

Value of Implementing a Robust Test Plan During Product Design of Portable Systems

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The timely introduction of a robust test plan during product design of a portable system is crucial to avoid issues that may negatively impact a product's cost and time-to-market. Last minute design changes stemming from test failures may create an increase in product cost that can negatively affect the operating profit. In addition, a product that is late to market due to test failures that require design changes can almost guarantee customer dissatisfaction.

There are a few key electrical and mechanical design milestones early in the design cycle when testing can be performed to almost eliminate last minute design changes. To identify and understand what these are, it is important to first understand the major milestones in the development cycle of a portable electronic device. From a testing point of view, the milestones in the development cycle are:

- Defining Product Specification
- Establishing Printed Circuit Board (PCB) Design
- Establishing Mechanical Design
- Releasing Prototype Samples
- Releasing Engineering Samples
- Releasing Final Production

Although each of these milestones is important to the design process, the two most critical from a testing perspective are establishing a PCB and mechanical design. Proper testing at these two phases of the process affords the opportunity to resolve most issues and fine-tune the product design without delaying the product's scheduled ship date.

Defining Product Specifications

Creating a product specification is an integral milestone in the design process. This specification thoroughly defines the product, the systems in which it is utilized, and the agency approvals that the product requires. Obtaining the information in the product specification early in the design process allows you to create a roadmap for testing that can be performed when the PCB and mechanical designs have been established.

Establishing PCB Design

Establishing PCB design is the most crucial electrical milestone. This is the point in the design process where the theoretical analysis of the circuit is completed and samples are available of the populated PCB. At this key electrical milestone, a couple of key design verification type tests can be performed using the populated PCB along with a stereo-lithography apparatus (SLA) housing. Two tests that are particularly informative at this stage are pre-compliance electromagnetic compatibility (EMC) scans and vibration testing

A power supply for a personal digital assistant (PDA) is a good example of where pre-compliance EMC scans, performed at the establishment of the PCB design, can prove to be very beneficial. The majority of the PDAs on the market have the capabilities to send and receive information to a personal computer via a USB connection. Therefore, in order to properly test a power supply for use in this type of system, you must test not only the power supply, but also the whole system including power supply, PDA, and computer- through the USB connection. The addition of the power supply and computer USB connection can create a much more complex overall system where EMC test results can vary enough to affect compliance to Federal Communications Commission (FCC) regulations and the European EMC Directive.

Since PCB layout can have a significant impact on EMC testing results, performing pre-compliance radiated emissions and conducted emissions “quick scans” can provide a good idea of where a product stands in comparison to the regulations. Obtaining these results at this point in the design process will identify any problems with the layout of the PCB, and provide the time to make the necessary changes without impacting the product ship date. In comparison, identifying the same issues at the release of engineering samples is too late in the process and will negatively affect the ship date of the project.

Vibration is another test that is best performed when the PCB design is established. Almost all design verification (DV) test programs, as well as the UN Recommendation on the Transport of Dangerous Goods regulation, require vibration testing. The purpose of the design verification vibration test is to simulate the way a product will be stressed during transportation, as well as verifying its overall durability. The vibration test is very important in determining the proper placement of components, the suitability of components utilized, and the integrity of the components as they are placed on the PCB.

The vibration test performed during the design verification process should be very stringent. In some instances, this can cause components to be sheared off of the PCB. This can happen if they are placed too close to the housing, or if they are just not strong enough to withstand the forces of the test. Issues like these can require PCB layout changes or housing modifications. So if the testing is performed at the PCB design set milestone, there is enough time to make changes. Unfortunately, many wait until the release of the engineering sample milestone to submit for DV testing. Since this is extremely late in the design process, if any failures are noted, the product will ship late and costs will increase.

Establishing Mechanical Design

Establishing mechanical design is the point in the design process where housing layout is complete, dimensional data is available, and construction material has been chosen. When the mechanical design of a product is established and sample housings can be built, it is critical to begin preliminary testing. Many environmental and/or mechanical tests can be performed on the first pre-production builds of a product’s housing using non-functional or old revision PCBs if the PCB layout is not yet established. Waiting until final tooling or completion of the electrical design is not necessary.

Some of the tests that can be performed at the earliest stages of development are thermal shock, temperature and humidity cycling, vibration, and random drop. The stresses involved in these tests are excellent indicators of how a product will perform mechanically over its lifetime and can quickly lead to possible product design changes. These tests can expose issues with the materials such as brittle plastic, areas of insufficient wall thickness, and gluing or welding

concerns. Waiting to perform testing until late in the design process or even until final production build can result in extended product design cycle time and missed ship dates.

Releasing Engineering Samples

One example that supports the need for early testing is a manufacturer who waits until engineering samples are produced to begin accelerated life testing (ALT). If during a drop test it is discovered that the product housing cracks in a particular area, the development team would be forced to re-evaluate the product design to find a solution to the cracking issue. At this point, the manufacturer's customer would have samples in hand and the ship acceptance date for the product would be rapidly approaching. Additional resources and an accelerated test schedule would be required to implement and test the various solutions that were proposed. If testing had been performed earlier in the design phase, the issue could have been identified and corrected prior to the customer receiving samples. Earlier testing would have also prevented the cost of expedited testing that was required to validate the product change.

Releasing Final Production

Simply stated, one should never allow oneself to get to this point. The major concern with releasing final production is that a potential field action may be needed to address issues with product that has already shipped.

Release of Prototype Samples

If a manufacturer waits until prototype level samples are available, unacceptable delays are likely. Additionally, the delays and costs of shipping product Class-9 (Miscellaneous Hazardous Goods) until testing is completed will impede the delivery of samples to the customer and potentially add delays to the development cycle. Having the testing performed at the establishment of mechanical design phase of development can identify necessary design modifications that can be addressed with minimal impact on the design cycle and have little or no visibility to the end customer.

Another example involves relatively new testing of lithium products to the standards in the "United Nations (UN) Recommendation on the Transport of Dangerous Goods." This test is required prior to shipping any new power source, such as a battery, that contains lithium. Until testing is complete and a Certificate of Conformance is issued, all shipments must be sent Class-9, a very expensive shipping class with many restrictions and potentially extended delivery times. Because the stress levels of this test program are higher than most product specifications, the risk of failure is also higher. Some common failure modes of this test program are enclosures opening or cell tabs breaking.

Working with a test and measurement facility that understands how to develop and implement an effective test plan for the specific portable product design is critical to keeping projects on budget and on time. The facility should staff professionals who create a custom plan that maximizes early and ongoing testing in the design process. Testing appropriately at early design stages affords time to make any necessary changes to the product's design without creating an overly compacted schedule later in the process. The time saved by early testing can easily translate into cost savings by helping to ensure that the product's ship date is met and overall customer satisfaction is achieved.

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