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# मुद्रित परिपथ बोर्ड ऐसेम्बली

भाग 1 -सुरक्षा आवश्यकताएँ

***Indian Standard***

# Printed Circuit Board Assembly

Part 1 –Safety Requirements

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**BUREAU OF INDIAN STANDARDS**

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2021 **Price Group**

Semiconductor Devices Components and Electronic Assembly Technology
Sectional Committee, LITD 05

NATIONAL FOREWORD

This draft Indian Standard (Part 1) may be adopted by the Bureau of Indian Standards, after the draft finalized on the recommendation of the Semiconductor Devices Components and Electronic Assembly Technology Sectional Committee and approval of the Electronics and Information Technology Division Council.

The object of this standard is to lay down the specific safety requirements for Printed Circuit Board Assemblies (PCBA).

The Printed Circuit Board Assemblies (PCBA) play a very vital role in electronic gadgets. The need and importance of a standard prescribing the specific safety requirements for PCBA with a view to ensure safe and reliable operation need not be over emphasized. A standard of this kind, without reference to any particular gadget, may not cover in detail all the requirements with which an individual PCBA comply. Consequently, compliance with this standard is not in itself a complete guarantee of safe performance of a gadget.

Other parts in this series are:
Part 2 Generic Requirements (to be taken up in future)
The generic and other function requirements would be covered in Part 2 of the Series

The composition of the Committee and Working Group 1, responsible for the formulation of this standard is given in Annex C and C1

*Indian Standard*

# Printed Circuit Board Assembly

# Part 1 –Safety Requirements

## 1 SCOPE

This standard (Part 1) provides specific safety requirements for Printed Circuits Board Assemblies (PCBA).

## 2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A. Annex B refers IEC Standards

## 3 TERMINOLOGY

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

**corrosion**
<chemical/electrolytic corrosion> attack of chemicals, flux, and flux residues on base metals

**corrosive flux**
flux that contains levels of halides, amines, or organic acids that cause corrosion of copper

**dendritic growth**
metallic filaments that grow between conductors in the presence of condensed moisture and an electric bias

**flux**
soldering flux
chemically and physically active compound that, when heated, promotes the wetting of a base metal surface by molten solder by removing minor surface oxidation and other surface films and that protects the surfaces from re-oxidation during a soldering operation

**metal migration**
electrolytic transfer of metal ions along an electrically conductive path from one metal surface to another when an electrical potential is applied to the two metal surfaces

**pinhole**
small hole that penetrates from the surface of a solder to base material

**surface insulation resistance (**SIR)
electrical resistance of an insulating material between a pair of contacts, conductors or grounding devices in various combinations, determined under specified environmental and electrical conditions

**soldering**
joining of metallic surfaces with solder and without melting of the base material

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

**soldering time**
time required for a defined surface area to be wetted under specific conditions

**lead-free solder**
alloy that does not contain more than 0,1 % lead (Pb) by weight as its constituent and is used for joining components to substrates or for coating surfaces

**solderability**
ability of the termination or electrode of the 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 the applicable temperature range of the solder alloy

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

**reflow**
technique for connection of components to a substrate by reheating and melting solder

**reflow soldering (**solder reflow)
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

**reflow soldering**
<nitrogen process> reflow soldering process, carried out in a nitrogen atmosphere, intended to retard oxidation of solder and board conductive surfaces and improve solder wetting

**reflow spike**
portion of the reflow soldering process during which the temperature of the solder is raised to a value that is sufficient to cause the solder to melt

**reflow temperature**
temperature range of a reflow soldering process during which the solder is in its liquidus phase

**resistance soldering**
soldering by a combination of pressure and heat generated by passing a high current through two mechanically-joined conductors

**resistance to solvents**
ability of the base laminate and other materials to resist damage to the material when exposed to solvents

**resistance welding**
welding in which heat is produced by an electric current through the resistance formed by the surfaces to be welded together, and in which the surfaces are simultaneously subjected to pressure

**wetting**
formation of an adherent coating of solder on a surface. A small contact angle is indicative of wetting

**non-wetting**
inability to form an adherent coating of solder on a surface. In this case the contact angle is greater than 90°

**de-wetting**
retraction of molten solder on a solid area that it has initially wetted NOTE In some cases an extremely thin film of solder may remain. As the solder retracts the contact angle increases.

**whisker**
single crystal growing in a filamentary form usually on a metal surface by diffusion of metal atoms

## 4 GENERAL REQUIREMENTS

4.1 The manufacturer/seller shall declare the type of PCBA laminate, type grade, flammability class, solderability requirement and resistance to soldering heat specifications and the alloy used for soldering along with any other information required by Laboroatory.

4.2 Accuracy, Precision, Resolution shall be as per Clause 3 of IS/IEC 61189-5: 2006.

## 5 SAFETY REQUIREMENTS

The requirements for safety parameters for Printed Circuit Boards Assemblies are given in Table 1.

**Table 1**

| 1 | 2 | 3 |
|---|---|---|
| Sr. No. | Parameters | Method of Test and Requirement/evaluation |
| 1 | **Corrosion, flux** | Test and evaluation as per Clause 8.1 of IS/IEC 61189-5: 2006;<br>(It shall be corrosion free) |
| **Visual Evaluation: Clause 8.1.4.6 of IS/IEC 61189-5: 2006** *(NOTE: For information only, May not be part of this Indian Standard)*<br><br>Carefully examine test panels prior to placing them in the environmental chamber. Note any discoloration.<br><br>After the appropriate exposure period, remove test panels from the humidity chamber, examine at 20X magnification and compare with observations noted prior to exposure.<br><br>Corrosion is described as follows.<br>– Excrescences at the interfaces of the flux residue and copper boundary or the residues or discontinuities in the residues.<br>– Discrete white or coloured spots in the flux residues. | | |

| |
|---|
| An initial change of colour which may develop when the test panel is heated during soldering is disregarded, but subsequent development of green-blue discoloration with observation of pitting of the copper panel is regarded as corrosion. |

| | | |
|---|---|---|
| **2** | Changes of the surface insulation resistance (SIR) caused by fluxes | Test and evaluation as per Clause 10.1 of IS/IEC 61189-5: 2006 |
| **Evaluation: Clause 10.1.2.10 of IS/IEC 61189-5: 2006** *(NOTE: For information only, May not be part of this Indian Standard)*<br><br>a) The insulation resistance values of each comb pattern shall be $>1 \times 10^8$ Ω. If the control coupon readings are less than $1 \times 10^9$ Ω, a new set of test specimens shall be obtained and the entire test repeated. Any reason for deleting values (scratches, condensation, bridged conductors, outlying points, etc.) shall be noted.<br>b) All specimens shall also be examined under a 10× to 30× microscope using backlighting within 24 h of completing the testing. If the specimens are to be held longer, they shall be placed in a non-contaminating container and stored in a desiccator. All specimens shall be evaluated within 7 days. It should be determined whether dendritic growth has occurred due to condensation within the chamber (see 10.1.4).<br>c) Rejection of results for more than 2 combs for a given condition shall require the test to be repeated.<br>d) Flux qualification shall be recorded in Table 3. | | |
| 3 | Surface insulation resistance(SIR), assemblies | Test and evaluation as per Clause 10.2 of IS/IEC 61189-5: 2006 |
| **Evaluation: Clause 10.2.4.8 of** IS/IEC 61189-5: 2006 *(NOTE: For information only, May not be part of this Indian Standard)*<br><br>All specimens will be visually inspected at 10×-30× within 24 h of test completion and the following conditions recorded.<br><br>a) Presence of dendrites. If present, record per cent of spacing between conductors bridged by the worst-case dendrite.<br>b) Presence of discoloration between conductors (discoloration on conductors only is acceptable). If present, discoloration shall be recorded as a colour image and included in the test report.<br>c) Presence of water spots. If present, these conditions should be recorded as a colour image and included in the test report.<br>d) Presence of subsurface metal migration. When examined with back-lighting, the presence of subsurface metal migration is evidenced by a dark subsurface “shadow” growing from the anode. If present, these conditions should be recorded as a colour image and included in the test report.<br>Any reason for deleting values (scratches, condensation, solder-bridged conductors, outlying points, etc.) shall be noted. Rejection of results for more than two test patterns for a given condition shall require the test to be repeated. | | |
| **4** | Reflow solderability test for soldering joint and Resistance to reflow solderability of test board | Test as per Clause 11 of IS/IEC 61189-5: 2006 (or) as per Clause 6 of IS/IEC 60068-2-58: 2015.<br>Requirement given in Annex E.3.8 of<br>IS/IEC 62137-4: 2014 |
| **Table 4 and 5 of IS/IEC 60068-2-58: 2015** *(NOTE: For information only, May not be part of this Indian Standard)* | | |

**Table 4 – Solder paste specification**

| Group | Alloy name [a] | Flux classification [b] | | Powder size type [c] | Nominal metal content, mass fraction % |
|---|---|---|---|---|---|
| | | IEC | ISO | | |
| 1 | Sn42Bi58 | ROL0 | 1.1.1 | 3 | 90 |
| 2 | Sn60Pb40A or Sn63Pb37A | ROL0 | 1.1.1 | 3 | 90 |
| 3 | Sn96,5Ag3Cu,5 | ROL0 | 1.1.1 | 3 | 88 |
| 4 | – | – | | – | – |

[a] Solder alloy designations and tolerance of composition according to IEC 61190-1-3:2007 and Amendment 1:2010, Annex B.

[b] Refer to IEC 61190-1-1 or ISO 9454-2 for details.

[c] Refer to IEC 61190-1-2:2014, Table 2. Any other powder size should be prescribed in the relevant specification.

**Table 5 – Solderability – Test conditions – Method 2: Reflow**

| Group | Solder alloy | $T_1$ °C | $T_2$ °C | $t_1$ s | $T_3$ °C | $t_2$ s | $T_4$ [a] °C | $t_3$ [b] s |
|---|---|---|---|---|---|---|---|---|
| 1 | Sn42Bi58 | 100 ± 5 | 130 ± 5 | 60 to 120 | 138 | 40 ± 5 | 170 | 10 |
| 2 | Sn63Pb37A Sn60Pb40A | 100 | 150 | 60 to 120 | 183 | 40 ± 5 | 215 | 10 |
| 3 | Sn96,5Ag3Cu,5 | 150 | 180 | 60 to 120 | 217 | 40 ± 5 | 235 | 10 |
| 4 | Not applicable | | | | | | | |

[a] Peak temperature ($T_4$) is defined as minimum for acceptance testing and maximum for qualification testing.

[b] Time above ($T_4$ – 5 °C) is defined as minimum for acceptance testing and maximum for qualification testing.

## Annex E (informative) of IS/IEC 62137-4: 2014 *((NOTE: For information only, May not be part of this Indian Standard)*

## Heat resistance to reflow soldering for test substrate

### E.1 General

This annex gives an explanation concerning the heat resistance with respect to reflow soldering of the test substrate.

When the test substrate has not sufficient thermal stability, the test substrate may get warpage during the reflow heating process, so that the temperature cycling test cannot sufficiently evaluate the durability of the solder joints.

### E.3.8 Final measurement

The final measurement should be carried out by visual inspection of the test substrate, magnifying 10×.

The following items should be checked.

- Substrate curving or warping/bending.
- Substrate or solder resist stripping.
- Substrate cracking.
- Substrate swelling.

| | | |
|---|---|---|
| **5** | Solderability testing | Solderability of parts shall be the responsibility of the supplier and shall meet the requirements specified and agreed to by the manufacturer.<br><br>Electronic/mechanical components and wires shall meet solderability requirements when tested in accordance with<br>The test method used shall be selected as per the relevant scope of the standards given as follows:.<br>Test as per Clause 4 of IS/IEC 60068-2-20: 2008 (For lead) (or)<br>Test as per Clause 8 to10 of IS/IEC 60068-2-69 : 2017 (or)<br>Test as per Clause 7/ 8/ 9 of IS/IEC 60068-2-83:2011 (or)<br>Test as per Clause 6 of IS/IEC 60068-2-58: 2015 |

**Clause 4 and Table 1 of IEC 60068-2-20** *(NOTE: For information only, May not be part of this Indian Standard)*

**Table 1 – Solderability, solder bath method: Test severities (duration and temperature)**

| Alloy composition | Severity | | | | | |
|---|---|---|---|---|---|---|
| | (215 ± 3) °C (3 ± 0,3) s | (10 ± 1) s | (235 ± 3) °C (2 ± 0,2) s | (5 ± 0,5) s | (245 ± 3) °C (3 ± 0,3) s | (250± 3) °C (3 ± 0,3) s |
| SnPb | X | X | X | X | | |
| Sn96,5Ag3Cu,5 | | | | | X | |
| Sn99,3Cu,7 | | | | | | 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 Sn96,5Ag3Cu,5. The solder alloys consist of 0,45 wt % to 0,9 wt % Cu and the remainder of Sn may be used instead of Sn99,3Cu,7.

NOTE 1 "X" denotes 'applicable'.

NOTE 2 Refer to 4.1 of IEC 61190-1-3 to identify alloy composition.

NOTE 3 The basic lead-free solder alloys listed in this table represent compositions that are currently preferred for lead-free soldering processes. If solder alloys other than those listed here are used, it has to be verified that the given severities are applicable.

**4.2.5 Final measurements and requirements**

Inspection shall be carried out under adequate light with normal eyesight or with the assistance of a magnifier capable of giving a magnification of 4 x to 25 x, depending on the size of objects.

The specimens shall be visually examined and, if required by the relevant specification, electrically and mechanically checked. The dipped surface relevant for soldering shall be covered with solder coating with no more than small amounts of scattered imperfections such as pin-holes or un-wetted or de-wetted areas. All leads shall exhibit a continuous solder coating free from defects for a minimum of 95% of the critical area of any individual lead. For solder alloys containing lead, **solder shall be smooth and bright.**

| | | |
|---|---|---|
| **6** | Resistance to soldering heat | Test as per Clause 5 of IS/IEC 60068-2-20: 2008 (or)<br>Test as per Clause 7 of IEC 60068-2-58 : 2014<br>Requirements As agreed between Manufacturer and supplier |

**Table 6 of IS/IEC 60068-2-58: 2014** *(NOTE: For information only, May not be part of this Indian Standard)*

**Table 6 – Resistance to soldering heat – Test conditions and severity, solder bath method**

| Group | Alloy composition [a] | Test conditions and severity | |
|---|---|---|---|
| 1 | Sn42Bi58 | (230 ± 3) °C | (10 ± 1) s |
| 2 | Sn60Pb40A or Sn63Pb37A | (260 ± 5) °C | (5 ± 1) s |
| | | | (10 ± 1) s |
| 3 | Sn96,5Ag3Cu,5 | (260 ± 5) °C [b] | (5 ± 1) s |
| | | | (10 ± 1) s |
| 4 | Sn99,3Cu,7 | (260 ± 5) °C [b] | (10 ± 1) s |

[a] Alloy compositions given here are for information only and do not state any prescription for specific alloys to be used in this test, see 7.5.2.

[b] Certain soldering methods may require the higher severity of (270 ± 3) °C for (5 ± 0,5) s or the more severe condition of (10 ± 1) s. Such conditions should be provided by the detail specification or agreed between the trading partners.

| | | |
|---|---|---|
| **7** | Whisker Investigation | Test as per Clause 8 of IS/IEC 60068-2-82: 2011<br>Requirements as per Annex C of IS/IEC 60068-2-82: 2011. (As agreed between the Manufacturer and the supplier) |

**Table 7 and Clause C.2 of IEC 60068-2-82** *(NOTE: May not be part of Indian Standard)*

**C.2 Acceptance criteria for whisker length**

Unless otherwise specified by the relevant specification, any whiskers in a class greater than class 4 is recommended to be considered as a fail for press-fit applications; for all other applications, any whiskers in a class greater than class 1 is recommended to be considered as a fail (for the definition of the different classes, see Table 7). There are, however, applications with different packing densities that may permit different acceptance criteria that shall be specified at the requirement specification. With optimized processes and electrolytes, class 0 can be fulfilled for electronic/electro-mechanic components.

**Table 7 – Classification for measured whisker length**

| | Length of individual whiskers | Number of observed whiskers |
|---|---|---|
| Class 0 | < 25 µm | |
| Class 1 | ≥ 25 µm < 50 µm | |
| Class 2 | ≥ 50 µm < 100 µm | |
| Class 3 | ≥ 100 µm < 200 µm | |
| Class 4 | ≥ 200 µm < 400 µm | |
| Class 5 | ≥ 400 µm < 600 µm | |
| Class 6 | ≥ 600 µm < 1 000 µm | |
| Class 7 | ≥ 1 000 µm | |

## ANNEX A

( *Clause 2* )

**LIST OF REFERRED INDIAN STANDARDS**

| *IS No* | *Title* |
|---|---|
| IS/ IEC 60068-2-20 : 2021 (Under Wide Circulation) | Environmental testing - Part 2 Tests Section 20 Test T: Test methods for solderability and resistance to soldering heat of devices with leads |
| IS/IEC 60068-2-58 : 2015 +Amd 1: 2017 | Environmental testing - Part 2 Tests Section 58 Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD) |
| IS/IEC 60068-2-69 : 2017 + AMD1:2019 | Environmental testing - Part 2 Tests Section 69 Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method |
| IS/IEC 60068-2-82 : 2019 | Environmental testing - Part 2 Tests Section 82 Test Xw1: Whisker test methods for components and parts used in electronic assemblies |
| IS/IEC 60068-2-83 : 2011 | Environmental testing - Part 2 Tests Section 83 Test Tf: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method using solder paste |
| IS/IEC 60194 : 2015 | Printed Board Design, Manufacture and Assembly —Terms and Definitions |
| IS/IEC 61189-5 : 2006 | Test methods for electrical materials + interconnection structures and assemblies - Part 5: Test methods for printed board assemblies |
| IS/IEC 62137-4 : 2014 | Electronics assembly technology – Part 4 Endurance test methods for solder joint of area array type package surface mount devices |

## ANNEX B

**IEC Referred Standard**

| | |
|---|---|
| IEC 61191-1: 2018 | Printed board assemblies – Part 1: Generic specification – Requirements for soldered electrical and electronic assemblies using surface mount and related assembly technologies |