

RAPID IMPLEMENTATION OF ADVANCES IN SOLDER PASTE

The Competitive SMT PROCESS: Reducing the Cycle Time for Solder Paste Qualification

BY ROBERT HERBER

Fierce competition in the electronics assembly market has increased demands on the SMT engineer. Engineers are forced to take advantage of new manufacturing technology almost as it becomes available. This requires a culture that allows for rapid implementation of new equipment, materials, and techniques that will result in the lower costs and better quality needed to maintain competitiveness. Given the cycle time reductions that have taken place in the development of new materials and equipment, SMT engineers have become ever more agile and nimble in their assessment of these new technologies.

Rapid Implementation: A Corporate Culture

The new product development cycle time for unique solder pastes is now down to nine to twelve months. Electronics companies that have instituted a culture of adapting early to Surface Mount Technology (SMT) improvements tend to be the same ones that are widening the gap between themselves and the competition. These early adapters have built-in techniques that implement new technology on the plant floor with the lowest risk and maximum results. Fundamentally, the evaluation of new technology candidates for potential installation on the plant floor requires consideration of what could be called the four R's of technology implementation: 1) Repeatable methodology, 2) Relevant experimentation versus the

The Four R's of Technology Implementation

Repeatable
Methodology

Relevant
Experimentation versus the SMT process

Resource Minimization in both engineering time and cost

Experimental **Resolution** to easily discern different technology candidates

current SMT process, 3) Resource minimization in both engineering time and cost, and 4) good experimental Resolution to easily discern differences between different technology candidates.

Best-in-Class SMT Operations

Defining the optimal SMT process can be as straightforward as looking at the results of best-in-class companies. Most of these companies use the following metrics to define their SMT process: Quality (ppm defects), Cycle time, Uptime, and end of line Yield.

Using the solder paste printing operation as an important example, Quality (ppm defect rate) is looked at as measurable common defects including insufficient deposits (opens), bridging (solder

Best In Class Operations

Quality
4 and 8 PPM Per Defect Opportunity

Print Cycle Time
Under 10 seconds

Uptime
Greater than 98%

Yield
Maximum First Time Pass Rate

shorts), and misaligned solder deposits (opens and solder shorts). Best-in-Class solder paste printing operations run between 4 and 8 PPM per defect opportunity. Print cycle time is defined as the time required for board transport, alignment, and printing. Other print cycle time elements to consider are stencil wiping frequency and time, post-print evaluation (2D and 3D), and paste replenishment. Best-in-Class solder paste printing operations have cycle times under 10 seconds.

Uptime is defined as the time the process is available to perform its function. Factors affecting uptime are hardware and software failures, "ease of use" of the software, and the tooling change-over system. Best-in-Class solder paste printing operations have uptime at greater than 98%. End of line yield is defined as how many of the assembled boards "work" or pass test the first time. Since there are numerous factors that impact end of line yield, its definition is flexible. However, an optimized printing process will obviously maximize the end of line yield.

SMT Process Standards: Elevated Expectations

Changing SMT process inputs, such as board design and component type, as well as shifts in process conditions like temperature and humidity, can cause an erosion of quality. This results in the need for operator or engineering intervention

Solder Paste Performance Standards

Performance Goal	Process Requirement	Performance Predictor
Ease of Printing	Response to pause, wipe frequency, 6" per second	27 board challenge D.O.E
Life (stencil, tack)	Life >1 shift (8 hours)	Change in tack
Component Placement	Tack (gantry, turret)	Tack >1.8g/mm ² for turret at 8 hours
Solderability	Pad (OSP) & Lead (Pd) Wetting	OSP Wetting Test
Reflow Tolerance	Wide reflow envelope, Solderball resistance	Solderball RH% test, 27 board challenge drop-in
Joint Cosmetics	Clear, colorless and tack-free residue plus shiny joints	Ceramic coupon: visual
Consistent Supply	Laborious test series, long commitment	Supplier evaluation checklist

into the process. Hands-free operation standards mean maximizing SMT process uptime with minimal resources.

The "Hands-Free" Process

Printing, placement and reflow can all require unplanned process adjustments to maintain quality standards. Of these, the most demanding area is the printing process. A recent survey of process engineers concluded that 2/3 of SMT assembly defects can be traced to the printing process. Specifically, shifts in printing process variables, such as first print quality after pauses in the operation, squeegee sticking, stencil life and stencil release can all result in defects.

The Role of Solder Paste

All of these changing process inputs play complex roles in the SMT operation. However, the role of solder paste in a hands-free process is clear. Solder paste in today's

and resume printing with print quality equal to that before the pause. See "Solder Paste Performance Standards" for a summary of recommended performance standards for solder paste.

Performance Predictors

With the recent proliferation of many satisfactory solder pastes, it is useful to look at performance predictors in order to determine how "hands-free" a solder paste is before committing evaluation resources. The "Solder Paste Performance Standards" table suggests several performance predictors, including the Change in Tack chart, the OSP Wetting Test, Solder-ball RH% test, as well as the Supplier Evaluation Checklist. Since printing can be a key source of defects, it is especially useful to look at the solder paste change in tack data. This simple technique uses tack data to predict printability. There is a strong correlation between changes in tack and noticeable changes in printability. A general requirement for no clean solder pastes would be a maximum allowable change in tack of 1 tack unit (g/mm²) over 8 hours (one shift). An example of change in tack data is provided in Figure 1.

Solder Paste Prove-out

To benchmark how "hands-free" a solder paste is in practice, or on-line, it is important to use a test that forces measurable results between solder pastes, while minimizing line time required to perform the test; i.e. good experimental resolution.

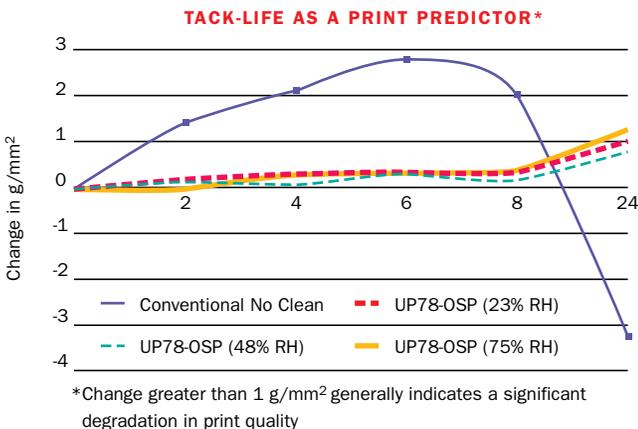
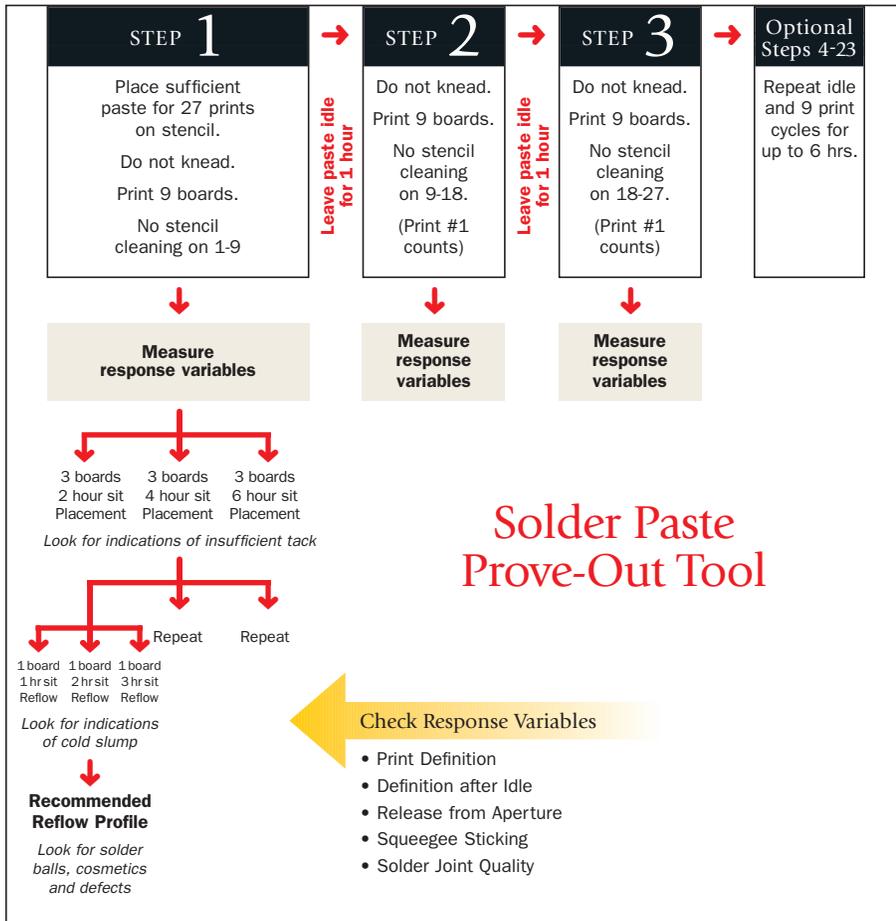


Figure 1



The Solder Paste Prove-Out Tool has been developed to aid in the evaluation of solder pastes. The test is a statistically based design of experiment and is a fractional factorial design. The test takes about 9 hours and can be performed using as few as 27 boards and an actual line time of

about 45 minutes (switching between the stencil for the candidate solder paste and one for the operating solder paste; includes blade wiping and leveling). This solder paste prove-out tool calls for extended periods of open exposure of the solder paste (3 pauses of 1 hour) with no kneading or stencil

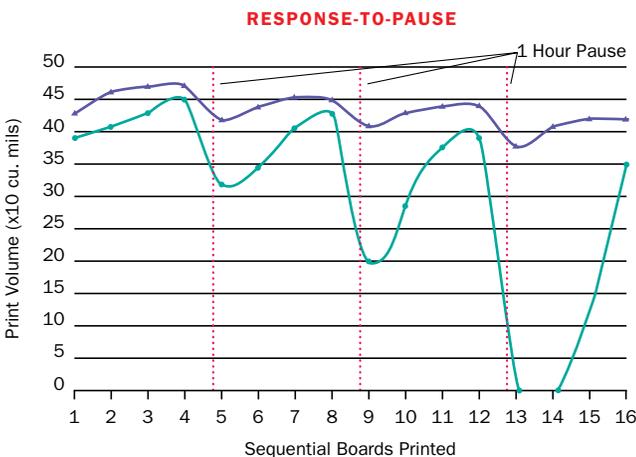


Figure 2 Note: Data represents 20 mil pitch QFP, north-south pads

wiping before printing. Key response variables include print definition, definition after idle times, stencil release, squeegee sticking, shifts in components during placement and solder joint quality. As noted in Figure 2 it is easy to see how important response to pause data can be to a hands-free SMT operation. This designed experiment calls for

boards with 16 to 25 mil pitch pads to discern solder paste performance. The north-south and the east-west oriented pads make up two different populations and should not be mixed in the data analysis. The solder paste indicated with triangles (top) maintains essentially the same print volume even after successive pauses while the solder paste indicated with circles (bottom) demonstrated almost immediate print performance erosion after only one pause.

Consistent Supply

The other axis of dependable solder paste performance is the availability of a consistent supply. Before evaluating a solder paste from a supplier, it is again useful to look at performance predictors. Three supplier performance predictors that are readily obtainable are; 1) implementation of advanced CAM software and hardware for solder paste flux manufacture, 2) a first-time-pass-rate for solder paste blending above 98% and 3) achievement of an industry recognized standard for quality systems capability, such as Ford Q1, ISO registration, or Q/S 9000 certification.

Rapid Implementation

The productivity demands on SMT operations require that the performance faults of the materials used on-line not be tolerated. Hands-free performance requires that fault tolerance be built out of the SMT process. Utilizing these performance predictors and the 27 board solder paste prove-out tool discussed here, as well as gaining full confidence in the electrical reliability of the solder joint produced, the solder paste qualification cycle time can be significantly reduced. These techniques are fundamental for early adapters seeking to rapidly implement new technology on the plant floor with the lowest risk and maximum results.

FOR MORE INFORMATION, CONTACT ALPHA METALS,
600 ROUTE 440, JERSEY CITY, NJ 07304;
(201) 434-6778. URL WWW.ALPHAMETALS.COM