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SIGMATRON INTERNATIONAL

Defect Mitigation: Four Areas Your Contract Manufacturer Should Be Focusing On

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By Curtis Campbell

As products get smaller and more complex, preventing defect opportunities is as important as screening for defects in the process. When outsourcing, this focus on defect prevention is ultimately managed by a contract manufacturer. Consequently, it is important to select a contract manufacturer with superior processes in this area. SigmaTron International, an electronics contract manufacturer with facilities in the U.S., Mexico and Asia focuses on four key areas in its approach to mitigating defect opportunities. These are:

- Design for manufacturability (DFM)
- Stringent process control
- Mistake-proofing as issues are identified
- Optimizing test to accommodate the rigors of volume production.

Design for Manufacturability

The best way to ensure superior quality in the field is to ensure that as many defect opportunities as possible are eliminated in the design phase. Unfortunately, not all design teams are expert in eliminating the manufacturability and testability issues that often increase the potential for unidentified manufacturing defects. Once the design has been finalized, adding a design spin simply to address these issues can be cost or time prohibitive. The best solution is to ensure that the design team and manufacturing teams interact as early as possible as opposed to operating in silos. This can be particularly challenging when the design efforts and production are outsourced, if the teams are not accustomed to working together.

In the electronics manufacturing services (EMS) industry, product development support can run from use of automated design for manufacturability/testability (DFM/DFT) software analysis tools to actual engineering support, so it important to determine the breadth of capabilities when selecting an EMS provider. The benefit of using the engineering resources of an EMS company is that those engineers typically look at likely commercialization challenges as well as actual design challenges. Quality track record of selected components, packaging recommendations related to intended use, DFM/DFT recommendations and potential obsolescence issues are all part of the analysis.

In SigmaTron International's business model, DFM/DFT analysis is typically offered as part of its New Product Introduction (NPI) process. More extensive product development engineering support is also available. The goal is to use a flexible set of resources to fill any gaps the customer has in its product development support team. This enables customers to work within a cost structure that makes sense for their project rather than be forced to utilize resources their project does not require.

DFM analysis is performed using Valor software tools. The documentation review process also uses a Valor parts library (VPL) to verify the footprint of all components specified in the BOM against the land patterns used in the layout. This helps eliminate both the opportunity for defects caused by manufacturability issues plus eliminates the non-value added time that can be spent reprogramming machines or re-spinning the printed circuit board layout if component packaging specified in BOM doesn't match the land patterns used in the layout.

SigmaTron can also perform product lifecycle analysis (PLM) as part of its NPI process. Additionally, it has an experienced materials team that works closely with suppliers to identify potential availability and obsolescence issues as early as possible and recommend the most appropriate solution. The Company can also provide product redesign recommendations. This type of proactive approach facilitates a thorough evaluation of best options.

Stringent Process Control

All of SigmaTron's facilities focus on stringent process control. In facilities building mission critical and/or highly regulated products specialized tools may be utilized. For example, in SigmaTron's Tijuana facility, Advanced Product Quality Planning (APQP) Failure Mode and Effects Analysis (FMEA) is utilized to set up the most efficient, defect-free process. The Product Part Approval Process (PPAP) is utilized on automotive projects to validate the process and customer-specific validation processes are used for projects in other industries. Once production is ongoing, statistical process control (SPC) and other forms of quality data collection and monitoring are utilized to monitor processes and track defects.

SigmaTron's systems also play a role in helping to monitor product quality. A bar code is laser etched at the beginning of the process to ensure that each assembly can be easily tracked through all process steps. Quality and traceability data are collected real-time and includes yields and component lot data.

Inline solder paste inspection (SPI), automated optical inspection (AOI) and x-ray inspection are utilized within SigmaTron's facilities as part of its process control focus. Use of these tools is typically tailored to specific customer requirements.

Mistake Proofing

Even with world class defect prevention methodologies, defects can and do occur for a variety of reasons. Consequently, it is important to have a process in place to identify and implement rapid corrective action. In SigmaTron's model, a kaizen event is scheduled and tools such as 8D problem solving, Six Sigma's Define-Measure-Analyze-Improve-Control (DMAIC) and poka yoke are utilized to analyze and correct the root cause.

One benefit of the poka yoke process is its focus on simple rapid solutions. Poka yoke is Japanese for mistake proofing and it was introduced by Shigeo Shingo as part of the Toyota Production System (TPS). When applied, the resulting process improvement eliminates a specific defect. Its focus on simplicity is its strength, in that simple fixes are often the best solution for small variances in the manufacturing process. Simple fixes are also easy to rapidly implement and encourage production operator involvement in the pursuit of product perfection.

For example, when an automotive product printed circuit board assembly (PCBA) which included a flex cable was experiencing intermittent failures following in-circuit test (ICT), SigmaTron's Tijuana team scheduled a kaizen event to analyze the test process and determine the root cause of this potential failure mode. The team determined that in some cases, the flex cable could catch in gaps in the test fixture bed as it was being removed creating an undetected defect. The poka yoke solution was fixture redesign that placed ESD-safe plastic over the openings in the fixture bed that created the issue.

As a result, the defect opportunity was eliminated with no changes to the product design and minimal fixture modification cost.

The Test Equation

One of the challenges many companies face is balancing the cost of test with test coverage requirements. An additional challenge is ensuring that test fixtures are robust enough handle the rigors of volume production, since faulty test fixtures can have false failures. Test strategy is aligned with each customer's goals for optimum test coverage and anticipated volumes. The end solution is the result of a collaborative process.

Test strategy focuses on four main areas:

- Keep it simple
- Eliminate excess handling
- Standardize and automate where practical
- Minimize system-generated variation.

Keep it Simple

The more complex the programming language and development environment, the more time test can take. For example, in SigmaTron's Suzhou, China facility, the test programming environment is focused on delivering the test coverage customers require at the lowest possible cost. The goal is to load data in and read it out as quickly as possible.

The team's formula is: "keep it simple and focus on what is needed." Programming is done utilizing C# and Basic Language, using RS232, USB, GBIP, etc. to communicate to test instruments, read back the test data, analyze data, transmit the test result to the terminal and then store the test result in the network database. The test engineering team is able to design test programs from functional specifications or even create a simple functional test from a schematic alone.

Eliminate Excess Handling

In a high volume test environment, test load and unload time can add significantly to cost of test. Inefficient handling can also increase the potential for defect opportunities. For that reason, in higher volume programs, clamshell hold down fixtures or bed of nails fixtures are preferred over connector-based test, since plugging and unplugging can weaken the connector and exceed target test time.

In one case where the customer originally supplied a connector-based fixture, the test time was one minute and the handling time was six minutes. SigmaTron's Suzhou test engineering designed a clamshell hold down gate with a pogo pin to establish contact with the connector along with a probe plate that allowed the tester to be actuated from either top or bottom. They also modified the programming to make it more stable, as the test program was not measuring voltage at the right time. The end result was still a one-minute test, but handling time was reduced to 30 seconds.

Standardize and Automate Where Practical

Where possible standardized functional test platforms are utilized. SigmaTron's test engineering teams can design equipment that does everything from simple functional test to a program, test and pack station. Optimizing a standard test platform to perform the right mix of activities for customer requirements has three advantages. First, it minimizes defect opportunities that could occur in segregated programming or serialization by grouping them in a single test station. Second, it simplifies maintenance activities. Finally, it provides some level of redundancy should a tester require unscheduled maintenance.

In most SigmaTron facilities data collection at each test station is integrated with the Company's proprietary Tango shop floor control system. Each product carries a bar code with a serial number to facilitate this tracking. This is particularly important to customers requiring genuine first pass yield data and in many cases is also used as part of an enforced routing strategy.

Minimize System-Generated Variation

While most failures in test are driven by issues with the product; in high volume production, failures can also be driven by tester or software-driven issues. Testers that exhibit this type of system-generated variation increase the cost of test and increase the time require to troubleshoot the root cause of test failures.

In Suzhou, one driver of the facility's strong internal test development capability was the occurrence of difficult to replicate failures in customer-supplied test equipment. The test engineering team found that many customer-developed testers had design issues or simply weren't up to the rigors of volume production. The problem was that typically that good contact wasn't being made with the unit or the test program wasn't measuring the signal at the right points. This caused intermittent failures that could be hard to replicate. When there is a trend of units that fail a test, but pass the second time, that is often a clue there is an issue with the tester, rather than the unit under test. In those cases, fixtures or jigs are fabricated to improve the contact and see if that changes the trend. If it doesn't the issue is normally software-related.

For example, in a project where functional test was performed at the end of the line and the customer was performing system test at their factory, units that passed functional test were failing system test. The test engineering team worked with the customer's team to understand the detail of the failure enough to replicate the failure. The end result in this case, was that the signal in the system test wasn't stable and required design modifications. This was due to the fact that most test programs take a signal reading a couple of times during the test and average out the results. If the signal isn't measured at the right time it causes a failure. Reprogramming the tester to optimize the timing of signal measurement eliminated the problem.

Achieving superior quality in today's smaller, more complex electronic products, requires more than just a focus on "inspecting quality in". Instead, it requires a holistic approach to eliminating issues that otherwise create the opportunities for defects to occur. Combining this defect opportunity mitigation focus with a collaborative, tailored approach to resource allocation, strong systems, industry-standard core tools and an expert team helps ensure even the most rigorous quality goals are achieved.

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