

IPC-1602A

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Standard for Printed Board Handling and Storage

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IPC-1602A

Standard for Printed Board Handling and Storage

Developed by the Printed Board Storage and Handling Subcommittee (D-35) of the Rigid Printed Board Committee (D-30) of IPC

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IPC-1602A Standard for Printed Board Handling and Storage

1 SCOPE

Historically, the printed board industry has relied on military specifications and guidelines to define packaging methods to preserve the quality and reliability of printed boards during shipment and storage. However, many of these documents are obsolete, incomplete, do not address Pb-free assembly processes or do not cover newer laminates or final finishes.

1.1 Purpose This standard provides requirements and recommendations for proper handling, packaging materials and methods, environmental conditions and storage for printed boards. The requirements and recommendations are intended to protect printed boards from contamination, physical damage, solderability degradation, electrostatic discharge (ESD) (when necessary) and moisture uptake. Moisture absorbed in printed board laminates expands at soldering temperatures, and in some cases, the resulting vapor pressure can cause internal delamination or excessive strain on plated-hole walls and other structures. This is especially challenging with the higher temperatures used for Pb-free soldering.

This standard provides control measures to prevent uptake of excess moisture prior to soldering, including:

- Process controls during printed board fabrication.
- Dry packaging of finished printed boards for shipment and storage.
- Process controls whenever printed boards are removed from dry packaging, for example before assembly and soldering.

These measures are intended to prevent the need to remove moisture by baking. Along with increasing cost and cycle time, baking increases risks for solderability degradation and handling damage.

Unlike standards that apply to moisture-sensitive microcircuits and other electronic components (e.g., IPC-J-STD-020, IPC-J-STD-033, IPC-J-STD-075), this standard does not include requirements for Moisture Sensitivity Level testing or characterization, floor life or moisture removal by baking. Characterizing or testing moisture sensitivity for a particular printed board design is often impractical because boards differ in many important respects from moisture-sensitive components. A printed board's rate of moisture uptake and sensitivity to moisture damage varies with the board thickness, distribution of copper features, the materials of construction and other features particular to the board design. In addition, printed board designs are usually unique to a particular user and used in much lower quantities than the components that are assembled to them.

Note: This document covers all phases from the manufacture of the bare printed board, through delivery, receiving, stocking, assembly and soldering.

1.2 Application The target audience includes those involved in all phases of printed board design, manufacture, assembly, shipping, storage and possible warranty activities. Information herein has been supplied for all of these functions.

1.3 Measurement Units All dimensions and tolerances in this specification are expressed in hard SI (metric) units and bracketed soft imperial [inch] units. Users of this specification are expected to use metric dimensions. All dimensions ≥ 1 mm [0.0394 in] will be expressed in millimeters and inches. All dimensions < 1 mm [0.0394 in] will be expressed in micrometers and microinches.

1.4 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word "should" reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this standard. The text takes precedence over the figures.

1.5 Process Control Requirements The primary goal of process control is to continually reduce variation in the processes, products, or services to provide products or processes meeting or exceeding user requirements. Process control tools such as IPC-9191 or other user-approved system may be used as guidelines for implementing process control.

A documented process control system, if established, **shall** define process control and corrective action limits.

This may or may not be a statistical process control system. The use of "statistical process control" (SPC) is optional and should be based on factors such as design stability, lot size, production quantities and the needs of the Manufacturer.

1.6 Order of Precedence The order of precedence of reference documents shall be defined in the procurement document. In the event of conflict, the following order of precedence applies:

- 1) Procurement as agreed and documented between customer and supplier.
- 2) Master drawing reflecting the customer's detailed requirements.
- 3) When invoked by the customer or per contractual agreement, this standard.

When documents other than this standard are cited, the order of precedence shall be defined in the procurement documents. The user has the opportunity to specify alternate acceptance criteria.

1.6.1 Conflict In the event of conflict between the requirements of this standard and the applicable drawings) and documentation, the applicable user-approved drawing(s) and documentation govern.

Some examples of documentation include the contract, purchase order, technical data package, engineering specification or performance specification.

In the event of a conflict between the text of this standard and the applicable documents cited in Section 2, the text of this standard takes precedence. In the event of conflict between the requirements of this standard and drawing(s) and documentation that has not been user approved, this standard governs.

1.6.2 Clause References When a clause in this document is referenced its subordinate clauses apply, unless the requirement references specific subordinate clauses.

1.6.3 Appendices Appendices to this standard are not binding requirements unless separately and specifically required by this standard, the applicable contracts, assembly drawing(s), documentation or purchase orders.

1.7 Use of "Lead" For readability and translation, this document uses the noun "lead" only to describe leads of a component. The metallic element "lead" is always written as Pb.

1.8 Terms and Definitions Other than those terms listed below, the definitions of terms used in this standard are in accordance with IPC-T-50.

1.8.1 Assembler The entity that receives a completed printed board and performs subsequent assembly, wiring, or soldering operations.

1.8.2 Dry Packaging Packaging that consists of desiccant material and a Humidity Indicator Card (HIC) sealed with the printed boards inside a Moisture Barrier Bag (MBB) (See 4.2).

1.8.3 Floor Life The maximum cumulative time allowed for a printed board design to be exposed to ambient conditions (< 30 °C/60% RH) before mass soldering, after being removed from dry packaging (moisture barrier bag (MBB) with desiccant and Humidity Indicator Card (HIC)), dry storage (dry nitrogen or desiccator cabinet), lamination stack, or dry bake. If the floor life is exceeded, the Maximum Acceptable Moisture Content (MANIC, see 3.3.6) may be exceeded.

1.8.4 Humidity Indicator Card (HIC) An indicator of relative humidity in the form of a card with printed deposits of moisture-sensitive chemicals, usually as round dots arranged in sequence, each changing color at a higher relative humidity. Color will change (depending on the chemicals, either from blue to pink or from brown to azure) when humidity exceeds the value printed on the dot. When humidity decreases, color will change back (to blue or brown).

1.8.5 Manufacturer (Printed Board Fabricator or Assembler) The individual, organization, or company responsible for the applicable printed board fabrication or assembly process, and verification operations necessary to ensure full compliance of printed boards or assemblies to this standard.

1.8.6 Moisture Barrier Bag (MBB) A bag designed to restrict the transmission of water vapor and used to pack moisture sensitive devices. An MBB is made of material with a low Water Vapor Transmission Rate (WVTR) (see 4.2.1). An MBB includes a metallized layer (aluminum), making the bag appear shiny and opaque.

1.8.7 Sulfur Free Materials that are unlikely to express corrosive sulfur compounds like H₂S or SO₂.

1.8.8 Supplier The individual, organization or company that provides the Manufacturer (printed board fabricator) with components and or materials (printed board materials of construction, inks, plating chemistry, cleaning agents, etc.).

1.8.9 User The individual, organization, company, contractually designated authority, or agency responsible for the procurement or design of electrical/electronic hardware and having the authority to define any variation or restrictions to the requirements of this standard, i.e., the originator, custodian of the contract detailing these requirements. The user is not always the design authority, the customer placing the purchase order, or the assembler.

1.8.10 Water Vapor Transmission Rate (WVTR) A measure of the permeability of plastic film or metallized plastic film material to moisture, an important rating for moisture barrier bags (MBBs).

1.9 Superseded Documents This document supersedes and replaces IPC-1602.

1.10 Requirements Flowdown When this standard is contractually required, the applicable requirements of this standard shall be imposed on all applicable subcontracts, assembly drawing(s), documentation, and purchase orders. Unless otherwise specified, the requirements of this standard are not imposed on the procurement of commercial-off-the-shelf (COTS or catalog) materials or components.

2 APPLICABLE DOCUMENTS

2.1 IPC¹

IPC-HDBK-001 Handbook and Guide to Supplement J-STD-001

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-A-311 Process Controls for Phototool Generation and Use

IPC-TR-585 Time, Temperature and Humidity Stress of Final Board Finish Solderability

IPC-TM-650 Test Methods Manual

2.6.27 Thermal Stress, Convection Reflow Assembly Simulation

2.6.28 Moisture Content and or Moisture Absorption Rate, (Bulk) Printed Board

IPC-2221 Generic Standard on Printed Board Design

IPC-4552 Specification for Electroless Nickel/Immersion Gold (ENIG) Plating for Printed Circuit Boards

IPC-4553 Specification for Immersion Silver Plating for Printed Boards

IPC-4554 Specification for Immersion Tin Plating for Printed Circuit Boards

IPC-4555 Performance Specification for High Temperature Organic Solderability Preservatives (OSP) for Printed Boards

IPC-4556 Specification for Electroless Nickel/Electroless Palladium Immersion Gold Plating for Printed Circuit Boards

IPC-6012 Qualification and Performance Specification for Rigid Printed Boards

IPC-6013 Qualification and Performance Specification for Flexible/Rigid-Flexible Printed Boards

IPC-6017 Qualification and Performance Specification for Printed Boards Containing Embedded Passive Devices

IPC-6018 Qualification and Performance Specification for High Frequency (Microwave) Printed Boards

IPC-7092 Design and Assembly Process Implementation for Embedded Components

IPC-9191 General Guidelines for Implementation of Statistical Process Control (SPC)

NCMS Solderability Component Long Term Storage Report - "Moisture Measurement in PCB's and Impact of Design on Desorption Behaviour"

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¹ www.ipc.org

² IPC Test Methods are available on the IPC website (www.ipc.org/test-methods)

2.2 Joint Industry Standards¹

IPC J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies

IPC J-STD-003 Solderability Tests for Printed Boards

IPC/JEDEC J-STD-020 Moisture, Reflow Sensitivity Classification for Non-hermetic Surface Mount Devices (SMDs)

IPC/JEDEC J-STD-033 Handling, Packing, Shipping and Use of Moisture Reflow Sensitive Surface Mount Devices

EIA/IPC/JEDEC J-STD-075 Classification of Passive and Solid State Devices for Assembly Processes

IPC/JEDEC J-STD-609 Marking and Labeling of Components, PCBs and PCBA's to Identify Lead (Pb), Lead-Free (Pb-Free) and Other Attributes

2.3 ASTM

ASTM E1131 Standard Test Method for Compositional Analysis by Thermogravimetry

ASTM F1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a **Modulated** Infrared Sensor

2.4 Electrostatic Discharge Association (ESD)⁴

ANSI/ESD S8.1 Protection of Electrostatic Discharge Susceptible Items - Symbols - ESD Awareness

ANSI/ESD S20.20 Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

ANSI/ESD S541 Packaging Materials for the Protection of Electrostatic Discharge Susceptible Items

2.5 Europa⁵

DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)

2.6 International Electrotechnical Commission⁶

IEC 61340-5-1 Electrostatics - Part 5-1: Protection of Electronic Devices from Electrostatic Phenomena — General Requirements

2.7 International Organization for Standardization⁷

ISO 9001 Quality Management Systems — Requirements

ISO 11358 Plastics - Thermogravimetry (TG) of Polymers - General principles

2.8 Military Specifications⁸

MIL-PRF-81705 Performance Specification: Barrier Materials, Flexible, Electrostatic Protective, Heat-Sealable

MIL-STD-3010 Test Method 20155 Puncture Resistance Test of Packaging

2.9 SAE International⁹

SAE AS9100 Quality Management Systems - Requirements for Aviation, Space and Defense Organizations

SAE AS9102 Aerospace First Article Inspection Requirement

³ www.astm.org

⁴ www.esda.org

⁵ www.ec.europa.eu

⁶ www.iec.ch

⁷ www.iso.org

⁸ www.dla.mil

⁹ www.sae.org