Pre-Compliance Testing Is Necessary For All Products

by Kevin Parmenter, Chair, and James Spangler, Co-chair, PSMA Safety and Compliance Committee

For some companies, pre-compliance testing may seem like a source of unnecessary expense or extra steps in an already time-constrained product development schedule. Or it may be something they've given no thought to at all. But when the risks associated with not performing pre-compliance testing are considered, it becomes clear that pre-compliance testing is a means of avoiding unwanted increases in product development cost.

Pre-compliance testing alerts the design, engineering management, and marketing teams that an issue may be lurking in the weeds and informs them of the potential problem *before* the product ships. By applying pre-compliance testing prior to production, excessive redesign costs, and production delays can be avoided.

While many companies have some awareness of this idea, there can still be resistance to pre-compliance testing. Perhaps some managers will argue that it's not really needed and the risks of not doing such testing don't outweigh the potential costs of doing it. Besides, they might say, we've gotten by in the past without pre-compliance testing.

But often these attitudes ignore the real risks at stake when pre-compliance testing is not performed. In this article, we'll identify and discuss the many and often unexpected ways in which compliance problems add cost and delay to the product development cycle. In some cases, these problems can be the difference between a successful product launch and a failure. As we'll see, all of these problems can be avoided through pre-compliance testing.

In addition to discussing the costs and delays associated with failure to perform pre-compliance testing, we'll identify sources of information and help in doing this testing. We'll also identify some of the most common test requirements that companies should consider when planning their pre-compliance testing.

The Costs Of Compliance Failures

The first cost can be attributed to missing shipping schedules due to a product's failure to pass in the compliance lab. Such delays can result in orders being lost to a competitor because a product failed to meet a compliance standard or agency regulation. When a new product shipping date is missed to a customer, this can cause the new product to be removed from the customer's approved vendor list.

The second cost can be engineer and technician work hours spent to redesign and retest a product. This second category of cost includes time, material and scheduling for a new pc board. A new pc board layout takes time and may require over-time for the layout person to maintain a project time schedule. A simple component change is not a major issue but adding a snubber circuit to a power device does require rearranging parts so that all components fit inside the allocated area.

Retesting is required after any component has been change or added, in order to verify those changes solved the issue. If an outside test lab is used, a premium may be paid to the test house to meet a tight schedule. If UL, CSA, or Intertek is used, this can add to the cost for retesting and there is often a delay as you wait for a time slot to open up at the test lab.

Another scenario occurs when a competitor has a new product and you want to be a second source. In this case, you will definitely want to make sure your product meets all the regulations and standards. In addition, if your competitor's product fails to meet regulations and standards you then have an opportunity to gain additional market share and sales. You will want to make sure your product is clean and ready for sale without any delays.

Sometimes there's a delay because your product needs to be tested to meet new a standard or rule because new rules or regulations have come into effect. Marketing and sales must work with engineering and product development to verify all the standards are met before a product ships. As an example, this problem can occur if a product is in production for markets in the USA and Canada, but there is suddenly a new opportunity to ship the product to Europe. In this case, there may be a delay for retesting or to file product certification paper work.

To illustrate with an EMC example, the FCC and IEC or CISPR have similar specifications but there may be slight differences in voltage level limits. Plus, test methods and test equipment are different. However, this can be a simple issue to solve such as retesting with the correct LISN network for CISPR. But as with all of the sources of delay, anticipation of the requirements and attention to pre-compliance testing can avoid this source of delay.

Avoid The Costs And Delays, Gather The Rules And Regulations

Early in the design process, marketing, sales, compliance department and engineering management must determine what standards and regulations are needed for a product. Although this may be just be another product line extension, someone must still verify that there are no new standards and regulations which have been issued.

As an example, suppose you have a battery backup in your system and you changed battery chemistry from a sealed lead acid battery to a rechargeable lithium-ion battery. The standard is different for lead-acid batteries compared to lithium-ion batteries. This is the case for UL, CAS, IEC, DoE and CEC requirements.

Underlying these different requirements is the knowledge that sealed lead acid batteries can be forgiving, while the various lithium-ion battery chemistries behave slightly differently. UL has new standards for lithium-ion batteries due to the history of lithium-ion cells catching on fire.

Naturally, to accomplish pre-compliance testing, design engineers must have the tools to do the testing. Arrangements must be made to have the engineers understand what rules are to be applied when performing the design and preliminary testing. The engineers' company needs to work with a Nationally Recognized Test Lab (NRTL) to determine what needs to be tested and how testing is to be performed.

The more tests performed in house, the lower will be the cost accrued from an NRTL. To this end, the NRTL or an outside testing lab can assist with testing procedures to facilitate in-house testing.

Consulting firms can be another resource. A web search for "product safety consulting" produced the names of many firms and companies. One consulting firm is Product Safety Consulting. [1] This Chicago-based firm is certified by UL, ETL, CE, etc.

These types of consulting firms can be used as a source of assistance to understand the rules and regulations and to provide advice. Such organizations can help avoid costly delays in getting a product out the door in order to meet production and shipping schedules.

Remember that UL, CSA, and Intertek, do not test for everything. If this is a kitchen appliance, there are two government agencies that have mandatory regulations that must be met: Department of Energy (DoE) and California Energy Commission (CEC). The Canadian Standard Authority (CSA) is another agency. It is believed that there are similar agencies in other parts of the world such as TUV Rheinland in Europe.

The FCC has both line conducted and radiated emissions levels. If a product has a microprocessor, it will radiate, and RF emissions can be an issue. This was reported in an earlier Safety & Compliance Column.[2] Please check with your testing house for CISPR standards that may apply as these can be different from those limits published by the FCC.

There are two additional Safety & Compliance articles that should be reviewed for DoE power supply rules: "Level VI DoE Rules And Regulations For External Power Supplies—Where To Find Them"[3] and "The DoE Views USB Chargers As External Power Supplies".[4]

Also noteworthy, there are new energy usage rules for electrical household appliances. The DoE and CEC must be checked for the latest requirements: See references 5, 6, and 7 for more on these requirements. The CEC also has its Appliance Efficiency Compliance Assistance Program.[8] There are other sources of information, easily searched for using the keywords "California Energy Commission testing for appliances".

The Importance Of Testing Early

It is wise to plan for at least four product revisions before a product is shipped. These would include design changes for electromagnetic radiation and line conduction issues. There can be electrical leakage issues, too, which may require changing mechanical assembly, changing a capacitor value, or adding insulation materials. Some of these were addressed previously in a Safety & Compliance column on materials compliance.[9]

On the subject of leakage, ac leakage from exposed metal may require changing mounting hardware and heat sink mounting insulation. The electrical leakage that is allowed for medical equipment is much lower than for other types of equipment. Please see UL 60601 or IEC 60601 for these limits.

In cases where leakage current produces corona, a convenient way of testing for this involves performing the test in a dark location so that you can observe the corona. The older hi-pot testers with a variac will work because corona is seen as a blue glow. This glow occurs prior to exceeding the leakage current limit. Once the corona area is detected, a fix can easily be made. The variac dark room approach saves time and cost because the glow shows where the leakage occurs.

Typically, a product's case temperatures must be measured to see if they exceed the touch temperature of the product listed in the UL or IEC product standard. This must be performed for all consumer products and is performed using a temperature chamber or hot box. Testing must be performed in an enclosure to verify that the maximum temperatures are not exceeded.

Maximum temperatures are listed for exposed plastic and metal parts and are given in the newest power supply standard, IEC62368-1, which has a chart for temperatures. It is believed that these temperatures will apply to all consumer products. Keep in mind that there is a different limit for each type of touch and surface. Moreover, exposed metal has one temperature limit, while plastic has another.

Internal component temperatures are also spelled out in the IEC 62368-1 standard. The temperatures should be measured in an old fashion test chamber, UL Hot Box or test chamber (test box) with thermocouples. The test box is set to have an internal ambient temperature of 40°C or more. The product should be placed inside the test box; and the temperature of the major components should be measured using a thermocouple during normal product operation.

Electrolytic capacitors should not exceed their maximum rated temperature. This could be 85°C or 105°C or whatever the manufacturer specified as the maximum rated temperature for their components. The various electrolytic capacitor manufacturers have guidelines for the electrolytic capacitor maximum temperature rise. These guidelines allow for calculated mean time to failure.

This maximum temperature testing needs to be performed at elevated temperatures, in a 40°C hot box, in order to verify the reliability of the product. The maximum temperatures that apply to all semiconductors—diodes, transistors, integrated circuits, etc.—will also be listed in their data sheets.

Such tests may determine that additional cooling is required if the major components have greater than their allowed temperatures. The additional cooling might take the form of additional slot openings in the case, or a change in the rating of a cooling fan, or perhaps adding a cooling fan.

In lieu of a purchased temperature chamber or UL Hot Box, a poor man's test box can be constructed using a cardboard box. In this case, incandescent lamps can be used as heaters to raise the internal temperature. However, the internal ambient temperature should not exceed 50°C or 122°F when using a cardboard box. LED driver products often exceed these temperatures when placed in the ceiling. There is a special UL standard for LED drivers, UL 8750, which has similarities to UL 935 for fluorescent lamp ballasts.

Overtemperature conditions must be monitored and protected. Component and case temperatures over those listed in the standard can cause fires, electric shock, and the explosion of electrolytic capacitors.

Lighting products have a special class of products that have overtemperature protection, Class P. This is to protect the product and the consumer from excessive temperatures and fire-related issues. In the case of an overtemperature event, a thermal protector opens on the input power line causing the product to be nonfunctional until the temperature drops.

Inductors and transformers have temperature ratings of 85°C, 105°C, 130°C, 155°C, etc. Many transformers and inductors have an internal thermal protector that opens when the internal temperature exceeds the device rating. Most switching power supplies have a 105°C rating due to a bobbin, and magnet wire insulation system. The rating of the purchased power supply needs to be verified before a product is shipped.

Products Driving Motors And Solenoids

The testing of products that drive motors and solenoids must use the proper UL, CSA, IEC, etc. standard. If the product drives a motor, there is a motor locked-rotor test. During this test, the temperature of the motor must not exceed its maximum insulation temperature rating.

If there are motors in a product or system, controls are designed to limit the maximum current. It is critical for safety that the motor case temperature not be exceeded. There is often current limiting and current protection including a thermal cut-out switch that might be a one-time (non-resettable) type inside the motor.

The selection of the proper input fuse is often required. Sometimes non-replaceable fuses are required. A product can be designed with a fuse that can only be replaced at a factory authorized repair facility.

Using a replaceable fuse might require the product to have a tamperproof case. The use of replaceable fuses is addressed in the product standards. When performing a UL test on a product that has a fuse, the fuse is replaced with the fuse that has the highest current rating for the fuse package. The unit must not catch fire or explode when a fault is applied.

Hazardous Materials

After the first prototype is built and tested, the information for California Proposition 65 must be collected. RoHS compliance materials investigation may be required. This task of gathering information is often assigned to the component engineering department along with the purchasing department. This is detail work and can lead to changing component selections. In terms of the material requirements, the insulation used on the lead wires and the internal cable harness is a concern along with some plastic mounting hardware.

Summary

This article attempted to show how pre-compliance testing can save a company money and reduce delays when the standards and regulations are available and understood before the design process begins. The process of gathering information is companywide, involving the participation of engineering, purchasing, manufacturing, compliance, and test departments.

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About The Authors

Kevin Parmenter is an IEEE Senior Member and has over 20 years of experience in the electronics and semiconductor industry. Kevin is currently director of Field Applications Engineering North America for Taiwan Semiconductor. Previously he was vice president of applications engineering in the U.S.A. for Excelsys, an Advanced Energy company; director of Advanced Technical Marketing for Digital Power Products at Exar; and led global product applications engineering and new product definition for Freescale Semiconductors AMPD - Analog, Mixed Signal and Power Division.

Prior to that, Kevin worked for Fairchild Semiconductor in the Americas as senior director of field applications engineering and held various technical and management positions with increasing responsibility at ON Semiconductor and in the Motorola Semiconductor Products Sector. Kevin also led an applications engineering team for the start-up Primarion where he worked on high-speed electro-optical communications and digital power supply semiconductors.

Kevin serves on the board of directors of the PSMA (Power Sources Manufacturers Association) and was general chair of APEC 2009 (the IEEE Applied Power Electronics Conference.) Kevin has also had design engineering experience in the medical electronics and military electronics fields. He holds a BSEE and BS in Business Administration, is a member of the IEEE, and holds an Amateur Extra class FCC license (call sign KG5Q) as well as an FCC Commercial Radiotelephone License.

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For many years, he worked as a field applications engineer (FAE) for Motorola Semiconductor, On Semiconductor, Cirrus Logic, and Active Semiconductor, assisting customers in using semiconductors. He published numerous application notes and conference papers at a variety of conferences: APEC, ECCE, IAS, and PCIM. Topics included power factor correction, lighting, and automotive applications. As an FAE, he traveled internationally giving switch-mode power supply seminars in Australia, Hong Kong, Taiwan, Korea, Japan, Mexico, and Canada.

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For further reading on power supply-related safety and compliance issues, see How2Power's special section on Power Supply Safety and Compliance.