

PRACTICAL ISSUES AND SOLUTIONS FOR HANDLING PLASTIC ENCAPSULATED MICROCIRCUITS (PEMs)

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ABSTRACT

This paper will describe some of the key issues that were experienced by the manufacturing team at Raytheon Integrated Defense Systems in Andover, MA during the implementation of a new program for PEMs handling. This project was initiated by a customer requirement to comply with the latest revision [1] of IPC/JEDEC J-STD-033.

The industry standard was found to be very challenging to implement on the production floor using traditional manual logs and procedures. The key issues were related to the complicated logistics associated with tracking and monitoring a wide variety of PEMs and their remaining floor life in various environments. The solution that was ultimately implemented at Raytheon Integrated Defense Systems relies on a software system that automates the tracking and monitoring of PEMs in full compliance with the guidelines of the industry standard (PEMs are also known as moisture-sensitive devices or MSDs). The project has evolved through a number of phases, including machine setup validation using “intelligent feeders” with a focus on systems integration and employee training to insure that everyone was supportive of the new program and was using the new system properly.

INTRODUCTION

Circuit cards are being assembled using moisture sensitive devices. MSDs are components that are encapsulated with a moisture permeable material (typically an epoxy material). Because the epoxy material is permeable, these devices are classified as moisture sensitive, which simply means that they absorb moisture after they are opened from their sealed packaging, and the amount of moisture absorbed increases with time. To avoid component damage or possible field failure caused by moisture expansion and cracking during the reflow soldering process, the moisture content in these components must be tracked and controlled. Typically that can be accomplished using a manual process. However, that is susceptible to human error. Raytheon determined that an automated tracking and control system was needed.

CHALLENGE

Before implementing an automated MSD control system, the assembly lines would stay idle for many hours each day while production operators were busy calculating the remaining floor life of all moisture-sensitive components. The process engineers were facing significant challenges to translate the industry standard requirements in simple

manual procedures that would have minimal impact on overall productivity. They were also spending a lot of time updating these procedures to keep up with the constant changes in the industry standards. The manufacturing team wanted to find a solution that would increase yields and accelerate production. The ideal system would provide real-time tracking, complete traceability and more importantly, total control over moisture sensitive devices [2]. The desired solution would reduce downtime and provide the records to demonstrate the quality of the finished products.

SYSTEM EVALUATION

Given the complexity and the critical nature of this issue, Raytheon wanted to procure the best possible system available on the market. After comparing the leading solution provider to alternative suppliers, Raytheon concluded that they possessed superior expertise and a clear focus on material control in the electronics manufacturing industry. They offered a patented solution for MSD Control that was fully compliant with the industry standard J-STD-033 which is what Raytheon customers demanded.

SOLUTION

Raytheon started to use the MSD Control System gradually to insure that production operators would adopt and support the system. They started by tracking the PEMs across the SMT production area, and eventually they integrated the Line Set-up Control application in their procedure to insure that operators could not forget to scan any PEMs in the system during product changeovers. Operators know exactly where all MSDs are located on the shop floor and their precise remaining floor life before they expire. The system forces operators to load each job and recipe into the system. It also provides them with easy to follow instructions about which part must be loaded or unloaded when the line is not validated. The system is completely error-proof which increased overall efficiency and reduced the number of parts that need to be baked. With the previous manual procedures, in any situation where the exact exposure time was not clearly established, it was necessary to err on the conservative side and bake the components. This never happens with the automated MSD Control system because it provides the complete history of exposure time for each individual tray and reel of components.

REDUCE DOWNTIME BY 83%

With the old manual procedures operators had to figure out the remaining floor life of all MSDs on both sides of the

PCBs for double-side reflow assemblies. Before using the automated MSD Control system, it took anywhere from one to two hours to perform a line set-up. Today, it only takes 10 to 20 minutes to get a bullet-proof set-up. As a result Raytheon eliminated the waste of time to manually track their MSDs, and significantly increased their productivity.

REDUCE BAKING CYCLES BY 94%

Because the implemented system tracks all MSD exposure and has the industry standard J-STD-033 rules embedded in the software, unnecessary dry baking is reduced or eliminated*. It also understands all of the rules regarding “short duration exposure” which allows the part to reset if it is properly stored in safe dry storage. Companies that don’t control their MSDs efficiently typically use excessive baking cycles to try to reduce the risk of future problems. Since we have so much control and confidence in the tracking system, we know exactly which parts need a baking cycle.

*The industry standard does not allow pausing the clock for MSDs with moisture-sensitivity level 4 and 5 even when in dry storage; therefore we still have to bake components associated with that condition.

STEP-BY-STEP SYSTEM EVOLUTION

The MSD Control system was implemented in multiple phases to facilitate implementation and adoption by operators. The system was originally installed as a completely standalone application. After some time it was integrated with the existing material management application to automatically share material movement transactions and birthing of new components.

NEW INTELLIGENT FEEDERS

In 2008 Raytheon proceeded to upgrade their existing SMT lines with a series of new placement machines. Raytheon evaluated 6 leading equipment vendors. One of the basic requirements for the new machines was to include intelligent feeders for setup validation because the prior equipment was using a barcode-based system which was not completely closed-loop and error-proof.

In the end many factors played roles in the final decision to select the SMT placement machines from a specific vendor. A significant weight was placed on the fact that this machine was offering a superior RFID intelligent feeder system [3] that was actually developed by the same company as the MSD Control system under an OEM re-selling agreement. As a result, the existing MSD Control application could be seamlessly integrated with the intelligent feeder system with a common user interface and a common database.

INTELLIGENT FEEDER STORAGE CARTS

Unlike other types of intelligent feeders that are limited to the placement machine, the RFID intelligent feeder system is based on a global platform for material tracking and it can be expanded to other types of materials across the whole factory. As an example Raytheon recently added intelligent

feeder storage carts in the stockroom. These are normal feeder carts equipped with RFID antennas similar to the ones mounted on the machine feeder trolleys. Once this new hardware is connected to the material control system it enables real-time inventory of all feeders and the associated components online and offline.

INTEGRATION WITH MACHINE SOFTWARE

Another benefit of the intelligent feeder system relative to the prior material management software is the direct integration between the central material tracking database and the actual machine software. Critical real-time production data can be shared between both systems yielding numerous benefits. For example the machine will stop production if an MSD component is expired. The machine also provides accurate component consumption which enables low-level warnings and other levels of proactive material management. In the future Raytheon will also benefit from this higher level of integration when they start collecting component-level traceability data, down to the individual reference designator location on each circuit board.

OFFLINE SETUP VALIDATION AND KITTING CONTROL

The intelligent feeder system also features an offline setup validation software module. When operators in our off-line kitting area create kits for production, they setup reels on feeders and feeders on mobile trolleys in a separate stockroom. At this stage the component information has to be associated to the intelligent feeder so the offline setup software had to be used for that process in replacement of the prior kitting management software. This created additional requirements for software integration with the global inventory tracking system. Following this implementation the stockroom employees benefited from an improved graphical user interface. This allowed them to see more quickly and precisely the status of each trolley for each job during setup.

FUTURE PLANS

Over the years, one of the most important features of the material control system has been the modular and scalable architecture. This has made it easy for Raytheon to break down a large project into smaller phases that are easier to manage and implement. More or less every year Raytheon has been expanding the original system, to gain more and more benefits associated with material control in various parts of the factory.

CONCLUSION

Since 2003 Raytheon Andover has been an industry leader in automating PEMs Control on the factory floor. As soon as the first phase of the MSD Control system was installed they realized significant savings in terms of productivity by reducing the time required to set up production lines and by reducing the number of unnecessary bake cycles. The Material Control system provides real-time visibility and control of all components in the factory floor. It insures that

all parts are at the right place at the right time, are handled according to industry standards, and it provides the historical records to prove it.

Over the years the system has been expanded in multiple phases to cover more and more aspects of material control, on both our production floor and in our kiting area. By adding new functionality in small increments Raytheon Circuit Card Assembly (CCA) engineering has enhanced our mission critical process while reducing the risk and effort associated with new systems implementation and this insures a short payback with minimal disruption to ongoing operations.

REFERENCES

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