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Foreword

If a conflict occurs between the English and translated versions of this document, the English version will take precedence.

1.1 Scope

This standard is a collection of visual quality acceptability requirements for electronic assemblies.

This document presents acceptance requirements for the manufacture of electrical and electronic assemblies. Historically, electronic assembly standards contained a more comprehensive tutorial addressing principles and techniques. For a more complete understanding of this document's recommendations and requirements, one may use this document in conjunction with IPC-HDBK-001, IPC-AJ-820, and IPC J-STD-001.

The criteria in this standard are not intended to define processes to accomplish assembly operations nor is it intended to authorize repair/modification or change of the customer's product. For instance, the presence of criteria for adhesive bonding of components does not imply/authorize/require the use of adhesive bonding, and the depiction of a lead wrapped clockwise around a terminal does not imply/authorize/require that all leads/wires be wrapped in the clockwise direction.

Users of this standard should be knowledgeable of the applicable requirements of the document and how to apply them.

Objective evidence of the demonstration of this knowledge should be maintained. Where objective evidence is unavailable, the organization should consider periodic review of personnel skills to determine visual acceptance criteria appropriately.

IPC-A-610 has criteria outside the scope of IPC J-STD-001 defining handling, mechanical and other workmanship requirements. Table 1-1 is a summary of related documents.

IPC-AJ-820 is a supporting document that provides information regarding the intent of this specification content and explains or amplifies the technical rationale for transition of limits through Target to Defect condition criteria. In addition, supporting information is provided to give a broader understanding of the process considerations that are related to performance but not commonly distinguishable through visual assessment methods.

Table 1-1 Summary of Related Documents

Document Purpose	Spec.#	Definition
Design Standard	IPC-2220 (Series) IPC-7351 IPC-CM-770	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 customer's own preferences or internal standard requirements.
End Item Standards	IPC J-STD-001	Requirements for soldered electrical and electronic assemblies depicting minimum end product acceptable characteristics as well as methods for evaluation (test methods), frequency of testing and applicable ability of process control requirements.
Acceptability Standard	IPC-A-610	Pictorial interpretive document indicating various characteristics of the board and/or assembly as appropriate relating to desirable conditions that exceed the minimum acceptable characteristics indicated by the end item performance standard and reflect various out-of-control (process indicator or defect) conditions to assist the shop process evaluators in judging need for corrective action.
Training Programs (Optional)		Documented training requirements for teaching and learning process procedures and techniques for implementing acceptance requirements of either end item standards, acceptability standards, or requirements detailed on the customer documentation.
Rework and Repair	IPC-7711/7721	Documentation providing the procedures to accomplish conformal coating and component removal and replacement, solder resist repair, and modification/repair of laminate material, conductors, and plated-through holes.

Foreword (cont.)

The explanations provided in IPC-AJ-820 should be useful in determining disposition of conditions identified as Defect, processes associated with Process Indicators, as well as answering questions regarding clarification in use and application for defined content of this specification. Contractual reference to IPC-A-610 does not additionally impose the content of IPC-AJ-820 unless specifically referenced in contractual documentation.

1.2 Purpose

The visual standards in this document reflect the requirements of existing IPC and other applicable specifications. In order for the user to apply and use the content of this document, the assembly/product should comply with other existing IPC requirements, such as IPC-7351, IPC-2220 (Series), IPC-6010 (Series) and IPC-A-600. If the assembly does not comply with these or with equivalent requirements, the acceptance criteria **shall** be defined between the customer and supplier.

The illustrations in this document portray specific points noted in the title of each page. A brief description follows each illustration. It is not the intent of this document to exclude any acceptable procedure for component placement or for applying flux and solder used to make the electrical connection; however, the methods used **shall** produce completed solder connections conforming to the acceptability requirements described in this document.

In the case of a discrepancy, the description or written criteria always takes precedence over the illustrations.

1.3 Classification

Accept and/or reject decisions **shall** be based on applicable documentation such as contracts, drawings, specifications, standards and reference documents. Criteria defined in this document reflect three classes, which are as follows:

Class 1 — General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly.

Class 2 — Dedicated Service Electronic Products

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically the end-use environment would not cause failures.

Class 3 — High Performance Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

The customer (user) has the ultimate responsibility for identifying the class to which the assembly is evaluated. If the user and manufacturer do not establish and document the acceptance class, the manufacturer may do so.

1.4 Definition of Requirements

This document provides acceptance criteria for completed electronic assemblies. Where a requirement is presented that cannot be defined by the acceptable, process indicator, and defect conditions, the word "**shall**" is used to identify the requirement. The word "**shall**" in this document invokes a requirement for manufacturers of all classes or product, and failure to comply with the requirement is a noncompliance to this standard.

All products **shall** meet the requirements of the assembly drawing(s)/ documentation and the requirements for the applicable product class specified herein. Missing hardware or components are a Defect for all classes.

1.4.1 Acceptance Criteria

When IPC-A-610 is cited or required by contract as a stand-alone document for inspection and/or acceptance, the requirements of IPC J-STD-001 "Requirements for Soldered Electrical and Electronic Assemblies" do not apply unless separately and specifically required.

In the event of conflict, the following order of precedence applies:

1. Procurement as agreed and documented between customer and supplier.
2. Master drawing or master assembly drawing reflecting the customer's detailed requirements.
3. When invoked by the customer or per contractual agreement, IPC-A-610.

When documents other than IPC-A-610 are cited, the order of precedence **shall** be defined in the procurement documents.

Criteria are given for each class in four levels of acceptance: Target Condition, Acceptable Condition, and either Defect Condition or Process Indicator Condition.

1.4.1.1 Target Condition

A condition that is close to perfect/preferred, however, it is a desirable condition and not always achievable and may not be necessary to ensure reliability of the assembly in its service environment.

Foreword (cont.)

1.4.1.2 Acceptable Condition

This characteristic indicates a condition that, while not necessarily perfect, will maintain the integrity and reliability of the assembly in its service environment.

1.4.1.3 Defect Condition

A defect is a condition that may be insufficient to ensure the form, fit or function of the assembly in its end use environment. Defect conditions **shall** be dispositioned by the manufacturer based on design, service, and customer requirements. Disposition may be to rework, repair, scrap, or use as is. Repair or "use as is" may require customer concurrence.

A defect for Class 1 automatically implies a defect for Class 2 and 3. A defect for Class 2 implies a defect for Class 3.

1.4.1.3.1 Disposition

The determination of how defects should be treated. Dispositions include, but are not limited to, rework, use as is, scrap or repair.

1.4.1.4 Process Indicator Condition

A process indicator is a condition (not a defect) that identifies a characteristic that does not affect the form, fit or function of a product.

- Such condition is a result of material, design and/or operator/machine related causes that create a condition that neither fully meets the acceptance criteria nor is a defect.
- Process indicators should be monitored as part of the process control system. When the number of process indicators indicate abnormal variation in the process or identify an undersirable trend, then the process should be analyzed. This may result in action to reduce the variation and improve yields.
- Disposition of individual process indicators is not required and affected product should be used as is.

1.4.1.4.1 Process Indicator Methodologies

Process control methodologies are to be used in the planning, implementation and evaluation of the manufacturing processes used to produce soldered electrical and electronic assemblies. The philosophy, implementation strategies, tools and techniques may be applied in different sequences depending on the specific company, operation, or variable under consideration to relate process control and capability to end product requirements. The manufacturer needs to maintain objective evidence of a current process control/ continuous improvement plan that is available for review.

1.4.1.5 Combined Conditions

Cumulative conditions **shall** be considered in addition to the individual characteristics for product acceptability even though they are not individually considered defective. The significant number of combinations that could occur does not allow full definition in the content and scope of this specification but manufacturers should be vigilant for the possibility of combined and cumulative conditions and their impact upon product performance.

Conditions of acceptability provided in this specification are individually defined and created with separate consideration for their impact upon reliable operation for the defined production classification. Where related conditions can be combined, the cumulative performance impact for the product may be significant; e.g., minimum solder fillet quantity when combined with maximum side overhang and minimum end overlap may cause a significant degradation of the mechanical attachment integrity. The manufacturer is responsible for identification of such conditions.

1.4.1.6 Conditions Not Specified

Conditions that are not specified as defective or as a process indicator may be considered acceptable unless it can be established that the condition affects user defined form, fit or function.

1.4.1.7 Specialized Designs

IPC-A-610, as an industry consensus document, cannot address all of the possible components and product design combinations. Where uncommon or specialized technologies are used, it may be necessary to develop unique acceptance criteria. However, where similar characteristics exist, this document may provide guidance for product acceptance criteria. Often, unique definition is necessary to consider the specialized characteristics while considering product performance criteria. The development should include customer involvement or consent. For Class 3 the criteria **shall** include agreed definition of product acceptance.

Whenever possible these criteria should be submitted to the IPC Technical Committee to be considered for inclusion in upcoming revisions of this standard.

1.5 Terms & Definitions

Items noted with an * are quoted from IPC-T-50.

1.5.1 Board Orientation

The following terms are used throughout this document to determine the board side. The source/destination side **shall** be considered when applying some criteria, such as that in Tables 7-4, 7-5 and 7-7.

Foreword (cont.)

1.5.1.1 *Primary Side

That side of a packaging and interconnecting structure (PCB) that is so defined on the master drawing. (It is usually the side that contains the most complex or the most number of components. This side is sometimes referred to as the component side or solder destination side in through-hole mounting technology.)

1.5.1.2 *Secondary Side

That side of a packaging and interconnecting structure (PCB) that is opposite the primary side. (This side is sometimes referred to as the solder side or solder source side in through-hole mounting technology.)

1.5.1.3 Solder Source Side

The solder source side is that side of the PCB to which solder is applied. The solder source side is normally the secondary side of the PCB when wave, dip, or drag soldering are used. The solder source side may be the primary side of the PCB when hand soldering operations are conducted.

1.5.1.4 Solder Destination Side

The solder destination side is that side of the PCB that the solder flows toward in a through-hole application. The destination is normally the primary side of the PCB when wave, dip or drag soldering is used. The destination side may be the secondary side of the PCB when hand-soldering operations are conducted.

1.5.2 *Cold Solder Connection

A solder connection that exhibits poor wetting and that is characterized by a grayish porous appearance. (This is due to excessive impurities in the solder, inadequate cleaning prior to soldering, and/or the insufficient application of heat during the soldering process.)

1.5.3 Electrical Clearance

Throughout this document the minimum spacing between noncommon uninsulated conductors (e.g., patterns, materials, hardware, or residue) is referred to as "minimum electrical clearance." It is defined in the applicable design standard or on the approved or controlled documentation. Insulating material needs to provide sufficient electrical isolation. In the absence of a known design standard use Appendix A (derived from IPC-2221). Any violation of minimum electrical clearance is a defect condition for all classes.

1.5.4 High Voltage

The term "high voltage" will vary by design and application. The high voltage criteria in this document are only applicable when specifically required in the drawings/procurement documentation.

1.5.5 Intrusive Solder

A process in which the solder paste for the through-hole components is applied using a stencil or syringe to accommodate through-hole components that are inserted and reflow-soldered together with the surface-mount components.

1.5.6 *Leaching

The loss or removal of a basis metal or coating during a soldering operation.

1.5.7 Meniscus (Component)

Sealant or encapsulant on a lead, protruding from the seating plane of the component. This includes materials such as ceramic, epoxy or other composites, and flash from molded components.

1.5.8 *Nonfunctional Land

A land that is not connected electrically to the conductive pattern on its layer.

1.5.9 Pin-in-Paste

See Intrusive Solder.

1.5.10 Wire Diameter

In this document, wire diameter (D) is the overall diameter of conductor including insulation. Unless otherwise specified, criteria in this standard are applicable for solid wire/component leads or stranded wire.

1.5.11 Wire Overwrap

A wire/lead that is wrapped more than 360° and remains in contact with the terminal post, Figure 6-64 (A).

1.5.12 Wire Overlap

A wire/lead is wrapped more than 360° and crosses over itself, i.e., does not remain in contact with the terminal post, Figure 6-64 (B).

1.6 Examples and Illustrations

Many of the examples (illustrations) shown are grossly exaggerated in order to depict the reasons for this classification.

It is necessary that users of this standard pay particular attention to the subject of each section to avoid misinterpretation.

1.7 Inspection Methodology

Accept and/or reject decisions **shall** be based on applicable documentation such as contract, drawings, specifications and referenced documents.

Foreword (cont.)

The inspector does not select the class for the assembly under inspection, see 1.3. Documentation that specifies the applicable class for the assembly under inspection **shall** be provided to the inspector.

Automated Inspection Technology (AIT) is a viable alternative to visual inspection and complements automated test equipment. Many of the characteristics in this document can be inspected with an AIT system. IPC-AI-641 "User's Guidelines for Automated Solder Joint Inspection Systems" and IPC-AI-642 "User's Guidelines for Automated Inspection of Artwork, Inner-layers, and Unpopulated PCBs" provide more information on automated inspection technologies.

If the customer desires the use of industry standard requirements for frequency of inspection and acceptance, J-STD-001 is recommended for further soldering requirement details.

1.8 Verification of Dimensions

The actual measurements provided in this document (i.e., specific part mounting and solder fillet dimensions and determination of percentages) are not required except for referee purposes. All dimensions in this standard are expressed in SI (System International) units (with Imperial English equivalent dimensions provided in brackets). All specified limits in this standard are absolute limits as defined in ASTM E29.

1.9 Magnification Aids

For visual inspection, some individual specifications may call for magnification aids for examining printed board assemblies.

The tolerance for magnification aids is ± 15% of the selected magnification power. Magnification aids, if used for inspection **shall** be appropriate with the item being inspected. Unless magnification requirements are otherwise specified by contractual documentation, the magnifications in Table 1-2 and Table 1-3 are determined by the item being inspected.

Referee conditions are used to verify product rejected at the inspection magnification power. For assemblies with mixed land widths, the greater magnification may be used for the entire assembly.

Table 1-2 Inspection Magnification (Land Width)

Land Widths or Land Diameters[1]	Magnification Power	
	Inspection Range	Maximum Referee
>1.0 mm [0.0394 in]	1.5X to 3X	4X
>0.5 to ≤1.0 mm [0.0197 to 0.0394 in]	3X to 7.5X	10X
≥0.25 to ≤0.5 mm [0.00984 to 0.0197 in]	7.5X to 10X	20X
<0.25 mm [0.00984 in]	20X	40X

Note 1: A portion of a conductive pattern used for the connection and/or attachment of components.

Table 1-3 Magnification Aid Applications - Other

Cleanliness (with or without cleaning processes)	Magnification not required, see Note 1
Cleanliness (no-clean processes)	Note 1
Conformal Coating/ Encapsulation	Notes 1,2
Marking	Note 2
Other (Component and wire damage, etc.)	Note 1

Note 1: Visual inspection may require the use of magnification, e.g., when fine pitch or high density assemblies are present, magnification may be needed to determine if contamination affects form, fit or function.

Note 2: If magnification is used it is limited to 4X maximum.

1.10 Lighting

Lighting **shall** be adequate for the item being inspected.

Illumination at the surface of workstations should be at least 1000 lm/m2 [approximately 93 foot candles]. Light sources should be selected to prevent shadows.

Note: In selecting a light source, the color temperature of the light is an important consideration. Light ranges from 3000-5000° K enable users to distinguish various printed circuit assembly features and contaminates with increased clarity.