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For News, Capability Updates and Success Stories at SigmaTron International

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About SigmaTron International

SigmaTron International (NASDAQ:SGMA) is a full service EMS provider with a network of manufacturing facilities in the United States, Mexico, China and Vietnam.

We focus on companies who want highly customized service plus a scalable global manufacturing footprint.

We serve a diversified set of markets which include: industrial, consumer and medical/life sciences customers. Our quality certifications include ISO 9001:2015, ISO 13485:2016, IATF 16949:2016 and AS9100D. We are also International Traffic in Arms Regulations (ITAR) registered.

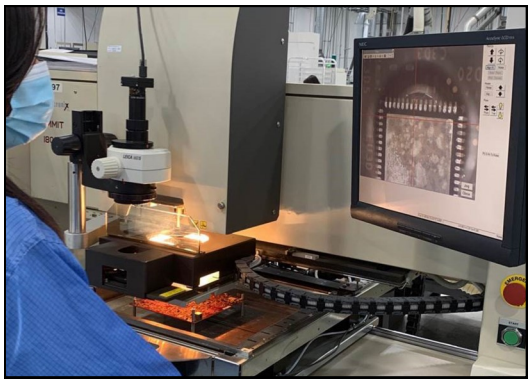
Union City Team's Expertise Gives BGAs New Life

Material constraints are one of the biggest issues facing electronics industry OEMs. The engineering team at SigmaTron's Union City (UC), CA facility is helping address that challenge with its BGA rework/reballing services.

"BGA components represent a significant cost to many customers, so we've had a rework/reballing capability in the facility since 1996, to address situations where high dollar, salvageable components could be reused," said Jay Vyas, Director Engineering.

With lengthening component lead-times, the service has gained in popularity as companies utilize this service to keep products with component availability issues in stock.

"The decision point for many customers is pretty simple. Wait 90 weeks for a new component or have a reballed unit that meets the requirements in 6-8 weeks?" said Khagesh Gupta, Engineering Program Manager.



SigmaTron's BGA Rework/Reballing services help reduce costs and improve component availability.

The team provides multiple service options:

- **Interposer** – where a part such as a QFN is

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Tijuana Facility Implementing Industry 4.0 Strategy

SigmaTron's facility in Tijuana, Mexico is enhancing its automated inspection capability with the addition of inline 3D solder paste inspection (SPI) and 3D automated optical inspection (AOI) stations incorporating Industry 4.0 capabilities to its SMT lines. Industry 4.0 automated inspection technology opens the door to enhanced levels of process control by creating a closed loop system where inspection stations automatically adjust process parameters on the line based on the trends data they receive.

In phase one, the AOI stations have been added following reflow. A planned phase two of this implementation will include adding 3D AOI to secondary assembly operations post-SMT, plus correlating AOI trending with final test data to fine-tune AOI acceptance/rejection parameters.

"People with no manufacturing experience often think implementing Industry 4.0 just requires installing intelligent equipment with machine-to-machine communications capability. In reality, it requires a strong team, development of an accurate program validation database and a methodology for utilizing trends tracking in continuous improvement activities. In addition to the programming done as part of implementation, the

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Industry 4.0

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machines continue to learn as they analyze trends," said Filemon Sagrero, the Tijuana facility's Continuous Improvement Engineer and a Six Sigma Black Belt.

A 3D solder paste inspection (SPI) unit is installed behind each SMT line's screen printer.

The inspection stations communicate with the screen printer and make adjustments to paste deposition based on the defects they identify, creating a closed loop system. They also track trends data enabling the team to pareto top five defects, and where indicated, implement continuous improvement initiatives beyond process adjustments. The systems communicate to a database accessible to technical personnel via remote computers. Analysis of the trending has already driven changes to stencil maintenance frequency and greater focus on monitoring pick & place machine placement variation.

"We are currently averaging 50ppm defect rates in first pass yield across our SMT lines. Our goal in increasing automated inspection is to drop that to zero defects. That may be challenging as long as material availability constraints are in place, because in some programs, material-related issues that are unassociated with process represent a third of our ppm rates," added Filemon.

A planned phase two of this implementation will include adding 3D AOI to secondary assembly operations post-SMT, plus correlating AOI trending with final test data to fine-tune AOI acceptance/ rejection parameters.

In setting up the systems, Filemon and two mechatronic technicians performed Gage R&R (GR&R) studies for repeatability and reproducibility using the Automotive Industry Action Group's acceptability definitions. CP and Cpk ratios were also calculated to measure the process capability against the Voice of the Customer (VOC) standards and requirements. The studies and calculations showed the specification limits for all 3D AOI machines were in acceptable GR&R condition and very good CP/Cpk condition. The program validation is used for machine verification every six months. Once control limits were established, programming parameters are adjusted for each printed circuit board assembly (PCBA) to assess acceptability based on the IPC-A-610 standard and customer documentation requirements.

"We are currently focusing on two improvement tracks. The first is driving yield improvements based on the information the trends analysis provides. For example, we recently found that a root cause of some defects was a fixture that had warped and was no longer seating correctly. So we replaced the fixture and will now check fixture condition more frequently. The second track is focused on improving our inspection process by fine-tuning operator accuracy in overriding AOI decisions, optimizing our traceability marking and improving the user-friendliness of the way data is displayed," said Filemon.

This Industry 4.0 strategy is creating a system that auto-corrects solder deposition-related issues in real time, plus provides the trends data to enable the team to monitor tooling, equipment accuracy and customer design issues that may be causing defect opportunities. The team's two-track approach to continuous improvement is eliminating defect opportunities while enhancing the system's accuracy over time.

A 3D automated optical inspection unit has been installed following reflow on each SMT line.

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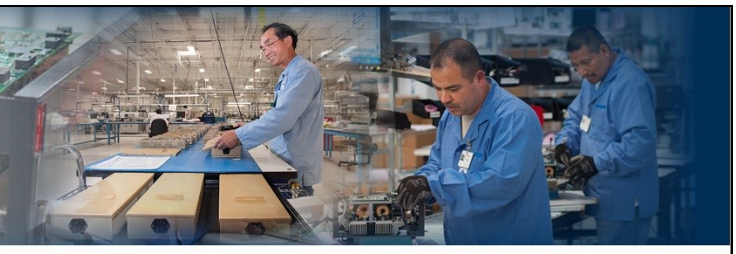

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BGA Rework

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converted to a BGA and either installed on a customer's printed circuit board assembly (PCBA) or shipped to a vendor as a component

- **Rework** – where working high dollar parts such as FPGAs are removed from scrap PCBAs for reuse
- **PCBA upgrade** – where a BGA is replaced on an older revision PCBA, enabling the PCBA's functionality to be upgraded with minimal need for new components.

Each project is unique. The UC team reviews the customer's requirements and develops appropriate tooling and processes which meet those requirements. There are four stations for BGA removal and reballing. Reballed components are placed utilizing SigmaTron's regular SMT lines. The facility's 5D x-ray laminography equipment helps validate the process parameters and inspect finished units for acceptable solder joint structural integrity.

"Each project has its own specific requirements and constraints. Our goal is to design a process and tooling that minimizes the amount of thermal cycling necessary to get the job done. While we use industry-standards in developing each process and inspect to IPC-A-610 or J-Std-0001, those represent an aerial view. Process development needs to consider the unique constraints associated with each project," said Jay.

Demand for the service this year has been high with multiple projects involving several thousand components. The service is giving customers high quality options for ensuring product availability, increasing functionality without complete product redesign and minimizing the loss of high dollar components when PCBAs must be scrapped.