Agilent "Shotgunning", a Bad Fit for Lead-Free Test

White Paper

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Introduction

Among all test and inspection techniques, functional test has the lowest diagnostic resolution, which has given rise to a common repair technique known as shotgunning.

In shotgunning, a repair technician suspects that a particular component is faulty, replaces it, then discovers that the problem has not been solved. At that point another suspect component is replaced, followed by another and another. This process continues until the board is repaired, or it is damaged beyond repair, or a preset number of repair attempts is reached, or the technician runs out of ideas and sends the failing board to the scrap pile.

Shotgunning is expected to have a more negative impact on lead-free processes. The higher reflow temperatures of lead-free solder and the additional stress on components and PCBAs during repair will likely reduce the number of acceptable repair attempts for boards using lead-free alloys versus traditional tin-lead solder. In lead-free, the use of shotgunning should be reduced as much as possible. Rather, the objective should be to minimize number of defects escaping to functional test.

That will not occur naturally with the move to lead-free. Quite the contrary, defect levels with lead-free are likely to increase, and the higher reflow temperatures are likely to increase internal component defects, which will result in more defects, higher scrap costs, and higher warranty costs.

When moving to lead-free test, the strategy for catching all possible manufacturing defects prior to functional test will involve increased test and inspection coverage upstream. This is especially important during the transition to lead-free test when defect levels are most likely to increase. Since fewer repair attempts will be available, methods to minimize shotgunning using software-based intelligent diagnostic solutions should also be considered.

In researching defect levels and test effectiveness of the normal tin-lead process, Agilent engineers have noted many defects escaping to functional test. Most of these defects could have been detected and corrected earlier with a more rigorous test and inspection strategy prior to functional test, and also a more rigorous repair implementation around AOI and AXI.

The optimal test strategy will be based on economic trade-off. The added cost of additional upstream testing should be compared to any savings realized in lower scrap and warranty costs if fewer defects escape to functional test and, ultimately, to the end customer.

Summary

Past editions of PCB Pulse have covered the impact of lead-free solder on the full array of test and inspection methods, including solder paste inspection (SPI), automatic optical inspection (AOI) both pre-reflow as well as post-reflow, automatic X-ray inspection (AXI), and in-circuit test (ICT). With this final article in the series, a variety of conclusions can be reached regarding the significant impact of lead-free methods on electronics manufacturing test.

Lead-free PCBAs will affect all manufacturers, mandated or exempt. The transition to lead-free is a major process change and an increase in defect levels is likely for many board types. It will be more important than ever to select optimal test strategies. An optimal test strategy should include both defect prevention as well as defect containment techniques.

Defect prevention should be focused on pre-reflow using solder paste inspection and pre-reflow AOI. The objective with defect prevention is to identify and eliminate systematic defects and their root causes. Systematic defects are expected to increase significantly with lead-free test.

Even with very good defect prevention strategies in place, random defects will still occur, so good defect containment strategies are needed. Higher defect levels caused by the transition to lead-free will also increase the need for an inspection and test strategy with high defect coverage. In many cases the optimal defect containment strategy for PCBAs will include AOI post-reflow, AXI, ICT and functional test.

The switch to lead-free solder is a significant process change, especially from a test and inspection point of view. Increased defect levels will result in a higher workload and the possibility of increased engineering hours and costs for this part of the manufacturing process. The changing defect spectrum will present additional challenges, and process variations might be extreme. Some board types may see very few challenges, others – especially higher complexity boards – can expect significant challenges in the form of higher defect levels and a changing defect spectrum. In light of these significant and unavoidable challenges for test and inspection, the best recommendation is to plan for the worst and hope for the best.

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