CIRCUIT CELLAR ONLINE

LESSONS FROM THE TRENCHES

George Martin

A Primer for Product Testing

Although he admits that product testing isn't exactly the most exciting area of engineering, George makes it interesting by covering the basics and then opens the doors of communication by inviting you to write to him with your testing issues.

For the first time in a while, unemployment is low, stocks are chugging along, and embedded systems are popular. Life is good.

I hate to be the person who brings good times to an end, but I need to talk about product testing. It's not exciting, but if I cover some basics, you'll be pointed in the right direction and perhaps the good times will last longer.

I'm also hoping that some of you will post your testing issues in the *Circuit Cellar* newsgroups. That way, we all get a chance to learn, and the dialogue will go both ways.

SETTING THE STAGE

Much of my design work is contracted with smaller (leaner-and-meaner) start-up companies. The products are new, not just replacements for existing devices. As a result, often when I ask about testing requirements, I get answers like, "I don't know, but we do want to build a good unit." And, because manufacturers have little or no established competition with similar products, they can't ask, "What's the competition doing?"

In contrast, larger, more established companies have defined testing plans and the cost is included in management-approved budgets. These companies determine customer and government requirements and the testing needed to meet those standards. They understand the ultimate cost of not testing properly.

For example, remember Texas Instruments' home computer from the '70s? It was recalled because the external transformers started fires. With no intention to slam TI, my guess is that the company probably overlooked some testing. It wasn't long after the recall that TI pulled out of that market. I'm sure there were many reasons for TI's exit, but the transformer issue couldn't have helped.

Regardless of whether you're working with big or small companies, remember that the level of performance and low failure rates in today's electronics are remarkable. The performance bar is set high and is constantly being raised.

It's foolish to think you can put a design together and get to market without thorough testing. If your design ships with a defect, your users will find it. You'll waste money trying to recover and may permanently damage your product's reputation. A good test plan ensures that your design will hold up in the customer's hands.

Let me start by listing some of the tests that are required, then I'll describe some of the tests that are easy to perform in-house, and finally, propose a newsgroup forum where you can add your two cents about other tests that might be valuable to other manufacturers.

FCC MANDATED TESTS

Required tests are the easiest ones to identify. FCC Part 15, which limits the amount of electromagnetic interference (EMI) computer-based devices can emit, has altered the embedded market more than any other regulation. Everyone knows about the requirements and has probably tested their designs for compliance using them.

The tests involve two device classes—one for home use (lower emissions required) and another for business use. All devices using a crystal above a certain frequency must pass the tests in order to be sold.

FCC Part 68 provides regulations for connecting to the public telephone system. You need to pass Part 68 to sell communications-connected equipment.

Testing for FCC compliance is straightforward for many test labs. If you pass the tests, you can label your device. *Circuit Cellar* and trade magazines have published numerous articles about how to modify your design practices to meet these requirements. However, my intention is to describe testing in general, so I won't go into the design aspect.

OSHA'S TWO CENTS

Another government agency with established requirements that will likely affect your product testing plans is OSHA, which regulates workplace safety. Specific electronic devices are listed in OSHA regulations, along with the testing requirements for them. Although OSHA does not perform the tests, it does certify Nationally Recognized Testing Labs, which can conduct all product safety tests that are required.

What is a safe workplace, and what is safe equipment? Well, look around at the equipment in your office and lab. Start with the PC, but don't forget the answering machine, telephone, and electronic stapler. All the equipment has labels establishing compliance with different standards for the U.S., Canada, North America, and Europe, and you can see how testing quickly becomes overwhelming.

You'd have to confirm this with a lawyer or an expert in safety tests, but my understanding is that, if your product is sold to the workplace, it must meet OSHA's regulations. OSHA enforces these regulations through workplace inspections. Companies are visited by OHSA, which checks that workplace equipment meets product safety tests. Employers are fined if they don't provide a safe working environment.

MEETING THE UL SPECIFICATION

If your product uses 115-V power, has an interface with the telephone lines, and is sold in the U.S. only, then you need to read Underwriters Laboratories' UL-1950 for U.S.-based products. Most of these requirements match European standards but are not as stringent in some areas. If you pass UL-1950, you may need to retest to sell in Europe. Conversely, if you pass a European test, you're probably all set for the U.S. market.

What does UL-1950 cover? It's a safety specification that gives guidelines for insulation resistance, safety shields (from high voltage), marking, labeling, and cabling. In general, it gives guidelines for good design practice.

The specifications for mechanical fastening and marking requirements are particularly interesting. You've probably seen and used the slip-on terminal connectors for individual wires. You can find examples under the hood of your car, as well as in appliances. Have you ever noticed that some of these connectors have a friction part around the edges, a little hole in the tab, and a mating detent in the connector?

That's because UL-1950 requires two forms of retention for the high-voltage (115-V) lines. The roll crimp around the edges is the primary, and the detent represents the secondary. If one fails, the other is available.

And there's more. Go to the crimp end of the same terminal. The two means of retention also apply where the wire attaches to the terminal. You can crimp or tie wrap to another wire. If you look closely, you'll see some terminals crimp the wire and the insulation separately to form the two means of retention. Why deal with this? If one fails, the other will keep the high-voltage lead from leaking onto internal circuitry and protect the user from risk.

As far as marking is concerned, UL-1950 requires the chassis ground wire to be green with a yellow stripe and attached to the chassis at a point marked with a specified chassis ground symbol. This makes the wire's intended location and whether or not it's missing obvious.

UL-1950 does not necessarily equal expensive designs. However, it does require more attention to detail and an independent audit of your design and manufacturing.

Again, I've barely scratched the surface of safety testing. If you're selling a product for the U.S. workplace, you'll likely need a safety test conducted by an NRTL.

WHEN OPTIONS MAKE SENSE

Let's assume you have no testing requirements from the customer or regulatory agencies—no FCC, no UL, no MIL specification, and no industry standard. What tests should you perform?

First, let's look at what tests you can perform in-house. Obviously, all your performance and acceptance testing falls into this category. You should have a comprehensive, formal test plan. And, when you conduct these tests, I'll bet you'll find a problem or two!

Temperature testing is something you can do in-house. You'll need a thermometer (thermocouple) and a plan. First, test temperature rise. Measure room temperature and start measuring the case temperature of the different components inside your system. You'll get a temperature rise above ambient. If the ambient temperature is 70°F and your maximum working temperature is 100°F, you can add 30°F to all the case temperatures. Then, test to see if you can exceed any of the manufacturer's published data. Don't forget to also run the temperature testing at high line voltage and high operating load (or activity). Typically, this makes for higher measured temperatures.

If your unit has an LCD display (or battery), must survive a freezing temperature, and runs for a specific period

after powerup, you'll need to use your freezer. You'll need to cold soak your device overnight. It's tedious, but it's a real test.

If you're designing a product in the winter and live where it's cold, you've probably walked to the test setup and zapped the emulator with static electricity. Usually you do no damage, other than startle yourself, but it serves to remind you that electrostatic discharge (ESD) testing should be on your list of tests. Some products are designed to operate and provide correct data during ESD events. Others are just required not to fail and do not necessarily need to operate correctly during ESD events.

If your customer or industry requires them, there are easy formal ESD test. You can rent equipment that makes standard discharges and set up your product for testing.

Another real-world problem you can test for is vibration. In the past, if I didn't have a formal test requirement, I used to pack a unit in its shipping container and put it in the trunk of the VW diesel Rabbit. After driving around for a couple days, I'd open it up and see if it still worked. This worked better 25 years ago. Electronics components and manufacturing techniques weren't as good, and the roads, car suspension, and my driving style have also improved.

Humidity, altitude, sand, fog, salt spray, fungus—the list goes on. Test for these elements are specialized.

TIME FOR A SOUND OFF

Now for the interesting part, I'd like to hear about your testing plans. I'll compile a list of testing categories and what test specifications are available in each of the categories. Send an in-house test specification that isn't available to the general public. I want to know if you discover a clever update to my vibration test, and I think we'd all like to hear about it.

I'll compile a list of tests, both formal and informal, along with your notes and suggestions. I have a news group in the *Circuit Cellar* server. Post what you have at local.cconline.articles, and we'll build a valuable knowledge base.

Next month, I'll discuss numbers, specifically *int*, *char*, and *long*, in both signed and unsigned form.

George started his career in the aerospace industry in 1969. After five years at a real job, he set out on his own and cofounded a design and manufacturing firm. Typical systems that George designs include servo-motion control, graphical input and output, data acquisition, and remote control. George is a charter member of the Ciarcia Design Works Team and most recently, he's been working on the people-tracking system for Bill Gates' new house. You can reach him at george.martin@worldnet.att.net.

RESOURCES

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