TeligentEMS

The Test Equation: Developing the Best Strategy for Your Project

Working Smarter Series

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As products have become smaller and more densely packed, in-process inspection capability has become more robust. The goal is detecting defects as early in the production process as possible to minimize rework time and scrap. In a perfect world, solder paste inspection (SPI), automated optical inspection (AOI) and selective use of x-ray inspection should catch virtually all workmanship-related defects. This often drives the argument for spending less on board-level test.

Unfortunately, workmanship-related defects are only part of what causes defective products. Recently an epidemic failure of 400 printed circuit board assemblies (PCBAs) in test at TeligentEMS was tracked to a bad date code in a single part. That defect was undetectable by in-process inspection equipment. Had those PCBAs been shipped to a customer for final assembly without a board-level test, the cost of three shipping legs, final assembly and functional test would have been incurred, in addition to cost of rework and any scrap. In short, a significant amount of unnecessary processing would have been done prior to detecting the defects and unnecessary shipping and handling costs would have been incurred for the repair process.

In TeligentEMS' processes, component-related defects are the root cause of 13 percent of defects detected in production and 40 percent of returned material authorization (RMA) defects. In short, the question isn't: "will a component level defect occur?" Instead it is: "How often will component level defects occur?" This becomes an even more important question when legacy products are involved, as in some cases they may be utilizing aging component inventories. The defect risk grows in times of allocation, as the risk of counterfeit parts entering the supply chain increases during periods when part lead-times increase.

Another lesser known benefit of parametric testing is its ability to protect functional test equipment from shorts during test. A PCBA is more likely to fail in the first 20-30 minutes it is powered up than at any other point in its lifecycle and in some cases that failure mode can damage a functional test station.

The final argument for some form of parametric testing that establishes a PCBA is good prior to shipment, is its benefits in defect root cause identification. When shipped untested, root cause analysis has to determine if the damage was caused by a bad component, handling in shipping, handling at the receiving factory or the assembly process at the receiving factory, if the cause isn't obviously workmanship related. For example, in one case at TeligentEMS where PCBAs underwent ICT, the root cause was determined to be operators at the receiving factory plugging PCBAs into the wrong power socket. Identifying and eliminating that problem would have taken much longer had known good PCBAs not been shipped from the factory.

From that standpoint, the best preventative strategy is having board-level parametric testing to establish that only known good products are shipped. Even when products are completely assembled and functionally tested at an electronics manufacturing services (EMS) provider, parametric testing helps save time and money. While functional tests can establish that the product is working, they don't have the success rate in catching components near failure that parametric testing does, because a functional test doesn't test for electrical values. Additionally, functional test occurs at the end of the process which means that rework involves product disassembly. Finally, while functional test will identify a non-working product, it does not identify why isn't working. This translates to larger amount of technician time spent on failure analysis. And none of those identified drivers of unnecessary cost factor in the costs associated with the work-in-process inventory and impact to the finished goods inventory pipeline that a bonepile of products waiting to be analyzed and repaired can represent.

Consequently, the decision becomes determining which parametric test makes the best sense for the product's test accessibility, volumes and cost targets. The two most commonly chosen are flying probe and in-circuit test (ICT). Figure 1 represents a quick comparison of the difference in cost and time that these two options represent.

COSTS	FLYING PROBE	ICT
PROGRAMMING	SAME	SAME
FIXTURE	$0-MINIMAL	$4K+
ECNs	MINIMAL	MINIMAL-$2K
PER UNIT	MORE	LESS
DEVELOPMENT TIME	1 WEEK	UP TO 6 WEEKS
TIME TO TEST	1-5 MINUTES	15 SEC- 1 MINUTE
TEST COVERAGE	MORE	LESS

Figure 1. Cost comparison of flying probe and ICT testing.

Advantages and Disadvantages of Flying Probe Testing

Flying probe is a fixtureless electrical test originally developed to support prototype test. Probes mounted on a moveable head move around the PCBA testing nets through predominately via-based access points. It typically can test PCBAs with limited test accessibility more fully than an ICT unit, because it can also probe a solder joint if a via is unavailable. While programming needs to change if the PCBA design changes, there is no fixture to modify. The major negative is the testing process is much slower than ICT. For example, on a PCBA with 500 nodes, a flying probe test would take 20 minutes compared with 1 minute on an ICT. Consequently, product design stability, product volumes and length of product lifecycle should be considered in determining which method is more cost effective.

Advantages and Disadvantages of In-Circuit Testing

ICT is typically the fastest way to parametrically test PCBAs. That said, it requires a fixture and a product designed to with enough test access to provide good coverage. The ICT must have a fixed location to test and that isn't always possible with a densely populated PCBA or on RF products where test points can become antennas. A PCBA with 50 percent accessibility translates to 30 percent coverage on an ICT. A fast test that only tests 30 percent of the components on the PCBA will not be performing the screening function that originally justified its cost. Typically, PCBAs should be designed with at least 70 percent access to achieve screening benefits and 100 percent access is preferred. The fixture must be modified or refabricated every time the PCBA design changes, so it is not a good option for products with frequent design changes. Consequently, this cost analysis should consider board complexity, test access, design stability, volumes and product lifecycle.

When the cost of unnecessary processing is considered, parametric testing pays for itself. The test engineering staff at TeligentEMS frequently helps its customer determine the optimum mix of test options to achieve a cost effective screening solution. Learn more by contacting sales@teligentems.com.

About TeligentEMS

For more than 30 years, TeligentEMS has provided a full range of electronic manufacturing services to companies in the industrial, medical, military/aerospace, telecommunications and instrumentation industries. We specialize in technically complex printed circuit board assemblies, subassemblies and box build. Our superior RF expertise enables us to support a wide range of communication technologies. We are ITAR registered and ISO 9001 and ISO 13485 certified.

Our global procurement and supply chain capabilities, combined with our real-time systems for project status, quality data collection and device history recordkeeping ensure we offer customers a cost effective and highly responsive solution.