Information and Electronic Warfare Systems

APEX Conference 2003

MSD Control in a High Reliability Production Environment

BAE SYSTEMS Information and Electronic Systems Integration Inc.
Information and Electronic Warfare Systems
65 Spit Brook Rd
Nashua, NH 03061

By:

J. Cambrils, M. Hickey, and D. Tibbets

The Information and Electronic Warfare Systems business of BAE SYSTEMS Information and Electronic Systems Integration, Inc. ("BAE SYSTEMS IEWS"), a subsidiary of BAE SYSTEMS North America, is involved in the manufacture of a wide range of military products for the government. One of the manufacturing focus factories within the IEWS group deals strictly with the production of circuit card assemblies ("CCA"). The CCA focus factory performs the hardware build for programs internal to the company and supports a contract manufacturing organization that seeks work from outside the company as well. To that end, the CCA Focus factory is best characterized as a low volume, high mix manufacturing environment. Given the type of business in which the CCA focus factory is engaged, areas of improvement are continually being identified. One such area pertains to the management of moisture sensitive devices ("MSD"). With the help of Cogiscan Inc. of Quebec, Canada, a solution to this industry wide problem of effectively managing MSDs has been addressed.

As the packaging of integrated circuits (IC) increasingly shifts from ceramic to plastic, the concerns relating to moisture sensitivity and the appropriate precautions has grown significantly. The JEDEC council of Arlington, VA and IPC of Northbrooke, IL released a joint publication, J-STD-033, in 1999. Th industry standard provides guidelines for the handling, packaging, and storage of moisture sensitive devices. Since the release of J-STD-033, companies have worked diligently to implement procedures for monitoring MSDs that comply with the standard. The majority of these procedures have relied heavily on manual tracking of the devices, which increases cost and is susceptible to human error.

In an attempt to best describe the CCA focus factory's current system as well as the associated benefits, which BAE SYSTEMS IEWS has realized therefrom, it is important to convey the system that previously existed. Prior to the implementation of the Cogiscan IC-Scan system, manual tracking of moisture sensitive devices was the only method employed. This method required that the exposure and bake time as well as the bake history would need to be carefully logged by an operator. Clearly, many potential problems existed with this approach.

First and foremost, the manual processes are inherently prone to human error. Any kind of incorrect information associated with a particular MSD can lead an operator to take measures that may adversely affect the MSD in question. The same is true when historical information about a component is simply unknown. One example of this can be seen in instances where the actual exposure of a particular MSD is unknown. As a precautionary measure in the previous system, an operator would be required to subject the parts to an additional bake. While this may seem like a safe solution, repeated bake cycles could potentially compromise the integrity of the parts by degrading the solder joint reliability and/or the lead solderability.[1]

An insufficient bake cycle or the absence of a bake cycle resulting from incorrect or unknown information can similarly lead to very potentially negative consequences. As parts are exposed to ambient moisture, a moisture gradient is formed as the moisture penetrates the component surface and approaches the die interface of the component. In order for the total gradient to decrease during the baking process, the gradient must first reach a maximum at the die interface. Consequently, for the initial portion of the bake process, the gradient at the die surface will actually increase until a maximum is reached, at which point the overall moisture gradient begins to decrease. For this reason, insufficient bake cycles often increase the moisture at the die interface, and in doing so, increase risks that may result due to moisture absorption.

Depending on the moisture sensitivity level of the component, ambient exposure time is limited. The consequences of overexposure can be seen after the SMT mass reflow of the parts. At mass reflow, the parts are exposed to high temperatures which cause the trapped moisture to turn to steam. If the pressure of the steam is greater than the strength of the plastic package, cracking can occur in the packaging, commonly refered to as the "popcorn effect." Even if cracks in the packaging do not occur, a delamination between the die and the packaging may.[2] These defects are difficult to detect, and if defects are detected, the root cause may not always be accurately determined. The most severe consequences are latent defects, those that occur after the parts have reached the field. It is for these reasons that the accurate tracking and appropriate handling of moisture sensitive devices is so critical in modern circuit card manufacturing.

While implementation of the automated tracking system results in an increase in product quality as shown, it is important to recognize the impact it has on cycle time, and consequently, production costs. As discussed, components with insufficient exposure and bake history are baked as a safety measure. This may add days to the assembly process. By accurately tracking the component history with the automated system, these unnecessary bake cycles are avoided. Additionally, the manual system requires an operator to manually log the component exposure and baking history at each stage of production prior to mass reflow. This process adds time, and therefore cost to the process. The Cogiscan system utilizes radio frequency identification technology (RFID). RF "tags" travel with the components as they are moved through the production process. The tags can hold more information than a barcode, and can withstand the heat of the ovens used for the baking process. The information from the RF tags is read through an antenna at each Local Control Unit ("LCU"). An operator needs only to log the RF tags in and out of the Cogiscan systems at each operation. All historical information is recorded automatically through the RF tags, reducing the cycle times at each operation. The Cogiscan system then gives instructions for the storage of the parts, and gives warnings when a part is nearing its critical exposure limit or when parts in baking need to be removed.

At this time, three Cogiscan LCUs have been installed at the BAE SYSTEMS IEWS facility in Nashua, NH. The units are strategically placed in the stock room, in the forming area and at the SMT assembly line. The location of the units allows the tracking of MSDs from the time the seal is broken on the original supplier's packaging until the mass reflow operation is complete. Operators throughout the CCA focus factory have been trained on the use of the LCUs as well as on the latest standards for handling all MSDs. Throughout the implementation, operator feedback has confirmed the ease of use of the new system.

The implementation of the new system has brought about many positive changes for the CCA focus factory. The CCA focus factory has revised its dry packaging requirements, dry bag sealing techniques, and its process for receiving MSDs in to the internal planning system. Additionally, in an effort to standardize MSD handling throughout the supply chain, communication with suppliers about the latest industry standards for packaging and handling will ensure compliance from the time the components enter the factory.

The CCA focus factory has realized benefits of the Cogiscan system outside of MSD tracking. The system provides a platform for the future management of other activities such as the component traceability recording function, which is required on certain critical programs in which BAE SYSTEMS IEWS is involved. In the future, all SMT components may be tracked by the Cogican system. The factory is in the process of upgrading to a networked version of the Cogiscan software, which will allow the factory greater visibility across the entire factory floor as to the status and location of any MSD or surface mount component.

In summation, the benefits of the system are evident. Beyond the reduction in cost and labor associated with managing these components manually, the system will allow BAE SYSTEMS IEWS to greatly reduce the costs incurred from damaged parts while improving quality and cycle time. This state-of-the-art solution to the management of MSDs will not only enhance the capability of the CCA focus factory at BAE SYSTEMS IEWS but places BAE SYSTEMS in an excellent position to attract more new business.

References

1. Lemontagne, J., Rouleau, J., Monette, F., "Should You Automate Control of Moisture-Sensitive Devices?," *Circuits Assembly Magazine*, May 2002.

2. Zarrow, Phil, "MSD: What You Don't Know May Be Killing You," *Circuits Assembly Magazine, On the Forefront*, June 2002.

Additional References

J-STD- 033A, "Handling, Packaging, Shipping, and Use of Moisture/Reflow Sensitive Surface Mount Devices," July 2002

Monette, F., Corriveau, A., And Dubois, V., "Tracking Moisture-Sensitive Devices for Improved Process Control," *EP&P Magazine*, February 2002.

Shook, R. and J.P. Goodelle, "Handling of Highly-Moisture Sensitive Components – Analysis of Low-Humidity Containment and Baking Schedules," IEEE ECTC, Lucent Technologies, 1999.