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Selective Soldering – The Future is Now

Optimize your through-hole soldering process down to the pin level.

"Any tool can be the right tool"
Red Green

Recessions and economic slowdowns rarely have an adverse effect on the evolution of technology. In fact, such times can serve as catalysts for process efficiency improvement. This is certainly the case when it comes to soldering through-hole components on mixed technology (SMT and through-hole) PCBAs. We all know that, for a majority of applications, through-hole components will persist. Usually they will be connectors or switches that, due to the application and its environment and reliability expectations, require the extra mechanical robustness of a through-hole interconnection. There are also a number of power related components that do not yet exist in surface mount packaging.

Wave soldering has been around for nearly 60 years and it really hasn't changed much. Attempts at adapting it to solder both SMT and through-hole components have included dual-wave (coarse and chip wave), vibrating wave(s), air knifes, inert waves and a host of others. Some offer some improvement but, in terms of process yields, they all amount to essentially duct taping the process. Wave soldering never anticipated surface mount and therefore we should not have high expectations. We have yet to see zero-defect wave soldering of assemblies with SMT.

Decisions, Decisions?

So, what to do? The first choice of many practitioners, as well as your humble authors, is to see if intrusive soldering (aka reflow of through-hole, paste-in-hole, pin-in-paste, etc.) is applicable. With modern convection dominant reflow ovens, this usually comes down to whether the components can survive the incurred thermal excursions of the reflow profile. This may become a bit of a problem with the further advent of lead-free solder and surface finish alloys that will require higher reflow temperatures.

When you can't run the mixed technology board through and the volume and reliability / repeatability expectations rule out hand soldering, we turn to selective soldering. As the name implies, we are selectively soldering only the through-hole components after the surface mount components have been reflow soldered.

Right now, the most common method of selective soldering is through the use of masking pallets. The PCBAs are mounted in pallets that have cutouts where the solder needs to go (through-hole interconnections). The pallets are run through the wave soldering machine with the wave only contacting the through-hole interconnections – not the surface mount components (that were previously soldered). Hey, you're thinking, this sounds pretty cool – no new equipment – I can use my existing wave solder machine. Yes, but there are limitations regarding the proximity of the cutouts. Also they have to beveled just right and they start to get expensive – We've seen some really good quality ones that cost around $1,000 each – and, if you have any kind of volume, you're going to need quite a few of them. Don't forget the manpower to load and un-load the pallets.

Down to Details

So let's get automatic. Selective soldering falls into two categories. There is, what can best be called, PCBA level and then there is micro soldering. We discussed micro-selective soldering in the December 2001 *On The Forefront* Column. These included robotic soldering irons, and X-Y-Z robotic systems fitted with induction, micro-flame and the laser systems. Today we are going to look at PCBA level selective soldering – a methodology that is encroaching upon wave-soldering as a replacement technology.

The most common types of PCBA level selective soldering are point-to-point and multi-wave systems. Point-to-point systems use a fluxing spray head and a single-point solder nozzle moved by a gantry or robot to select the exact solder locations on a PCBA. As the name implies, multi-wave systems have multiple nozzles that solder several locations simultaneously. Both systems have their advantages and disadvantages, with the biggest being a trade-off between flexibility and application dependent throughput vs. increased thermal transfer and speed.

Benefits are Made of This

Every advance in technology has its obvious benefits, and selective soldering is no different since it allows the user to optimize the solder process down to the pin level verses the compromise techniques in flux application and contact time that are the norm with wave soldering. The fact that flux deposition, nozzle height, solder dwell time and peel-off parameters are fully programmable – and, can be optimized for individual components, makes it an ideal method for soldering those thermally challenged through-hole components that we all love so much (DC power supplies, coax connectors, etc.).

The obvious benefit of selective soldering is not only improved solder quality, but also minimized thermal coefficient of expansion (TCE) issues with minimalistic SMT components that don't survive thermal shocking of wave soldering. Using selective soldering can even reduce or eliminate the bottom-side gluing process for SMT passives. Reducing hand soldering and eliminating secondary masking and gluing operations results in significant direct labor savings. And since it's a data driven process, selective soldering improves your time to market when launching a new PCBA by eliminating dedicated tooling and the lead-time to order or make changes.

Selective soldering is environmentally friendlier than wave soldering since its flux and solder usage and emission levels are significantly less. We know of several cases were users operate their selective systems with self-contained flume extractors thus eliminating the cost and hassle of roof venting and a fire suppression system entirely! (When was the last time you had a plant visit from your local air quality agency?)

Selective soldering is ideal for soldering PCBAs with high component density since it can maintain clearances between through-hole pads and adjacent SMT pads that aren't achievable with masking pallets or bench-top solder fountains. Another consideration to keep in mind is that selective soldering allows you to solder through-hole components on both sides of PCBAs without restrictions in component height. Masking pallets are generally limited in depth so they don't adversely affect the dynamics of the wave soldering process and as a result cannot shield tall SMT or through-hole components on the solder side of the PCBA. Selective soldering can process very tall bottom-side components making it an ideal replacement for hand soldering those "ugly" through-hole components that always seem to be the last assembly step.

But the biggest advantage selective soldering offers is its ability to reduce solder defects and thus improve first pass yields. Soldering a PCBA at a faster rate in a masking pallet only to have to perform secondary hand soldering, "touch-up" or other manual operations doesn't necessarily result in an efficient operation (Figure 1).

Figure 1: Gains in efficiency are more easily attained by reducing defects then faster cycle time

Conclusion

With the continued convergence of SMT and through-hole for the foreseeable future, more attention then ever needs to be paid to through-hole solder joint quality. Selective soldering is rapidly becoming the preferred method to improve solder quality, reduce conversion costs and increase factory utilization. Remember, we're all in this together.

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