by Bob Neves

What's The Standard?

Why do we need standards? I ask myself that question sometimes after several days of disputing three sentences in a standard. I spend an appreciable amount of my time working in standards development. My "two cents" can be seen in military, IPC, and IEC standards. Needless to say, I am a strong believer in formalized standardization.

Let's say you want to celebrate the new millennium with a special bottle of French champagne. You get the phone number to Domaine Chandon and, attempting to sound French, pronounce "sham-p-on" to the nice Frenchman on the phone who dutifully takes your order. That fateful day, when your special box arrives from France, you open the package and, low and behold, you have a box of mushrooms. Disappointment abounds. The pronunciation "sham-p-on" in French means mushrooms—not champagne. What's the moral to this story? Never order mushrooms from a Frenchman. More generally, sometimes verbal instructions can be misunderstood. A written "contract" with a thorough description of what you want can save you considerable frustration.

Not too long ago, people would buy domestic products from a nearby store. "Imported" goods were a luxury item. You knew the farmer who raised the crops, the butcher who cut your meat, and the baker who made your bread. You knew the products had quality because the people who made them were your neighbors and friends. Today, we still go to the local store, but very little of what we buy there is "local." In fact, most everything we purchase today comes from somewhere else.

Today's marketplace is global. Although your friends may be in many parts of the country (or world), it is seldom the case where friends and neighbors are ensuring the quality of the products you buy. This global market place requires the use of standards and specifications in order to make the "purchaser" and "buyer" feel comfortable with each other. Standards help us to know the products we buy from Timbuktu (a real place in Mali, Africa) are of similar quality to the products manufactured locally, giving both the "buyer" and "seller" quality and protection.

The market for PWBs is a very global market, and the requirements that exist for PWB products are quite diverse. Below are highlights from most of the performance testing requirements that exist today. Obviously, many customers have their own specifications, or have modified and taken exceptions to one of the standards listed below. There are several organizations which provide standardization efforts for the PWB industry. I compiled a list of the most prevalent organizations and documents relating to our industry. I have never seen a compilation of these standards in one place, and I hope it will serve as a reference.

IPC—Association Connecting Electronics Industries

For over forty years, the IPC has developed standards and guidelines for our industry. The IPC is an international trade association that brings members together to develop industry consensus standards and guidelines. Below are many of the documents which directly affect the PWB industry. In an effort to better "globalize" its documents, the IPC recently published its first joint document with the JPCA, in the HDI arena. Another joint document is on the horizon.

The IPC-6010 series of documents are industry consensus "commercial" standards for printed boards. The series of documents is broken up into the following sectional standards:

- IPC-6011 - Generic Standard which includes Quality System & Sampling Plan requirements
- IPC-6012 - Performance Standard for Rigid PWBs
- IPC-6013 - Performance Standard for Rigid-Flex/Flex PWBs
- IPC-6014 - Performance Standard for PCMCIA PWBs
- IPC-6015 - Performance Standard for MCM-L PWBs
- IPC-6016 - Performance Standard for HDI PWBs
- IPC-6018 - Performance Standard for High Frequency PWBs

Some Other IPC Standouts

- J-STD-003 - Solderability Tests for Printed Boards
- IPC-T-50F - Terms and Definitions
- IPC-A-600E - Acceptability of Printed Boards
- IPC-TM-650 - Test Methods Manual
- IPC-ET-652 - Guidelines and Requirements for Electrical Testing

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- IPC-QL-653A - Qualification of Facilities that Inspect/Test Printed Boards
- IPC-MS-810 - Guidelines for High Volume Microsection
- IPC-SM-840C - Qualification and Performance of Permanent Solder Mask
- IPC/JPCA-6202 - Performance Guide Manual for Flexible PWBs
- IPC-9201 - Surface Insulation Resistance Handbook
- J-STD-001B - Requirements for Soldered Electrical and Electronic Assemblies
- IPC-A-610B - Acceptability of Electronic Assemblies
- IPC-2221 - Generic Standard on Printed Board Design
- IPC-2222 - Sectional Standard on Rigid PWB Design
- IPC-2223 - Sectional Design Standard for Flexible Printed Boards
- IPC-2224 - Sectional Standard for Design of PWBs for PC Cards
- IPC-2225 - Sectional Design Standard for Organic Multichip Modules

Defense Supply Standard Columbus (DSCC)

DSCC is the organization within the government in charge of "establishing and maintaining a known-good supplier base that have successfully demonstrated their products meet the specified performance, quality, and reliability levels via the DoD product qualification program." In other words, the DSCC acts as the government's "hall monitor." For many years its standards have dominated our industry, but with peace breaking out and the end of the Cold War, military standards have diminished influence in our industry. Unfortunately, many of the things we now use as gospel (1-mil copper, thermal stress test) were pulled out of the hat when Moses brought the first MIL SPEC down from the mountain.

MIL-PRF-55110. This is the last in a long line of military qualification and conformance standards for rigid printed boards. The "RF" MIL-PRF-55110 came after some administrative hocus pocus which moved the requirements out of the document and into an appendix for "Perry Initiative" purposes. The document is currently at revision "F" and is considered inactive for new designs.

MIL-P-50884. This is the military's document for flex and rigid flex printed boards. The latest (not necessarily "current") revision has been around for the last two presidents, and is at "C" with amendment 5 (yes 5—the amendment is new). There has been no significant changes to a lousy PWB standard, although rumors abound that the military standards people have been working on a secret revision (without industry participation).

MIL-PRF-31032. The military decided, with the help of the Reagan administration, to move from product qualification specifications to "performance" specifications, which deal primarily with quality and process control issues. The document then has "slash sheets" which deal with performance issues by technology.

- MIL-PRF-31032/1 - Performance Slash Sheet for Rigid Multilayer PWBs
- MIL-PRF-31032/2 - Performance Slash Sheet for Rigid Single-/Double-Sided PWBs
- MIL-PRF-31032/3 - Performance Slash Sheet for Flexible Single-/Double-Sided PWBs

NASA: To Boldly Go . . .

The National Aeronautics and Space Administration (NASA) decided many years ago that the conventional military specifications for printed boards were not adequate for its needs. It decided to publish its own printed board standard within its reliability program requirements document structure: NHB 5300.4. This set of requirements has many sub-documents, the PWB requirements being just one part of them. Below are a couple of the many documents within the NHB 5300.4 document set.

- NHB 5300.4(1A) - "Reliability Program Requirements for Aeronautical and Space System Contractors"
- NHB 5300.4(3I) - "Requirements for PWBs"

Telcordia Technologies (The artist formerly known as BELLCORE)

BELLCORE was recently purchased by SAIC (for detailed information, see my column, "Bellcore's Last Stand(ard)" in August 1998) and now has a new name—Telcordia Technologies. BELLCORE was created during the divestiture of the Bell System in 1984 to serve the Bell operating companies by providing a center for technological expertise and innovation. Out of this has come many standards for the electronics and telecommunications industries. BELLCORE has documents developed into families by system type. The families relevant to our industry are FR-796 or FR-2063, and within the these families exists the GR-78-CORE document. The GR-78 is the document that most people in our industry referred to regarding BELLCORE documents. It contains the qualification and conformance requirements for printed boards, soldermasks, and flux.

International Electrotechnical Commission

Founded in 1906, the International Electrotechnical Commission (IEC) is a world organization that prepares and publishes international standards for all electrical, electronic, and related technologies. The IEC was founded as a result of a resolution passed at the International Electrical Congress held in St. Louis in 1904. The membership consists of more than 60 participating countries, including all the world's major trading nations, and a growing number of industrializing countries. I serve as a U.S. representative to the IEC, and can vouch for its slow pace of action. It takes literally years to get anything through the IEC, and its standards are typically well behind the "state of the art." They do have quite an influence in the EU, along with having close ties with CENELEC (see below).

- IEC 60194 - Terms and definitions for printed circuits
- IEC 60249 – 2 (sheet 1-19) - Individual material specifications for Base Materials
- IEC 60249 – 1 - Test Methods for Base Materials
- IEC 60249-3-1 - Prepreg
- IEC 60249-3-3 - Permanent polymer coating materials (solder resist)
- IEC 60326-2 - Test methods for printed boards
- IEC 60326-3 - Design and use of printed boards
- IEC 60326-4 – Single- and double-sided printed boards with plain holes
- IEC 60326-5 – Single- and double-sided PTH printed boards
- IEC 60326-7 – Single- and double-sided flexible printed boards without through connections
- IEC 60326-8 – Single- and double-sided flexible printed boards with through connections
- IEC 60326-9 - Flexible multilayer printed boards with through connections
- IEC 60326-10 - Flex-rigid double-sided printed boards with through connections
- IEC 60326-11 - Flex-rigid multilayer printed boards with through connections
- IEC 60326-12 - Mass lamination panels (semi-manufactured multilayer printed boards)
- IEC 61189-1 - General test methods and methodology
- IEC 61189-2 - Test methods for materi-

als for interconnection structures
- IEC 61189-3 Test methods for interconnection structures (printed boards)
- IEC 61249-2-12 - Reinforced base materials, clad and unclad - Epoxide nonwoven aramid laminate of defined flammability, copperclad
- IEC 61249-2-13 - Reinforced base materials, clad and unclad - Cyanate ester non-woven aramid laminate of defined flammability, copperclad
- IEC 61249-3-3 - Un-reinforced base materials, clad and unclad (intended for flexible printed boards) - Adhesive coated flexible polyester film
- IEC 61249-3-4 - Un-reinforced base materials, clad and unclad (intended for flexible printed boards) - Adhesive coated flexible polyimide film
- IEC 61249-3-5 - Un-reinforced base materials, clad and unclad (intended for flexible printed boards) - Transfer adhesive films
- IEC 61249-5-1 - Copper foils (for the manufacture of copperclad base materials)
- IEC 61249-5-4 - Conductive foils and films with or without coatings
- IEC 61249-7-1 - Restraining core materials - Section 1: Copper/invar/copper
• IEC 61249-8-7 - Marking legend inks
- IEC 61249-8-8 - Temporary polymer coatings
- IEC 62326-1 - Printed boards - Part 1: Generic specification
- IEC 62326-4 - Rigid multilayer printed boards with interlayer connections

Japan Printed Circuit Association

The Japan Printed Circuit Association (JPCA) is Japan's standardization arm for the PWB industry. It has been drafting JIS (Japan Industrial Standards) on printed circuits since 1983. The JPCA also has many standards of its own, and has adopted a global policy similar to the IPC. In fact, the JPCA and IPC have been working together to start publishing jointly developed documents. This bodes well for consistency and continuity within our industry. Below are a list of JIS & JPCA documents relevant to our industry.

JIS Standards
- JIS C 5010 - General rules for PWBs
- JIS C 5012 - Test methods for PWBs
- JIS C 5013 – Single- and double-sided PWBs
- JIS C 5014 - Multilayer PWBs
- JIS C 5016 - Test methods for flexible PWBs
- JIS C 5017 - Flexible PWBs - single-sided, double-sided
- JIS C 5603 - Terms and definitions for printed circuits
- JIS C 6471 - Test methods of copper-clad laminates for flexible PWBs
- JIS C 6480 - General rules of copper-clad laminates for PWBs
- JIS C 6481 - Test methods of copper-clad laminates for PWBs
- JIS C 6482 - Copperclad laminates for PWBs - Paper base, epoxy resin
- JIS C 6483 - Copperclad laminates for PWBs - Synthetic fiber fabric base, epoxy resin
- JIS C 6484 - Copperclad laminates for PWBs - Glass fabric base, epoxy resin
- JIS C 6485 - Copperclad laminates for PWBs - Paper base, phenolic resin
- JIS C 6486 - Copperclad laminates for multilayer PWBs - Glass fabric base, epoxy resin
- JIS C 6488 - Copperclad laminates for multilayer PWBs - Glass cloth surfaces, cellulose paper core, epoxy
- JIS C 6489 - Copperclad laminates for multilayer PWBs - Glass cloth surfaces, nonwoven glass core, epoxy resin
- JIS C 6492 - Copperclad laminates for multilayer PWBs - Glass fabric base, Bismaleimide/Triazine/Epoxide
- JIS C 6490 - Copperclad laminates for multilayer PWBs - Glass fabric base, modified and unmodified polyimide resin
- JIS C 6493 - Thin copperclad laminates for multilayer PWBs - Glass fabric base, modified or unmodified polyimide resin
- JIS C 6494 - Thin copperclad laminates for multilayer PWBs - Glass fabric base, Bismaleimide/Triazine/Epoxide
- JIS C 6520 - General rules of Prepreg for multilayer PWBs
- JIS C 6521 - Test methods of Prepreg for multilayer PWBs
- JIS C 6522 - Prepreg for multilayer PWBs - Epoxy resin-Impregnated glass cloth
- JIS C 6523 - Prepreg for multilayer PWBs - Modified or unmodified polyimide resin-impregnated glass cloth
- JIS C 6524 - Prepreg for multilayer PWBs - Bismaleimide/Triazine/Epoxide resin-impregnated glass cloth

JPCA
- JPCA-TD01 - Terms and definitions for printed circuits
- JPCA-RB03 - Single and double-sided PWBs—without PTH
- JPCA-RB02 - Double-sided PWBs—with PTH
- JPCA-DG01 - Design-guide for multilayer PWBs
- JPCA-ML01 - Multilayer PWBs
- JPCA-FC01 - Single-sided flexible PWBs
- JPCA-FC02 - Double-sided flexible PWBs
- JPCA-FC03 - Design-guide for flexible PWBs
- JPCA-DG02 - Design-guide manual for single- and double-sided flexible PWBs
- JPCA-BM01 - Copperclad laminates for flexible PWBs - Polyester film, polyamide film
- JPCA-BM02 - Test methods of coverlay for flexible PWBs
- JPCA-BU01 - Build-up PWBs - Terms and definitions/Test methods/Design examples)

Others of Worthy Mention:

UL – Underwriters Laboratory

I have written extensively here on UL (April–July '98), and will follow up again in a month or two. UL has become a strong influence on our industry, and has its own set of standards that apply to the PWB industry.

ASTM – American Society for Testing and Materials

The ASTM's technical committee structure is similar to the IPC's, but they are not a trade association, and focus primarily on testing standards. Many tests performed on PWBs and related materials are either done to ASTM methods or to methods "borrowed" from ASTM methods.

CENELEC

CENELEC is the European Committee for Electrotechnical Standardization. It was set up in 1973 as a nonprofit organization under Belgian Law. It has been officially recognized as the European Standards Organization in its field by the European Commission in Directive 83/189 EEC. Although it has not put much effort into printed board and material standards, there is beginning to be some activity. Since it is now an EU standards body, I'm sure it will be flexing its muscles soon.

I hope this helps you to understand the variety of specifications and standards that permeate our industry. Despite the rather mundane nature of standards, they are necessary in today's global market place—and will ultimately protect us as consumers.