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CASE STUDY | DEFENSE MARKET

Leveraging Vapor Phase Reflow to Improve Yields

PROBLEM

A Dense Board Experiencing Poor Yields Driving System Failures

Microboard's customer with a Department of Defense program was experiencing excessive fallout on a complex board that was part of critical equipment intended to save soldiers' lives on the battlefield. This printed circuit board assembly (PCBA) was being manufactured by a competitor to Microboard. Part of a five-board suite of PCBAs in an upper level assembly, the failures on this complex board were driving system level fallout of 60-70% after burn-in. Our customer was performing costly system level troubleshooting and rework, while delivering unacceptable overall program performance. Microboard was successfully delivering the other four PCBAs in the upper level assembly with excellent yields, so the customer asked Microboard to evaluate the situation.

Description of the PCBA

The problem PCBA was a dense 28-layer, .060-inch-thick, double-sided ENIG board with over 20 ounces of copper. The assembly featured over 2500 total component placements, including an FPGA in a large 1930 ball BGA, several other BGAs, over 40 QFNs, DFNs, and other fine-featured components. Our customer was debugging the failures down to the component level, but had been unable to isloate consistent root cause. The Microboard team was challenged to figure out why this board exhibited such a high failure rate featuring multiple random failures across any given assembly.

Description of the Symptoms

Leveraging destructive physical analysis tests supplied by the customer on the failed boards, Microboard collaborated with the customer and the PCB house on root cause analysis wherein several problems were revealed, but chief among them: poor wetting.

The customer was experiencing random failures across the PCBA. Microboard observed that the customer was removing and replacing suspect components using additional flux and achieving good test results. Based on Microboard's broad experience, we determined that a possible root cause could be related to excessive heat that was burning up the flux during the oven reflow process. These initial findings led Microboard to determine that the entire reflow process needed to be examined and more extensive experiments conducted in order to further investigate how to improve the yield.

INVESTIGATION

The Microboard Team Conducted Experiments Based on Failure Analysis Results

Microboard's engineering team designed an experiment to review the current reflow process utilizing a down revision assembly from the customer. Microboard proceeded to drill out the board across the top and bottom of the assembly and install six thermocouples. Thermocouples were installed into the large FPGA and various other locations on the board. Upon validating the existing reflow process in the convection oven, Microboard found that there was a 17-degree temperature delta from the center of the FPGA compared to the rest of the board.

It appeared that in order to achieve optimum wetting and voiding criteria on the FPGA itself, an excessive heat profile was employed that was burning off too much flux across the rest of the board. This condition served to help explain the randomness of component failures due to solder joint integrity that was being exhibited. Microboard's Engineering team reviewed all the findings and decided to evaluate the use of vapor phase for reflowing the assembly.

SOLUTION

Microboard's Expertise In Vapor Phase Played A Key Role

Microboard reached out to our vapor phase supplier as well as other partners in the industry with vapor phase expertise. Microboard's engineers visited several sites to perform process experiments and to develop reflow validation. Based on successful results using vapor phase reflow, Microboard proceeded to invest in a state-of-the-art vapor phase machine. Within three weeks of delivery, Microboard was in a position to execute control builds, develop a new reflow profile using vapor phase technology, and demonstrate preliminary results.

Advanced Capabilties of the Vapor Phase Machine

The Vacuum Inline Reflow Vapor Phase Soldering Oven offered unparalleled soldering quality, achieving a void reduction from an initial 40% to less than 5% on critical components such as QFNs and BGAs. This level of performance was pivotal in meeting the reliability standards demanded by our customer's defense applications.

The patented vacuum chamber ensured superior solder joint integrity by minimizing voids and maintaining consistent thermal performance. The Intelligent Profiling System allowed Microboard engineers to finely control temperature profiles, reducing temperature deltas across assemblies to just 1-2 degrees, compared to the 17-degree variance observed during the initial convection oven process. This precision mitigated risks such as over-heating and warpage, critical for maintaining component reliability across the dense 28-layer PCBA.

Designed for versatility, the Vapor Phase machine seamlessly managed the high-mix requirements of Microboard's production line. Its capacity to handle dense, multi-layer boards with over 2500 components—including BGAs with 1930 solder balls—enabled consistent results across assemblies regardless of complexity. Additionally, operating within an inert, oxygen-free atmosphere eliminated the need for nitrogen, and contributed to the cost reduction of approximately 20% compared to traditional reflow methods.

Automation features, such as automatic lane adjustments and integrated thermal profiling, supported a first-pass yield improvement to 96%, significantly reducing rework and scrap rates. These capabilities, combined with a 15% lower energy consumption compared to convection ovens, contributed to a more efficient and sustainable manufacturing process.

By incorporating this innovative solution, Microboard delivered a repeatable process that ensured consistent product quality and reliability, solidifying its position as a leader in high-quality manufacturing for mission-critical applications.

OUTCOME

Program Success

The customer was thrilled with Microboard's results. Their Program Manager said, "We engaged Microboard who recommended we change to one of their trusted fab shops and make several other changes, including moving to the vapor phase process instead of standard convection. These changes have increased yields at the circuit card level, but more importantly have enabled us to greatly reduce fallout on our fully assembled unit through final production, which includes Environmental Stress Screening (ESS). Microboard was a key partner in solving our yield problems and helped us achieve program success."

WE FOCUS ON LIFE SAVING AND LIFE CHANGING PRODUCTS.

Capabilities

- PCBA, System Integration, HLA, and Test
- Best-in-Class SMT, Inspection, and Test Equipment
- Customized Process Solutions
- NPI to Production Volumes
- High Mix, High Part Count, Mid to High Complexity Assemblies
- Small to Large Form Factor Flex and Rigid-Flex Assembly
- EW, SIGINT, & Jamming Applications

Quality, Manufacturability, and Compliance

- ISO13485, ISO9001, ISO14001, AS9100D
- 21 CFR Part 820 Compliant QMS
- IPC-A-610, J-STD-001, IPC-7711-7721
- DFM, DFA, and DFT Capabilities
- Integrated Production Quality Data Capture
- Full Component and Date Code Traceability
- Manufacturing Execution Software Workflow Traceability
- Established Continuous Improvement Processes

Supply Chain Management

- **BOM Management and Life Cycle Services**
  - Design for Supply Chain Services
  - Part Number Validation
  - End of Life Status
  - RoHS/REACH Classifications
  - PCN Notifications
  - Obsolescence Material Management
- **Customer-Specific Supply Chain Solutions**
  - Turnkey and Consignment
  - Build to Forecast
  - Pull Based Models
  - Direct Fulfillment
  - Warranty Services
- **Integrated ERP, Supply Chain, and Manufacturing Execution Software**

System Test

- Secure, Remote Access Data & Reporting
- Broad Test Capabilities Including RF
- ESS Chambers
- In Process and Final Test

Microboard is an electronics manufacturing services provider delivering circuit card assembly, system integration, and test services.

Microboard has a proven track record of solving critical electronics manufacturing challenges with leading-edge technologies producing repeatable results.

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203.881.4300 • WWW.MICROBOARD.COM
MICROBOARD PROCESSING, INC. • 36 COGWHEEL LANE • SEYMOUR, CT 06483 • USA

Website

https://microboard.com/

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brilliant together

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