On The Forefront: **December, 2001**
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Micro Selective Soldering - The Special Ops of Electronic Assembly

"Any tool can be the right tool."
Red Green
"It ain't necessarily so."
George Gershwin

Most of us have encountered an application that simply cannot be either reflow soldered by conventional means - convection dominant oven, convection / infrared oven, vapor-phase or conductive area heating (conveyorized hot-plate). Maybe it is a coaxial cable connector or a termination that must be soldered within a deep cavity housing. Sometimes you can get it with a soldering iron but there is that inherent risk that comes with any manual soldering method - human induced variables, usually duration of application of heat as well as pressure and other damaging factors. The key is to control application of the heat as well as the actual temperature to attain accuracy and repeatability of the soldering operation. The solution is automation.

Selective Soldering falls into two categories. There is, what can best be called, PCBA level and then there is Micro Soldering. The former is encroaching upon wave-soldering as a replacement technology and we will discuss this technology in a future column. Today, however, we are going to examine the Special Operations of electronics - Micro Selective Soldering.

The simplest version of micro selective soldering is the robotic soldering iron. These have been around for many years and there are many sources of such devices. A soldering iron is basically mounted to an X, Y, Z, programmable gantry system. A spool feeder introduces a programmable amount of flux-cored wire solder to the application (if solder paste is not being used) and soldering is thus accomplished with the precision and repeatability required. More advanced (and more expensive) models may offer motion on other axes as required by particular applications.

Induction heating is a non-contact heating methodology. Here, the parts to be soldered (or brazes) are put in position and touching one another and placed inside, but not in contact with, a loop comprised of a copper conductor. A high-frequency voltage is applied to the conductor, creating an alternating magnetic field. With currents flowing through the pieces being connected, heating takes place as a result of the Joule effect.

Though it offers the advantages of being a non-contact process, quite a few variables present themselves including shape of the parts, proximity to the conductive loop, the metallurgical composition of the parts as well as their mass. This makes temperature rise very difficult to predict. The process is limited to conductive material heating (of course) and really requires considerable knowledge and experience to be effective.

If inductive is a bit obscure in our industry, one micro selective soldering technique that has attracted quite a bit of interest in the last few years is laser soldering. Laser technology lends itself nicely to the much smaller termination soldering that characterizes surface mount technology. Actually, laser has been around for quite a few years.

In the early days of surface mount, it was believed by some that a virtual "sound barrier" would be encountered regarding just how fine a pitch one could solder using the solder paste print / reflow process. Some practitioners believed that the process would not support 0.020" pitch and smaller due to control of solder paste slump. A laser system was marketed that utilized a YAG source. It was very expensive (compared to the Convection /IR and vapor phase systems of the day) and took a long time to program and, being a point-to-point method (as opposed to mass soldering) took a very long time to solder a PCBA. Needless to say, solder paste and printing technology evolved and the aforementioned obstacle was never encountered. That particular laser manufacturer attempted to resurrect their product by noting that the system automatically inspected every solder joint after soldering it (by noting the IR signature). This was nice, but no one wanted to sacrifice throughput and inspect every solder joint.

There are a number of laser based soldering systems on the market today. Most use diode laser which is far less expensive than YAG or CO_2 systems. Most are mounted on an X,Y gantry and are quite versatile. Because the energy intensity can be varied very precisely (yet with no physical contact with the assembly), soldering can be accomplished over a wide range of application materials and masses. The result is highly repeatable, versatile soldering. Mounted in stand-alone or in-line modules applications have included odd-form (post-reflow) soldering, soldering of RF shielding to a previously soldered assembly, and even PCB rework/repair. Because the exact point of heat application can be controlled, laser systems have been used for soldering BGAs and other area arrays (and not with smoke and mirrors, either). Solder can be applied in paste form (via dispensing, stencil or micro-stencil) or by wire-feed. A technology related to laser is xenon based light soldering[1]. Many xenon based soldering cells have seen duty for odd-form and through-hole component soldering in post-reflow assembly. Laser has also been applied here and there have been cells built with multiple heads that will yield higher production throughput. Typically, we have observed laser soldering to take in the vicinity of about 1 second per joint though higher mass components may take a bit longer.

Laser soldering has received quite a bit of press lately and I personally like laser a lot. However, there is one major limitation that I have not observed being mentioned in those articles, including those whose authors have a metallurgical background. It seems that laser does not work too well with gold. Due to the reflectivity of gold and the frequency that laser light falls into, it seems that gold likes to reflect laser rather than be heated up

[1] The Panasonic Soft-beam is the most successful application of xenon

by it. Uh-oh - this could be a problem since many of us are building PCBs with some sort of gold finish on them. In fact, NiAu is currently the most popular alternative surface finish to HASL. (Xenon based systems, though, working in a different portion of the spectrum, does not appear to have a problem with gold finish). Well, add another reason to consider immersion tin or immersion silver.

Another form of micro-selective soldering is microflame soldering. I know, you're conjuring up visions of soldering an electronic assembly with a propane torch. Not quite but not far off - far smaller nozzles and hydrogen. Here, the right amount of energy is applies to point of junction by a flame which offers high consistency and yet is non-contact. A smaller needle is used for preheat and this, and the main needle are mounted on a head capable of moving in several axes - as may be required by the application. This methodology offers a very high degree of versatility and flexibility at a relatively low cost. The range of applications that have been best served by micro-flame is amazing, particularly electromechanical and sensors in housings. Like laser, the accuracy of the positioning system is extremely critical.

So there might indeed be a better way of tackling that difficult, out-of-the-norm soldering application. A little automation will go a long way to assure high yields let alone increase through-put. Remember, we're all in this together.

Special thanks to Heinz Bokard of Global Automation, Old Lyme, CT - the commander of Special Ops soldering applications.

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