IPC-A-600H-2010

Acceptability of Printed Boards

April 2010
Supersedes IPC-A-600G
July 2004

A standard developed by IPC

Association Connecting Electronics Industries

IPC®

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Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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Developed by the IPC-A-600 Task Group (7-31a) of the Product Assurance Committee (7-30) of IPC

Supersedes:
IPC-A-600G - July 2004
IPC-A-600F - November 1999

Users of this publication are encouraged to participate in the development of future revisions.

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Acknowledgment

Any standard involving a complex technology draws material from a vast number of sources. While the principal members of the A-600 Task Group (7-31a) of the Product Assurance Committee (7-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of IPC extend their gratitude. Special thanks goes to the members of the Rigid Printed Board Committee (D-30) for their efforts in establishing acceptance criteria for printed boards.

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Introduction

1.1 SCOPE

This document describes the preferred, acceptable, and nonconforming conditions that are either externally or internally observable on printed boards. It represents the visual interpretation of minimum requirements set forth in various printed board specifications, e.g.; IPC-6010 series, J-STD-003, etc.

1.2 PURPOSE

The visual illustrations in this document portray specific criteria of the requirements of current IPC specifications. In order to properly apply and use the content of this document, the printed board should comply with the design requirements of the applicable IPC-2220 series document and the performance requirements of the applicable IPC-6010 series document. In the event the printed board does not comply with these or equivalent requirements, then the acceptance criteria should be as agreed between user and supplier (AABUS).

1.3 APPROACH TO THIS DOCUMENT

Characteristics are divided into two general groups:

- Externally Observable (section 2)
- Internally Observable (section 3)

"Externally observable" conditions are those features or imperfections which can be seen and evaluated on or from the exterior surface of the board. In some cases, such as voids or blisters, the actual condition is an internal phenomenon and is detectable from the exterior.

"Internally observable" conditions are those features or imperfections that require microsectioning of the specimen or other forms of conditioning for detection and evaluation. In some cases, these features may be visible from the exterior and require microsectioning in order to assess acceptability requirements.

Specimens should be illuminated during evaluation to the extent needed for effective examination. The illumination should be such that no shadow falls on the area of interest except those shadows caused by the specimen itself. It is recommended that polarization and/or dark field illumination be employed to prevent glare during the examination of highly reflective materials.

The illustrations in this document portray specific criteria relating to the heading and subheading of each page, with brief descriptions of the acceptable and nonconforming conditions for each product class. (See 1.4.) The visual quality acceptance criteria are intended to provide proper tools for the evaluation of visual anomalies. The illustrations and photographs in each situation are related to specific requirements.

The characteristics addressed are those that can be evaluated by visual observation and/or measurement of visually observable features.

Supported by appropriate user requirements, this document should provide effective visual criteria to quality assurance and manufacturing personnel.

This document cannot cover all of the reliability concerns encountered in the printed board industry; therefore, attributes not addressed in this issue **shall** be AABUS. The value of this document lies in its use as a baseline document that may be modified by expansions, exceptions and variations which may be appropriate for specific applications.

When making accept and/or reject decisions, the awareness of documentation precedence must be maintained.

This document is a tool for observing how a product may deviate due to variation in processes. Refer to IPC-9191.

IPC-A-600 provides a useful tool for understanding and interpreting Automated Inspection Technology (AIT) results. AIT may be applicable to the evaluation of many of the dimensional characteristics illustrated in this document.

1.4 CLASSIFICATION

This standard recognizes that electrical and electronic products are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in producibility, complexity, functional performance requirements, and verification (inspection/test) frequency. It should be recognized that there may be overlaps of product between classes.

Process Indicator imperfections are permitted and are deliverable.

The user is responsible for defining the product class. The procurement documentation package **shall** state the product class and any exceptions to specific parameters, where appropriate.

Criteria defined in this document reflect three classes, which are as follows:

Class 1 — Includes limited life products suitable for applications where the requirement is function of the completed product.

Class 2 — Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical.

Class 3 — Includes products where continued high performance or performance-on-demand is critical, product downtime cannot be tolerated, and the product must function when required.

Introduction (cont.)

Acceptability criteria in this document have been separated so that printed board product may be evaluated to any one of the three classes. The use of one class for a specific characteristic does not mean that all other characteristics must meet the same class. Selection should be based on minimum need. The customer has the ultimate responsibility for identifying the class to which the product is evaluated. Thus, accept and/or reject decisions must be based on applicable documentation such as contracts, procurement documentation, specifications, standards and reference documents.

1.5 ACCEPTANCE CRITERIA

Most of the illustrations and photographs included in this document represent three levels of quality for each specific characteristic; i.e., Target Condition, Acceptable and Nonconforming. The text included with each level establishes the ''Acceptance Criteria'' for each class of product.

Target Condition in many cases is close to perfect. While this is the desired condition it is not always achievable and may not be necessary to ensure the reliability of the printed board in its service environment.

Acceptable indicates that the condition depicted, while not necessarily perfect, will maintain the integrity and reliability of the printed board in its service environment. The acceptable condition is considered acceptable for at least one or more classes but may not be acceptable for all classes, as specified by the associated acceptance criteria.

Nonconforming indicates that the condition depicted may be insufficient to ensure the reliability of the printed board in its service environment. The nonconforming condition is considered unacceptable for at least one or more classes of product but may be acceptable for other classes as specified by the associated acceptance criteria.

The target, acceptable and nonconforming conditions depicted herein and the associated acceptance criteria are intended to represent typical industry practices. Requirements of individual product designs may deviate from these criteria.

The examples shown in the photographs and/or illustrations are sometimes exaggerated to make the referenced imperfection more apparent. The relationship between the text and the examples is not always parallel; it would be difficult to find many cases so specific that they would always match the acceptance criteria. When photographs or illustrations contained in this standard are not consistent with discussion in the written text, the written text takes precedence and should be followed.

It should also be noted that some of the photographs used may have more than one type of condition on the same example. It is necessary that the users of this document pay particular attention to the subject of each section to avoid misinterpretation.

It should be understood that the first inference to nonconformance given implies that all other conditions of lesser magnitude are acceptable. Thus, a criteria which states a nonconformance condition as 50% of the surface is pitted, for example, implies that anything less than 50% of the surface being pitted is acceptable for that characteristic in that class. Obviously, nonconformance in Class 1 implies nonconformance in Class 2 and Class 3; and likewise, nonconformance for Class 2 implies nonconformance in Class 3.

An inspector **shall not** make the selection as to which class the part under inspection belongs. When making accept and/or nonconformance decisions, the awareness of precedence of documentation must be maintained.

In all cases, documentation should be available to the inspector defining to which class the part submitted for inspection belongs.

Procedures and requirements for conducting visual inspections related to this document **shall** be in accordance with the requirements of the applicable performance specification.

In the event of conflict, the following order of precedence **shall** apply:

1. Purchase Order (including exceptions to the master drawing, if any)
2. Procurement documentation reflecting the customers detailed requirements (such as master drawing)
3. Other documents to the extent specified by the customer
4. The end item performance specification such as the IPC-6010 series when invoked by the customer
5. This acceptability document. Printed boards should be of uniform quality and **shall** conform to the IPC-6010 series.

IPC-6010 series establishes the minimum acceptability requirements for printed boards. This document, IPC-A-600, is a companion and complementary document, providing pictorial interpretation of these requirements. It is not intended to be used as a performance specification for printed board manufacture or procurement.

IPC-A-600 can be used as a support document for inspection. It does not specify frequency of in-process inspection or frequency of end product inspection. Nor is the allowable number of nonconforming process indicators or the number of allowable repair/rework of defects specified.

Visual examination for applicable attributes **shall** be conducted at 3 diopters (approx.1.75X). If the acceptable condition of a suspected defect is not apparent, it should be verified at progressively higher magnifications (up to 40X) to confirm that it is a defect. Dimensional requirements such asspacing or conductor width measurements may require other

Introduction (cont.)

magnifications and devices with reticles or scales in the instrument, which allow accurate measurements of the specified dimensions. Contract or specification may require other magnifications.

Plated-through holes (PTHs) **shall** be internally examined for foil and plating integrity at a magnification of 100X. Referee examinations **shall** be accomplished at a magnification of 200X.

Automated Inspection Technology (AIT) results may be applicable to the evaluation of many of the dimensional characteristics illustrated in this document.

1.6 Applicable Documents The following specifications of the revision in effect at the time of order form a part of this document to the extent specified herein. If a conflict of requirements exists between this specification and the listed applicable documents, this specification **shall** take precedence.

1.6.1 IPC[1]

J-STD-003 Solderability Tests for Printed Boards

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

IPC-TM-650 Test Methods Manual[2]

2.1.1 Microsectioning

2.1.1.2 Microsectioning, Semi or Automatic Technique Microsection Equipment (Alternate)

2.2.2 Optical Dimensional Verification

2.3.25 Detection and Measurement of Ionizable Surface Contaminants

2.4.1 Adhesion, Tape Testing

2.4.22 Bow and Twist

2.4.28.1 Adhesion, Solder Resist (Mask), Tape Test Method

2.6.25 Conductive Anodic Filament (CAF) Resistance Test (Electrochemical Migration Testing)

IPC-SM-840 Qualification and Performance of Permanent Solder Mask

IPC-2220 Family of Design Documents

IPC-4562 Metal Foil for Printed Wiring Applications

IPC-4781 Qualification and Performance Specification of Permanent, Semi-Permanent and Temporary Legend and/or Marking Inks

IPC-6010 Family of Board Performance Documents

IPC-9191 General Requirements for Implementation of Statistical Process Control

IPC-9691 User Guide for the IPC-TM-650, Method 2.6.25, Conductive Anodic Filament (CAF) Resistance Test (Electrochemical Migration Testing)

1.6.2 American Society of Mechanical Engineers[3]

ASME B46.1 Surface Texture (Surface Roughness, Waviness and Lay)

1.7 DIMENSIONS AND TOLERANCES

All dimensions and tolerances specified herein are applicable only to the end product. Dimensions are expressed in hard SI (metric) units and parenthetical soft imperial [inch] units.

Reference information is shown in parentheses ( ).

1.8 TERMS AND DEFINITIONS

Terms and definitions **shall** be in accordance with IPC-T-50 and as defined in 1.8.1.

1.8.1 Process Indicator A detectable anomaly, other than a defect, that is reflective of material, equipment, personnel, process and/or workmanship variation.

1.9 Revision Level Changes Changes made to this revision of the IPC-A-600 are indicated throughout by gray-shading of the relevant subsection(s). Changes to a figure or table are indicated by gray-shading of the figure or table header.

1.10 WORKMANSHIP

Printed boards fabricated to the requirements of this document **shall** be processed in such a manner as to be uniform in quality and to preclude the introduction of dirt, foreign matter, oil, fingerprints, flux residues, or other contaminants that may affect the life or serviceability of the product. Printed boards **shall** be free of defects in excess of those allowed by this document. Acceptance of imperfections not specifically covered by this document *shall* be AABUS.

1. www.ipc.org
2. Current and revised IPC Test Methods are available on the IPC Web Site (www.ipc.org/html/testmethods.htm)
3. www.asme.org