

IPC Standards: Negotiating Design Trade-Offs

As is the case with all engineering, PCB design is an art and science of managing trade-offs. Sure, you could spend hundreds of design hours trying to ensure there is absolutely no side overhang on a flat gull-wing lead ... but if that is not absolutely necessary to the product's performance, the effort won't be warranted.

One of the important roles that IPC standards play in PCB design is to help designers and manufacturers negotiate the trade-offs between design effort and product performance. This paper outlines the IPC standards that OCM Manufacturing relies upon to ensure quality and manage the inherent trade-offs of PCB design.

What Are IPC Standards?

The IPC calls itself the Association Connecting Electronics Industries. Standards development and training are a key part of the IPC's work, with the goal of training and certifying manufacturing professionals to provide standardized workmanship, processes and quality in a traceable fashion. These standards are developed through the consensus of industry, including IPC members, academics, government agencies, OEMs, electronics manufacturing service providers (like OCM Manufacturing), and IMS companies. The IPC's standards are used worldwide and participation is voluntary.

From our perspective as a contract manufacturer (CM), using the IPC's standards puts us and our customers on the same page. When we pass a PCB as "acceptable", it's not a relative concept – the product meets standards that are acceptable to the industry at large.



Figure 1: Sample pages from IPC-A-610 Standard

In IPC's own language, the goals of being trained and certified to use IPC standards include:

- Provide a standardized set of industry developed, recognized, approved and traceable training programs to enhance understanding and appropriate application of criteria in the standard.
- Provide an understanding of accept/reject criteria to enhance an individual's motivation and ability to consistently and correctly apply the technical discrimination criteria.
- Teach methods and processes to improve an individual's skills and ability to achieve acceptable workmanship.
- Teach methods and techniques how to use, navigate, locate and to apply the criteria contained in a document to the appropriate class or classes of production.



Why We Use IPC Standards at OCM

We have had an IPC specialist on staff since 1997 and in 2005, we solidified our commitment to IPC standards by certifying that staff member as an IPC trainer. This enables all of our manufacturing staff to keep very current with IPC standards, including:

- Training and (re)certification every two years for all assembly staff on the IPC-A-610 standard, which governs the acceptability of an electronic assembly.
- Training and (re)certification every two years for staff working in areas that are affected by the other standards we use (rework; and, cable and wire harness assembly).

The in-house training requires four days and recertification two days. In addition, our in-house trainer is recertified every two years.

Why do we make this investment? Our goal is to be accountable and credible to our suppliers and our customers for the quality of products we manufacture. Our customers can be assured that we are building high-quality products on their behalf, and they in turn can assure their end markets and partners that the product they market and sell will perform well.

IPC Standards also give us a common language to speak with our customers and suppliers. It is a common language between designers, assemblers, and testers. When we all speak the same language, it helps to eliminate confusion, to speed verification, and can reduce costs – such as when rework on an assembly is deemed to be not required.

The IPC Standards We Use

There are many IPC standards, and some come in a variety of flavours, or classes. In our contracts with customers, the IPC standard(s) and class(es) that we will use on a particular project are specified and agreed to (or waived) by the customer.

At OCM Manufacturing, the IPC-A-610 Acceptability Standard is our primary measure for quality and all of our production is certified to this standard. A-610 provides “a collection of visual quality acceptability requirements for electronic assemblies,” and, “a pictorial interpretive document indicating various characteristics of the board and/or assembly as appropriate relating to desirable conditions that exceed the minimum acceptable characteristic indicated by the end item performance standard ...”

These are just a handful of examples of the hundreds of elements that IPC-A-610 covers:

- Heat sinks
- Solders
- Terminal connections
- Component mounting
- Chip components
- Terminations
- Arrays
- Laminate conditions

Our customers are responsible to identify which CLASS of the A-610 standard their assemblies will be evaluated against. There are three classes to choose from, based on the product's use:

- Class 1 – General Electronic Products. Includes products suitable for applications where the major requirement is ***function*** of the completed assembly. At OCM, we rarely use this class.



- Class 2 – Dedicated Service Electronic Products. Where ***continued performance and extended life*** is required, and for which uninterrupted service is desired but not critical. We commonly use this class.
- Class 3 – High Performance Electronic Products. Where ***continued high performance or performance-on-demand*** is critical, downtime cannot be tolerated, and end-use environment may be uncommonly harsh, and equipment must function when required. We use this class when manufacturing assemblies that will be used in life-support, military, other critical systems.

In addition to A-610, we also use the following standards:

- **IPC/WHMA-A-620B** – Guiding the acceptability of cable and wire harness assemblies. This standard is developed in conjunction with the Wiring Harness Manufacturer's Association (WHMA).
- **IPC 7711 & 7721** – Guiding how to achieve acceptability in rework, modification, and repair of electronic assemblies. These standards provide “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.” Rework occurs in-house at OCM if an assembly fails to meet the agreed upon A610 standard class, ensuring that customers do not receive defective product.

The nature of the rejection determines the type of corrective measure that we apply:

- Rework – used when an assembly does not comply with the standard. We Reprocess noncomplying articles through the use of original or equivalent processing.
- Modification – used when new acceptance criteria, such as design changes, are introduced. We revise the functional capability of a product to satisfy the new criteria.
- Repair – used when an assembly is functionally defective. The functional capability of the defective article must be restored in a manner that does not assure compliance with applicable drawings of specifications.

IPC-A-600 – Guiding the acceptability of PCBs and substrates. We use this standard to verify the boards we receive from board manufacturers; however, we do not have in-house trainers in this standard. The IPC describe this standard as: “The target, acceptable, and non-conforming conditions that are either externally or internally observable on PCBs.”

Managing Preferences and Conflicts

We feel strongly that OEMs can and should be able to trust IPC standards – they are worldwide standards accepted throughout the industry. They are exceptionally well documented and tested across countless industries and applications. Occasionally, an OEM may have particular preferences for standards of quality which do not align with the IPC's standards. Preferences may be based on past experiences or in-house standards. While it is possible to do our work to accommodate preferences, those preferences must be clearly defined and documented before work begins.

Documentation and drawings are a critical component of strong communication between OEM and contract manufacturer. In the event of a conflict related to product acceptance, the IPC applies the following order of precedence:

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



Continuous Improvement

IPC Standards are also an important aspect of continuous improvement at OCM Manufacturing. The ideal, of course, is to never have non-conformance or defect issues – to achieve perfection. IPC-defined conditions help us to tweak and refine our processes in that ongoing pursuit. These conditions include:

Target Condition – this “close to perfect” condition is most desirable and not always achievable. The target condition may not be necessary to ensure reliability of the assembly in its service environment, but it provides an ideal to aim for.

Acceptable Condition – the product is not necessarily “perfect” but will maintain the required integrity and reliability in its service environment. This speaks to the inherent trade-offs between design and performance.

Defect Condition – the product is rejected and must be reworked, modified, or repaired.

Process Indicator Conditions – these are conditions that do not affect the form, fit, or function of a product. They may be the result of material, design, or operator/machine-related causes. We monitor process indicators as part of our process control system, with the goal of eliminating defects and process indicators.

Maximizing the Value of Standards-Based Assembly

Electronics design, engineering, and manufacturing is a constant balancing of trade-offs to achieve an optimal cost-performance ratio while also sometimes allowing for differentiation through innovation. IPC Standards help us as a contract electronics manufacturer to clearly understand the customer’s expectations for performance and quality, and to meet those criteria with confidence.

When you work with OCM Manufacturing, you will select the IPC standard class that applies to your product, and can be assured that our trained and certified staff will effectively meet that standard in a traceable manner.

But, there’s much more to your relationship with your CM than a contract that defines the standards for manufacturing. To get the most value out of your relationship with us, and to get the maximum benefit of the standards we use, get us involved early, near the end of the first design cycle.

We will review your manufacturing documentation (Gerber files, assembly drawings, and PCB fabrication drawings) with an eye to the manufacturability of the proposed assembly. This enables us to provide high-value design-for-manufacturing (DFM) feedback before it’s too late – well before PCB fabrication and assembly begins.

If you are looking for a high-quality design and manufacturing partner for industrial control systems, please contact us at OCM Manufacturing, at 1-800-268-3961.