



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-A-600F

Acceptability of Printed Boards

ANSI/IPC-A-600F

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A standard developed by IPC

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1.0 INTRODUCTION

Introduction

1.1 SCOPE

This document describes the preferred, acceptable, and non-conforming 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, i.e.; IPC-6010 series, ANSI/J-STD-003, etc.

1.2 PURPOSE

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 Classification). 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 agreed upon between user and supplier. 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.

This is a document for minimum acceptability requirements and is not intended to be used as a performance specification for printed board manufacture or procurement.

In the event of a conflict between the requirements of this document and the applicable product performance specification, the following precedence shall be used:

- a) Approved Printed Board Procurement Document
- b) Applicable Performance Specification
- c) Generic Specifications
- d) Acceptability of Printed Boards (IPC-A-600)

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-PC-90, "General Requirements for Implementation of Statistical Process Control."

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 dimen-

sional characteristics illustrated in this document. Refer to IPC-AI-642, "User's Guidelines for Automated Inspection of Artwork, Innerlayers, and Unpopulated PWBs."

1.3 APPROACH TO THIS DOCUMENT

Characteristics are divided into two general groups:

- Externally Observable (section 2.0)
- Internally Observable (section 3.0)

"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.

1.4 CLASSIFICATION

This document recognizes that the acceptable extent of imperfection for specific characteristics of printed boards may be determined by the intended end use. For this reason, three general classes have been established based on functional reliability and performance requirements.

Class 1 — General Electronic products: Includes consumer products, some computer and computer peripherals suitable for applications where cosmetic imperfections are not important, and the major requirement is function of the completed printed board.

Class 2 — Dedicated Service Electronic Products: Includes communications equipment, sophisticated business machines, and instruments where high performance and extended life is required, and for which uninterrupted service is desired, but is not critical. Certain cosmetic imperfections are allowed.

Class 3 — High Reliability Electronics Products: Includes equipment and products where continued performance or performance on demand is critical. Equipment downtime cannot be tolerated, and the equipment must function when required, such as life support systems or flight control sys-

1.0 INTRODUCTION

Introduction (cont.)

tems. Printed boards in this class are suitable for applications where high levels of assurance are required and service is essential.

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 board in its service environment.

Acceptable indicates that the condition depicted, while not necessarily perfect, will maintain the integrity and reliability of the 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 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 industrial 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 a photograph or procurement documentation seems incongruous with the criteria in the text, follow the text.

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 Classes 2 and 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, i.e., typically contract, procurement documentation, specifications and referenced documents.

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. Procurement documentation
2. Procurement documentation reflecting the customers detailed requirements
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.

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.

1.0 INTRODUCTION

Introduction (cont.)

Visual examination for external attributes **shall** be conducted at 1.75X (3 diopters); defects, if not readily apparent should be verified by magnifications up to 40X. Dimensional requirements such as spacing or conductor width measurements may require other magnifications and devices including reticles or scales in the instrument that allow an accurate measurement of the specified dimension. Contract or specification may also require other magnifications. The visual inspection/referee should be 1.75X minimum and 10X maximum.

Plated-through holes **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. AIT may be applicable to the evaluation of many of the dimensional characteristics illustrated in this document. Refer to IPC-AI-642, "User's Guidelines for Automated Inspection of Artwork, Innerlayers and Unpopulated PWBs."

1.6 REFERENCE

The following documents form a part of this document to the extent specified herein. The revision of the document in effect at the time of solicitation shall take precedence.

J-STD-003 Solderability Tests for Printed Boards

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

IPC-9191 General Requirements for Implementation of Statistical Process Control.

IPC-D-325 Documentation Requirements for Printed Boards.

IPC-QE/CD-605 Printed Board Quality Evaluation Handbook

IPC-AI-642 User's Guidelines for Automated Inspection of Artwork, Innerlayers, and Unpopulated PWBs

IPC-SM-782 Surface Mount Design and Land Pattern Standard

IPC-TM-650 Test Methods Manual

2.1.1 Microsectioning, Manual Method

2.2.2 Optical Dimensional Verification

2.2.7 Hole Size Measurement, Plated

2.2.11 Registration, Terminal Pads (Layer to Layer)

2.2.13.1 Thickness, Plating in Holes Microhm Method

2.3.25 Detection and Measurement of Ionizable Surface Contaminants

2.3.26 Ionizable Detection of Surface Contaminants (Dynamic Method)

2.3.38 Surface Organic Contaminant Detection Test

2.3.39 Surface Organic Contaminant Identification Test (Infrared Analytical Method)

2.4.1 Adhesion, Tape Testing

2.4.22 Bow and Twist (Percentage)

2.4.28 Adhesion, Solder Mask (Non-Melting Metals)

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

2.5.4 Current Carrying Capacity, Multilayer Printed Wiring

2.5.7 Dielectric Withstanding Voltage, PWB

2.5.16 Shorts, Internal on Multilayer Printed Wiring

2.6.10 X-Ray (Radiography), Multilayer Printed Wiring

DOCUMENT RELATIONSHIP – IPC-6010 series/IPC-A-600/IPC-SM-782

Document Purpose	Spec. #	Definition
Design Standard	IPC-2221 IPC-SM-782	Design requirements reflecting three levels of complexity (Levels A, B, and C) indicating finer geometries, greater densities, more process steps to produce the product. Component and assembly process guidelines to assist in the design of the bare board and the assembly where the bare board processes concentrate on land patterns for surface mount and the assembly concentrates on surface mount and through-hole principles which are usually incorporated into the design process and the documentation.
End Item Documentation	IPC-D-325	Documentation depicting bare board specific end product requirements designed by the customer or end item assembly requirements. Details may or may not reference industry specifications or workmanship standards as well as customers own preferences or internal requirements.
End Item Document	IPC-6010 series	Final product requirements for printed boards or final requirements for printed board assemblies depicting minimum end product acceptable characteristics as well as methods for evaluation (test methods), frequency of testing and process control requirements, if applicable.
Acceptability Document	IPC-A-600	Pictorial interpretative document indicating various characteristics of the board relating to undesirable conditions that exceed the minimum acceptable characteristics indicated by the IPC-6010 series and reflect various out-of-control (nonconforming) conditions.

1.0 INTRODUCTION

Introduction (cont.)

IPC-SM-840 Qualification and Performance of Permanent Polymer Coating (Solder Mask) for Printed Boards

IPC-2220 Series of Design Standards for Printed Boards

IPC-6010 Series of Performance Specifications for Printed Boards

1.7 DIMENSIONS AND TOLERANCES

All dimensions and tolerances specified herein are applicable only to the end product. Dimensions are expressed in millimeters.

Reference information is shown in parentheses ().

1.8 TERMS AND DEFINITIONS

Terms and definitions shall be in accordance with IPC-T-50.

1.9 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 agreed upon by the user and supplier of the product.