

SYSTEMATIC TROUBLESHOOTING IN ELECTRONICS ASSEMBLY: A Case Study in Solder Balling and Process Optimization

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Manufacturing defects in surface mount technology (SMT) assembly can be persistent and difficult to diagnose without a structured troubleshooting approach. When a contract assembler encountered recurring solder balling on a single capacitor, initial efforts to correct the issue through reflow profile adjustments proved ineffective. This case study demonstrates how a systematic troubleshooting framework can be applied to identify and resolve assembly defects.

Identifying the Issue: Initial Observations

Solder balling can result from a range of process variables, including stencil printing errors, placement inconsistencies, reflow conditions, and contamination. In this case, the defect was limited to a specific component, appearing inconsistently but repeatedly. Additional issues, including occasional blowholes, further complicated the diagnosis.

The troubleshooting process began with standard diagnostic questions:

- Was the solder paste fresh and properly handled?
- Did defects consistently occur on the same component and location?
- Were boards misprinted, cleaned, or rebaked before use?
- Did adjusting the reflow profile impact defect occurrence?

Despite verifying all standard process parameters, the solder balling issue persisted, prompting further investigation.

A Systematic Troubleshooting Approach

Step 1: Evaluating Material and Environmental Factors

Process engineers confirmed that the solder paste was within its shelf life and properly acclimated to room temperature before use. Boards and components were

evaluated for moisture absorption, but baking trials showed no improvement. Environmental conditions were within acceptable humidity and temperature ranges.

Step 2: Analyzing the Printing and Placement Process

The team examined stencil printing quality and ensured that no misprinted boards were being reworked improperly. Pick-and-place accuracy was within specification, and placement pressure settings were verified. However, an unexpected observation emerged: the problematic capacitor exhibited “billboarding,” a defect where the component stood on its side rather than lying flat (**FIGURE 1**).

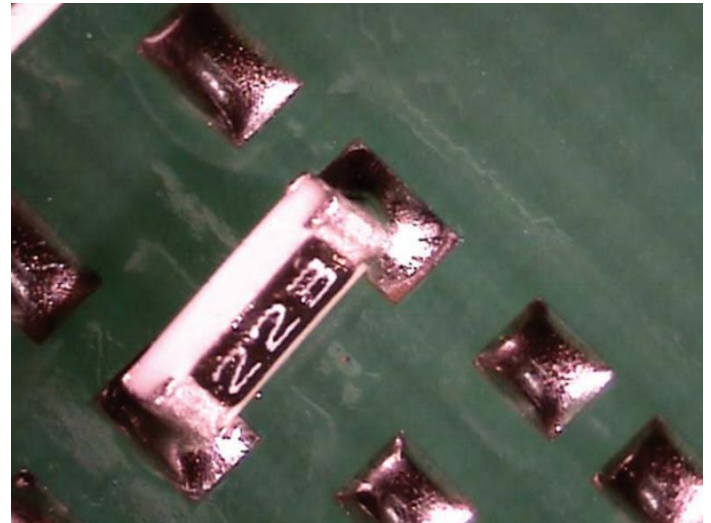


FIGURE 1. Component billboarding, where the part stands on its side.

Step 3: Examining the Reflow Process

A reflow profile was optimized and approved by QA, but the defect persisted. Given that billboarding is typically a placement-related issue rather than a reflow defect, the team redirected their focus to handling and secondary processes.

Step 4: Investigating Secondary and Manual Handling Effects

An inspector revealed that the billboarding was intentional—part of the customer’s specification. Operators were manually rotating the component using tweezers before reflow. This step had not been initially documented as part of the standard process. Further investigation revealed that stray solder paste was being transferred onto the component by dirty tweezers, leading to solder balling during reflow.

Root Cause Identification and Resolution

By isolating manual handling as the contributing factor, the solution was straightforward: operators were given clean tweezers, and best practices for handling components were reinforced. A five-board sample run confirmed that the defect was eliminated.

Key Takeaways and Lessons Learned

- **Structured troubleshooting prevents misdiagnosis:** Rather than assuming the issue stemmed from reflow conditions, a step-by-step approach helped identify an overlooked variable.
- **Unexpected process variations matter:** Even minor undocumented handling steps can introduce defects.
- **Cleanliness is critical:** Something as simple as tool contamination can lead to persistent defects.

Conclusion

This case highlights the importance of a methodical troubleshooting approach in electronics assembly. By systematically eliminating variables, engineers can pinpoint and correct defects efficiently. The key to success lies in thorough process evaluation, attention to detail, and an open-minded approach to identifying root causes.