On The Forefront: February, 2002

By Phil Zarrow

Selective Soldering - Wave-Soldering Redefined and Replaced

As much as surface mount technology continues to evolve with newer and more extensive packaging, it is pretty much a given fact that there will always be, in most applications, through-hole mounted components. While there are more and more Type I PCB assemblies comprised of total surface mount components, the vast majority of us are building applications with through-hole components on them.

The majority of surviving class of through-hole components are those that have to endure rather rough service. Switches, connectors, some sockets may have to endure mechanical stressing that demands the robustness of a through-hole interconnection can provide. There are some applications that call for components with high-power ratings that do not exist, as of yet, in surface mount form. So, what is the best way to solder mixed technology (surface mount and through-hole populated) PCBAs?

Wave soldering is a great technique - for soldering through-hole components. When we went from point-to-point wiring to printed circuit boards about 50 years ago, wave-soldering firmly established itself as the ideal methodology. But surface mount was not foreseen back then and when we evolved to SMT, a lot of effort was put into making wave soldering work for the surface mount components on the board. We've extended lands, added thieving pads, came up with orientation recommendations. We've implemented spray fluxers, extended preheaters, developed dual waves (with a specific "chip" wave), inerted the solder wave area. All of which helped - a little bit. But in the grand scheme of things, these all really amounted to duct-tape. Has anyone actually seen zero-defect wave soldering of surface mount components? I didn't think so.

So how does one effectively - as in high yields- solder mixed technology PCBAs ? If the through-hole component population is small enough, there are micro-selective soldering systems.[1] The majority of assemblers are hand-soldering and this is most prevalent where labor is inexpensive. Being a manual operation, hand-soldering is prone towards variations and defects.

Another approach (fairly widely used) has been to place the PCBAs in pallets that mask previously reflow soldered SMCs but have openings where the leads protrude through the board. These palletized boards are then run through the existing wave-soldering machine effectively soldering the through-hole components. Not a bad technique however, there are limitations to the pallet aperture location, shape, and proximity and the pallets have to manually loaded and unloaded. The better pallets can run up in the area of $1000 each and you generally need a few. And it is hard tooling which tends to be resistant to ECNs.

[1] As discussed in the December, 2001 "On The Forefront" column

Your author is a big fan of Reflow of Through-hole (also known as Intrusive Reflow).[2] However, there are a few limitations to the process, sometimes imposed by thermal sensitivity limits of components as well as other flexibility limiting factors that doesn't exactly make it a process for everyone.

The ultimate answer for most medium and high volume mixed-technology applications might very well be Selective Soldering. We're talking about the big boys here. These are machines where the PCB assembly is soldered by positioning the solder site over first a spray fluxer and then a solder fountain. On some systems, such as those produced by Seho, Pillarhouse and Vitronics-Soltec, the PCBA is moved while the solder-fountain and fluxer remain fixed. ERSA, on the other hand, uses an x / y / z servo positioning system to locate the fluxer and solder-fountain, respectively, to the interconnection point. And with an impressive +/- 0.010" positioning accuracy. The wave-fountains can be inerted. Program data is developed from downloaded Gerber files. Either way, only through-hole component leads are subjected to the diminutive solder wave - not surface mount components. (The SMCs were previously reflow soldered - the way SMCs ought to be soldered).

These machines are not inexpensive. Expect to spend roughly as much as you would for a wave-solder machine. However, energy consumption is lower and labor is much less than aperture wave pallets (let alone hand-soldering). Emissions of VOCs and other pollutants is also reduced helping to alleviate hassles with local Air Quality agencies. Engineering changes to the circuit board require only software changeover - no hard tooling and quick implementation.

The real savings, however, are realized in defect reduction. But of course - we're not subjecting surface mount components to a wave and generating mass quantities of related defects - only the through-hole component leads to a precision, directed solder fountain. Bob Klenke[3], a definite industry authority on Selective Soldering has seen numerous applications where DPMOs have dropped from well over 100 to under 30 through the implementation of Selective Soldering. (And your wave-soldering DPMO is what?). Start calculating in the cost of finding the defects (assuming, of course you find them before the end-user does) and the cost of repair, and we are getting into some serious money.

	Former Rework Frequency	***Selective Soldering Rework Frequency***	***Inspection/ Repair / PCBA***	***Savings / PCBA***	***Yearly Savings***
PCBA #1	30 / 300	1 / 300	60 min.	5.8 min	6,160 man-hours

[2] As are my friends Bill Barthel and Bob Willis, among others.
[3] Bob Klenke is Vice President of Sales & Marketing for ERSA, Plymouth, WI

PCBA #2	50 / 100	6 / 100	10 min.	4.4 min	3,386 man-hours
PCBA #3	20 / 100	12 / 100	15 min.	1.2 min	1,262 man-hours

Courtesy of ERSA, Inc

The early adapters of Selective Soldering are mostly automotive electronic assemblers - a major bastion of high-volume, mixed technology assemblies. It appears clear, though, that this is a definite replacement technology for wave-soldering. Wave-soldering is good and it works, but just as PCBAs have evolved to being predominantly surface mount with a minority of through-hole components, wave-soldering has also had to evolve. The obvious direction is Selective Soldering. Selective Soldering, when incorporated into an SMT / PTH assembly process offers greatly increased process quality. With a reduction in direct labor, tooling, energy and a much easier conversion effort, the real cost of ownership is fairly easily realized in many applications.

A Selective Soldering system is well worth considering when it comes time to replace that old wave-soldering system you've been trying to upgrade to do a better job with SMT. Or maybe you don't want to wait that long. Remember, we're all in this together.

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