The High Cost of Wave Solder Defects

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The problem is not only with "poor quality" wave soldering, but also with wave solder results that are generally considered "satisfactory" and even "excellent."

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Cost alone - cost of inspection, cost of touch up and the cost of a company's reputation for quality and reliability - are forcing every organization to review its wave solder methods. The cost of reducing wave solder defects is much lower than any other method of improving PCB assembly results and the most direct approach to measurably reducing operating budgets.

When wave soldering replaced hand soldering it produced an enormous improvement in productivity. The fact that the machines and materials were not perfect did not outweigh the spectacular reduction in labor expenditure. Thus was born the use of personnel for inspection and rework. Early on, small boards with simple circuitry were the order of the day, making inspection and rework quite feasible.

Machines improved, better solder and fluxes were developed, devices for thermal control were introduced, and even some broad mechanical measurements of the solder wave, such as those from a glass plate, were implemented. Still, the solder joint inspector and touch up operator continued as significant and inevitable parts of operation.

However, with the increasing complexity of PCBs, they have come to be used not as backup for deficiencies in materials or machines, but to cover a lack of process control, inept accounting when the cost of the soldering process is calculated, poor training of operators and frequently a lack of understanding by management of the nature of the wave solder process.

More than any other cost element, the cost of wave solder defects is misunderstood. A common assumption is that wave soldering is a relatively cheap process and if there are problems it only means putting on another touch up operator. This, of course, is a total fallacy brought about by incorrect calculations of the true cost of faulty wave soldering.

Wave solder defects are the most expensive process deficiencies in the electronics packaging industry. When the cost of wave soldering is considered, the evaluation must stretch further than the actual wave soldering itself. The cost of assuring reliable PCBs - the cost of inspection, touch up and rework - and, of course, the ultimate expenditure of making right field failures, must be included in the final figure.

The Real Cost of Defects

When all factors are put together and the calculation correctly done, even a very tiny increase in yield will result in important cost savings. Wave solder defects are very, very expensive. Anything that will reduce the number of defects will show a cost savings.

The problem is not only with "poor quality" wave soldering, but also with wave solder results that are generally considered "satisfactory" and even "excellent."

Since a defect rate of 0.5% is considered good, the overall cost of "acceptable" wave soldering in the electronics industry is nothing short of astronomical. A major problem is that normal accounting procedures usually put field failures into a separate budget from that of the factory, and so the true costs are never articulated.

Your own data will provide compelling evidence that new steps are not only necessary but also extremely cost effective even when only a part of the overall figures are considered.

Improved Process = Fast Results

In company after company, the prevailing defect rate now considered "acceptable" causes annual costs many, many times more than the implementation of sound procedures. Even worse, it can result in a field failure rate that can only damage the reputation of the product and eventually confidence in the assembly plant.

This is so completely unacceptable in this era of contract manufacturing, so damaging to the competitive posture and profitability of the assembly facility, it is astonishing that the vast

majority have not already taken advantage of new, production-oriented tools which can near instantly address these issues.

Fortunately, throughout the world manufacturing managers and engineers are waking up to this absolute necessity - pulled by the vision of moving forward and upward and pushed by the fear of being left behind to forever battle with their current wave solder saga.

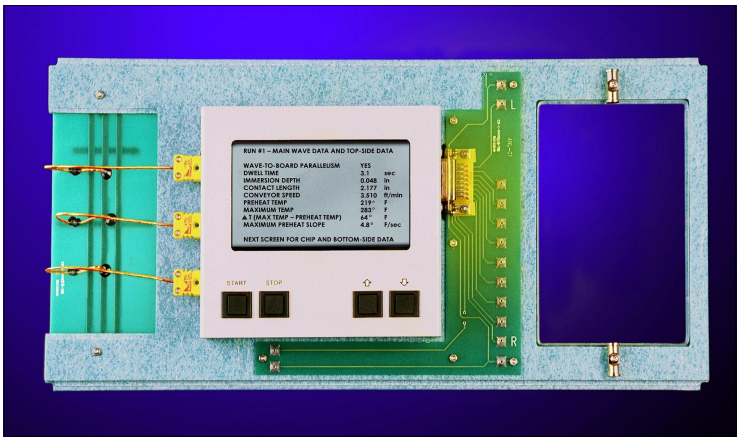

Figure 1: Use of the Wave Solder Optimizer is an opportunity for immediate improvement of wave solder quality. Direct measurement of the solder wave is key. Production costs and defects will decrease.

Inspection and Rework are Futile

Regarding inspection, at normal levels of solder joint inspection the inspector is at best sampling the quality of the joints on each board and, from the external appearance of the joints, assessing the chances that a satisfactory result has been achieved on all of them. This assessment of each and every joint is obviously ridiculous. The responsibility for high quality PCBs lies with the process, not with the inspector.

Likewise for rework. There is general agreement that rework of defects results in joints with shorter lives than those successfully made in the wave solder environment.

Conclusion

The real solution is to ensure that the wave solder process produces the highest portion of joints possible that are correctly soldered from the start. Direct data on board-wave interaction - parallelism, dwell time and immersion depth - are essential for the achievement of real repeatability and true optimization. Fortunately, this is now easily attainable.

Ralph W. Woodgate is the author of The Handbook of Machine Soldering, John Wiley & Sons, New York City, from which this article was adapted.

Parallelism Checklist

- ✓ Am I measuring parallelism every shift on each of my wave machines?
- ✓ Am I measuring my wave for parallelism across its full width?
- ✓ Do my boards see a dwell time on their left hand side that is within 0.2 seconds of the dwell time on their right hand side?
- ✓ Am I using finger marking stickers to determine which of my wave machines' fingers are loose, bent (even slightly), or crooked?
- ✓ Are my rails level to my solder pot?
- ✓ Is my solder pot level to the ground?
- ✓ Is my nozzle bent or crooked?
- ✓ Is my nozzle firmly connected to my solder housing so that my solder wave flows evenly?
- ✓ If I run my boards on pallets, do I have data showing my pallets are not warped?
- ✓ Is my backplate uneven, causing my wave to collapse more quickly on one side?

Sample Solder Wave Adjustments for Defects

Problem: Skipping on the left side of printed circuit board and/or bridging on the right side.
Solution: Address disparallelism.

Problem: Bridges.
Solution: Decrease dwell time. If problem persists, decrease immersion depth.

Problem: Insufficients.
Solution: Increase immersion depth. If problem persists, increase dwell time. If problem continues, verify fluxer performance.