



Taking the Mystery out of UL

Everyone likes a good mystery—well, one that doesn't really affect them. We go to mystery movies, read mystery books and even go to interactive who-done-it mystery theaters. Our infatuation with the mysterious dissipates substantially when the mystery involves us directly. People who both created and solved mysteries have made it part of our folklore. Places and companies have also gained reputations for mystery.

Those of you out there (and you know who you are) who are in charge of keeping your company's UL file together and updated regularly deal with one of those mysteries. The mystery and mystique surrounding UL is a product of folklore in our industry. As a UL client agent, we deal with UL on a daily basis, so I will try to pass some of the insight and experience we have gained on to you in this column, hopefully demystifying UL. This column will address many of the questions we repeatedly receive, and will hopefully give you a clearer picture of UL.

Who is UL?

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit product safety testing and certification organization. UL has tested products for public safety for more than a century. Each year, more than 14 billion UL marks are applied to products worldwide. UL has five testing laboratories in the United States. UL also has several affiliate, agency and representative offices, of which Microtek Labs is a Certified Engineering Agency, as well as field representatives located throughout the world.

Why is UL Certification Necessary?

Electrical and electronic items sold within the United States must meet the U.S. National Electrical Code (NEC) as well as various city, county and state electrical codes. In order to comply with these codes, electrical and electronic products must be "listed" as compliant by an "authority having jurisdiction to identify a listed product." UL has been recognized as the de-facto authority for listing products as compliant to the U.S. electrical codes, and electrical inspectors and U.S. Customs agents look for the UL mark as a demonstration of

this compliance. UL has developed a variety of "end-product" standards to deal with listings and special requirements for different types of finished products. Each of these end-product standards flows down requirements for components and parts used in the end product. For Printed Boards and Materials, the standards for "component/part level" compliance can be found in the UL 746 series, UL 796 and UL 94 documents.

It is often difficult for the board manufacturer to determine which "end-product" specification their customer is working to (i.e., UL 1950, etc.) and, therefore, most PWB and material manufacturers desire the most stringent levels of possible UL product listing to cover all of the possible customer requirements, regardless of which end-product specification they are working to. Balancing this need with material capabilities typically places the product at (or sometimes over) the edge of its capability, giving us the wide variety of listings currently found in the UL "Yellow Books."

How are UL's Testing Services Organized?

UL's Engineering Services division is organized into sections that evaluate specific types of products. Examining how products are constructed, conducting tests, evaluating results and developing safety standards for products are a few of UL's responsibilities. UL also has field representatives who visit manufacturers' facilities and perform "follow-up" services. They help confirm that products bearing the UL mark comply with applicable UL safety requirements.

How Do I Find the Path?

When seeking the mysteries of the universe, one finds a mystic, priest, guru or shaman. When seeking the mysteries of UL, one finds a UL client agent. I know the name doesn't sound as cool as those "universe information guys," but if experience with UL is something you lack, contact one of UL's certified client agents for assistance.

Client agents typically have extensive experience in the product categories for which

they are agents. They also have developed relationships with the UL engineers who help facilitate speed, accuracy and understanding of the product approval process. Client agents serve as liaison between the company and UL. Answering general questions about UL's services, directing manufacturers to the correct engineering staff, and working with UL management to resolve issues of concern to UL clients are just a few responsibilities of these helpful organizations.

What's in My UL File?

If you have a UL file, read it and become familiar with it. The UL file contains information on your process flow as well as specific material and process limits, which may not correspond to the processes and materials you are currently using. Typically, file revisions are used to add new products in response to a particular customer need (i.e., a new laminate, prepreg or soldermask). In doing this, it is easy to forget modifications to your processing parameters. These modifications can usually be combined with other projects, without an increase in cost, thereby providing you a measurable cost savings.

How Much Testing is it Going to Take?

Everyone wants to know how much testing will be necessary to accomplish a particular file update. When you submit your project request, the UL project engineer will determine what testing (if any) will be required. Like anything else, how you ask is almost as important as what you ask for. This is an area where experience can make all the difference in the world.

For PWBs, UL 796 defines the UL testing and acceptance requirements. It includes a section titled, "Variations in Printed Wiring Board Construction," which contains several tables that define the test program for specific types of file revisions. Another helpful document, IPC-A-22, is published by the IPC (www.ipc.org) and shows the same UL tables with recommendations on how to construct the test coupons for maximum effectiveness. The IPC-A-22 also includes the artwork (Gerber files) necessary for UL testing and can be adjusted to your specific needs.

Bob Neves is the president of Microtek Laboratories, an independent test facility. Prior to his tenure at Microtek, Bob worked in quality management and engineering in PWB manufacturing. He currently serves as the IPC's Rigid Board General Committee chairman, Rigid Board Test Method Task Group chairman, Laboratory Qualifications (IPC-QL-653) Committee chairman, member of DESC's Tiger Team for MIL-P-RRRRR (MIL-PRF-31032), member of Blue Ribbon Committee for MIL-S-XXXXX (MIL-PRF-5X) and convener of IEC TC52 Working Group 10 Printed Wiring Test Methods. You can reach him by e-mail at BobNeves@thetestlab.com or at the company web site: <http://www.thetestlab.com>.

How Do I Contact UL?

UL has several facilities in the United States with engineering departments and testing laboratories. Specific information about UL can be found on their Web site: www.ul.com. Any correspondence with UL regarding your file should contain the name of the project engineer who was last involved in a project for your company, along with your file number, which is what UL uses to identify your company.

If you are going to use the direct approach (no client agent), you should contact your UL project engineer personally. The personal touch, as with all business dealings, can be the difference between complete and limited success. UL makes extensive use of e-mail, but nothing works better than a phone call directly to the project engineer. It is important to always follow up conversations with a letter confirming the discussions and decisions made during any verbal contact with UL personnel.

Your correspondence should consist of a concise letter to your project engineer asking for project initiation and explaining your desired file changes. If you will be requiring sample aging (per the UL 796 charts), you should explicitly request to have both the ten- and 56-day testing conducted concurrently. This strategy can save a tremendous amount of time should your ten-day test samples fail. Because the ten-day test is conducted at a much higher (therefore more severe) test temperature than the 56-day test, the ten-day test often fails. If this strategy is used, UL will simply discard the results of the ten-day and continue with the 56-day test without loss of time. If the ten-day test passes, the 56-day test will then be terminated.

What Will UL's Response Be?

UL will respond to you in writing with a project application that defines the scope of the project and the UL costs you will incur to complete your file change. If test samples are required, they will specify both type and quantity of coupons for each. There are typically several ways to construct a multilayer package, and it would be best to use previously submitted constructions (if applicable), or use some of the helpful multilayer construction information found in the IPC-A-22 document. Again, experience or a client agent can help you tremendously when putting together the correct samples for testing.

Review any letters from UL carefully to be sure that everything requested was addressed. If the samples requested do not meet your expectations, do not hesitate to contact the engineer for clarification. This initial process will define the scope of your program as well as how it will be listed in your file, and it is very important that everything be right at this stage of the game.

You will also receive a follow-up services agreement that you must sign and return to be considered for UL recognition. This program is the means by which UL assures that your

product continues to meet the UL requirements. Typically, one- to four times a year a UL follow-up services engineer will come to your facility, review your manufacturing process and sample marking, and then pick samples from your production to be tested at one of UL's facilities. Of course, the cost of this is passed on to you, so be prepared!

What Kind of Test Samples are Required?

Sample constructions need to demonstrate both pattern and material limits desired for recognition. Although UL 796 explains basic construction techniques, IPC-A-22 details several approaches to combining limits including how to minimize the variety of constructions, and is well worth looking at. IPC-A-22 also contains a generic artwork pattern that may need to be modified to adjust for your needs.

Always make plenty of samples (two- to three times what UL requests)! These extra samples allow you to have a backup in case the coupons get lost, ovens overheat, or other unforeseen things happen. A few extra panels up front will provide you cheap insurance just in case.

Delamination. These coupons are comprised of solid round metal patterns (2-inch, 3-inch, 4-inch . . . diameter) on both external layers, along with the inner two layers of the multilayer. The rating for a four-layer coupon will extend the processing of three- to x number of layers. The external layers must be plated in the same as if it had plated through-holes.

Bond or Peel Strength. Test coupons must be made with the same laminate/prepreg constructions as the delamination and bond coupons. The geometry of the peel coupons is defined in UL 796. UL will typically request uncoated coupons plus coupons coated with one or two of your "recognized" soldermasks.

Flammability. As with the bond/peel strength samples, these coupons must be made from the same laminate/prepreg constructions as the delamination and bond coupons. There can be no metal in these samples, and UL will typically request uncoated coupons plus coupons coated with one or two of your "recognized" soldermasks.

Submitting Test Coupons

Prior to submission to UL, it is a good idea to inspect the samples to assure that they do not have lifted conductors, scratched plating, voids or delamination. Assure that the samples are the correct size, and that the edges are smooth. Identify your samples with your company name, UL file number, type designation and the UL assigned project number.

UL usually requires that the test samples be submitted along with the signed project application form and any requested payments. It is a good idea to include a short letter with the samples, which is also sent separately to the UL project engineer. Then, follow up with a call or

e-mail to let him/her know that the samples have shipped from your facility. Just remember that communication is key to a successful project.

What Happens During the Testing?

Unfortunately failures do occur. Don't be surprised if, despite your good planning, close attention to detail and high-quality materials, your samples fail. If this unfortunate circumstance occurs, ask for the failed test coupons back in order to determine why they failed. Bond and peel strength failures are fairly rare, while delamination failures during the 10-day test are not uncommon. For FR-4 materials a 94 V-0 Flammability rating is expected while a 94 V-1 rating is typical for most other materials. Sample preparation, material thickness, soldermask and testing procedure can greatly affect these expected ratings.

If failures occur that prevent UL approval of the file changes, the UL project engineer will give you two options: 1) resubmit coupons for a retest (this is when those extra samples come in handy); 2) accept a lower level of approval (if applicable).

The experience of a UL guru can be extremely valuable to you at this point. Failure analysis, test record review and negotiated results by an expert can get you back on track with a minimum amount of inconvenience, cost and delay.

What Can I Expect after the Testing?

Once the testing is completed, the UL project engineer will develop a formal report based on the test results. The engineer will then develop specific guidelines for a follow-up services program. This follow-up services program is a document that describes in detail the construction(s) and process flow of the product(s) listed, and is intended to help the field engineers when they visit your facility.

If, for some reason, your product doesn't meet UL's requirements, you will receive a letter from UL describing the specific requirements your product did not meet. If you choose to modify the product and are interested in having it re-tested, you can contact the UL engineering staff who originally tested the product for any re-testing or re-examination that may be necessary.

The Key to the Mystery

Like all mysteries, understanding is the key to unraveling them. When it comes to understanding the meaning of life, go see one of those Universe Guys. When it comes to demystifying UL, you can do one of two things: 1) Take the time and training to get the experience yourself (i.e., become a UL guru or shaman); 2) Hire someone (i.e., client agent/industry mystic) to help you get down the UL path of enlightenment. Choose wisely and you will be rewarded.