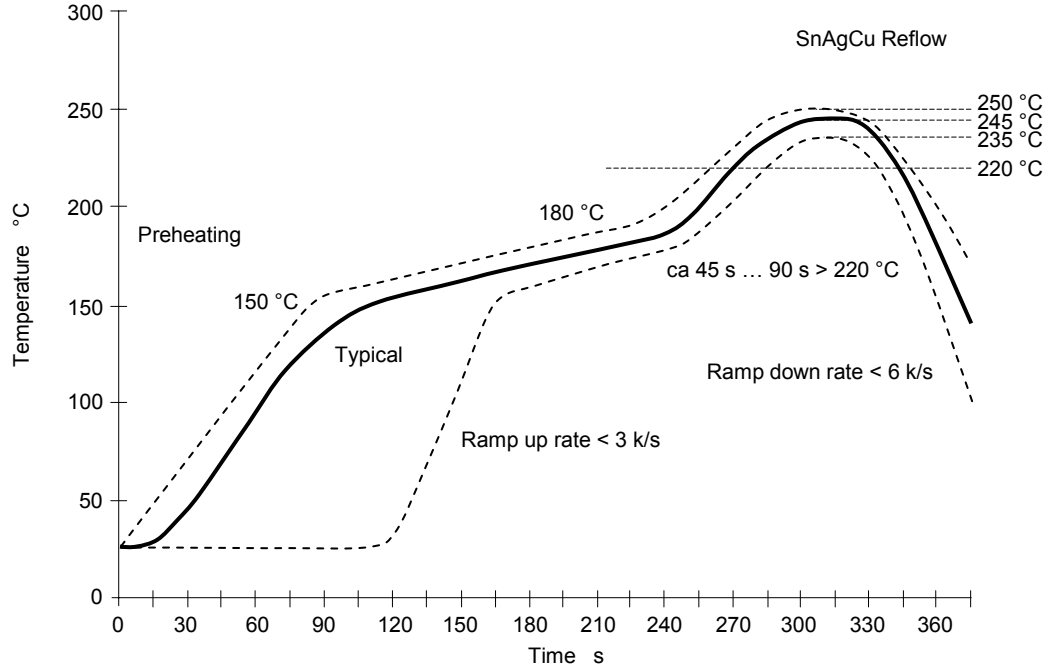
5 Mounting method

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 µm to 150 µm.

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.



Continous line: typical process (terminal temperaure)

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

IEC 1176/07

Figure 2 – Typical reflow soldering profile

6 Test conditions

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 mm ± 0,5 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 N ± 0,1 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)

Annex A
(normative)

Cyclic bending test equipment

A.1 Application

Annex A applies to the test equipment for substrate bending strength specified in 4.1 and specifies the requirements.

A.2 Cyclic bending test equipment

Unless otherwise specified by the relevant product specifications, the cyclic bending test machine should be able to meet the following requirements.

A.2.1 Tension compression testing machine

The machine shall have the following characteristics:

a) It shall be capable of pushing the indenter to the prescribed displacement (0,5 mm to 5 mm) with the use of triangular waves at the prescribed speed (0,5 mm/s) and after this, pulling the indenter back to the initial position at the same speed. This test machine also needs the capability of repeating this activity. Precision of displacement measurement should be ±1 % of the indication on the test machine (set values) and cyclic precision should be ±2 %.

   NOTE As the test is effective with sine waves in place of triangular waves, the test machine should also be able to function with sine waves.

b) The test machine should be able to measure elapsed time and the forces applied to the test substrate in the course of testing.

c) The test machine should be able to shut down when receiving signals from the electrical resistance-measuring instrument.

A.2.2 Substrate bending jig

The substrate bending jigs should be able to support the substrate with the face down of the component side of the printed circuit board, push the centre of the substrate down with the indenter, and then pull the indenter back. Unless otherwise specified by the relevant product specifications, these jigs shall meet the following conditions:

The structure shall be as indicated in Figure A.1.

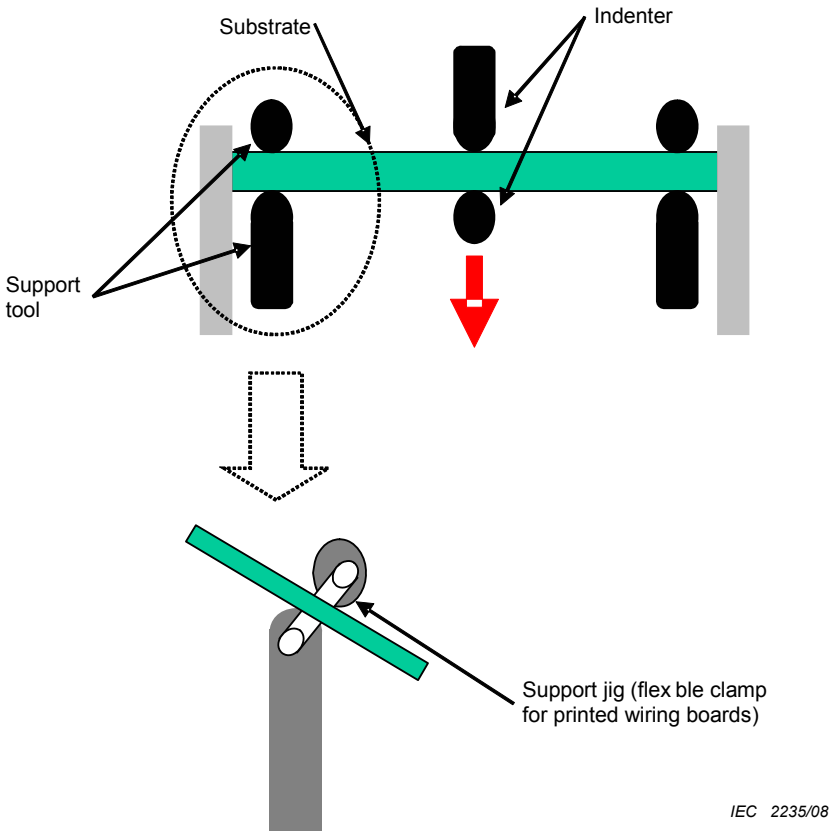


Figure A.1 – Sample structure of substrate bending jig

a) Material: Steel

NOTE Steel of high strength is recommended to prevent deformation due to application of cyclic bending.

b) Indenter

The indenter has a radius of 3 mm ± 0,2 mm with the structure that can clip the central part of the substrate from front to back on both sides. This structure shall prevent the substrate from distorting after a certain time in the direction that the indenter pushes during the cyclic bending test; it shall also be able to pull the substrate back to the initial test position.

c) Support jig

The support jig has a radius of 3 mm ± 0,2 mm. Its structure shall be such that both ends of the substrate can be clipped from front to back on both sides to pull the substrate back to the initial test position. However, it should not be too tightly constrained, in that it uses head knocking type rollers on the upper side (see Figure A.1).

d) The distance between the support jigs is 90 mm ± 1 mm.

e) The displacement range (distance between the initial position of the substrate and the lowest position of the substrate).

Displacement range is 0,5 mm to 5 mm and the test machine needs to have the structure to function under this condition.

A.2.3 Electrical resistance measuring instrument

The electrical resistance measuring instrument should have the mechanism to verify electrical continuity and discontinuity on the test substrate and to be able to judge an interruption when the resistance value exceeds 1×10^3 Ω. In order to detect even the minutest electrical discontinuity, a desirable instrument is the one that can detect momentary continuity interruption of 10 µs to 100 µs. This instrument should have the ability to output signals so as to shut down the tension-compression testing machine when electrical interruption is detected.

A.2.4 Recorder

The recorder is the piece of equipment that records the number of cycles that causes electrical continuity interruption on the substrate. It is desirable that the equipment records the displacement and the force of the test machine while the test lasts.

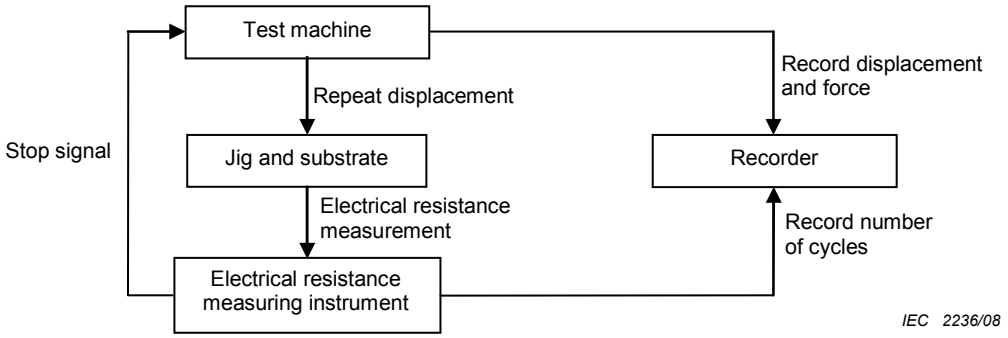


Figure A.2 – Sample structure of cyclic bending strength test

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