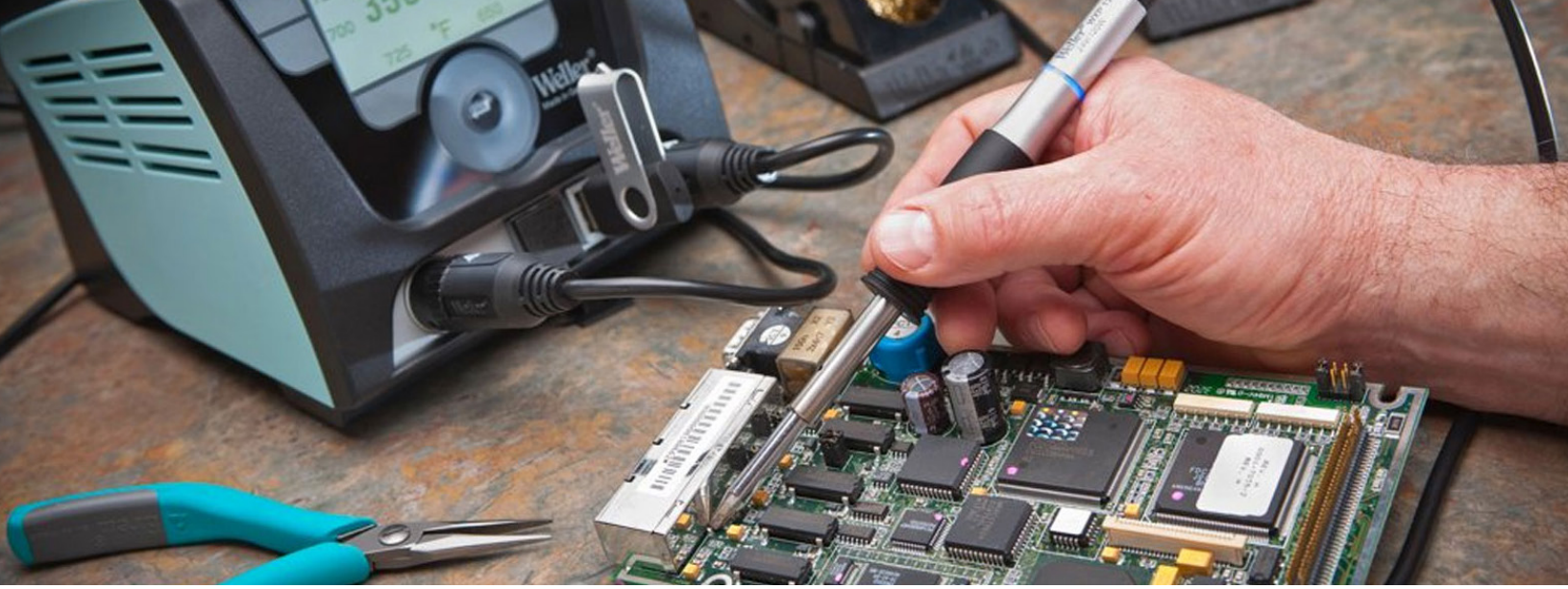

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Drag Soldering: The Best Way to Touchup and Rework High Pin Count SMDs

Abstract

Rework is a necessary evil. No matter how hard we try to perfect the printed circuit board (PCB) assembly process, you-know-what hits the fan sometimes. So we will always need good soldering and rework tools at the benchtop. Some devices, like quad flat packs (QFPs), require a great deal of time, training, skill and dexterity. High pin counts (often up to 256 leads) and fine pitch (down to 0.015") can present challenges even for experienced solder technicians. So what's the best way to handle the challenges of high pin count surface mount devices (SMDs)?

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Figure 1: Top view of the corner of a QFP

Background

Just as the introduction of surface mount devices in the 1980s revolutionized automated PCB assembly, so, too, was the introduction of quad flat packages (QFPs) (Figure 1) to the surface mount technology (SMT) automated process. QFPs enabled very high I/O counts in a small footprint. But as always, new technologies bring new challenges.

During the initial SMT manufacturing process, solder paste is printed onto the SMT lands of the substrate, then the SMDs including QFPs are robotically placed on their corresponding land patterns. At this point, the entire assembly is processed through a reflow oven, resulting in a completely soldered assembly when it exits the oven.

The most common source of problems in any automated SMT process is the paste printing process. It has always been the single greatest point of origin for SMT defects. Problems with the paste printing process can result in misalignment, skips, bridges, slump, etc. As the lead count increased and the lead pitch decreased, QFPs became more problematic to process. Not only do you have the variables of the printing process, QFPs add the extra variables of alignment and coplanarity. Then add the fact that QFP leads are so delicate, it really ramps up the likelihood of problems. The more leads on a device, the more opportunities for misalignment and coplanarity problems. This results in a greater need to rework QFPs after the initial manufacturing process. When rework needs to be done, there may be cases where the device has to be removed and replaced and other cases where the device only requires some portion of the leads to undergo some touchup. The technique of "Drag Soldering" often is the best option for QFPs/high pin count SMDs.

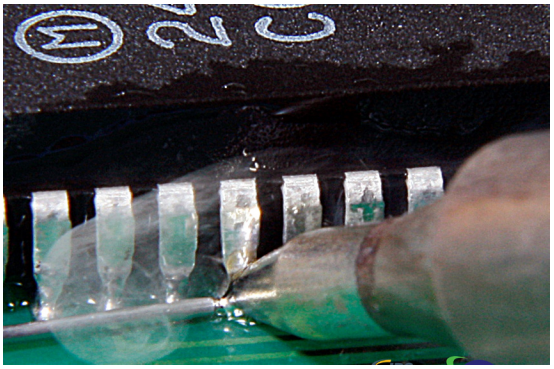

Figure 2: Soldering of individual leads with the point-to-point method

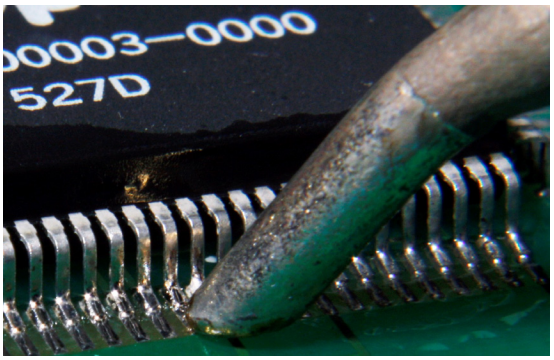

Figure 3: Drag soldering with a mini wave tip

Figure 4. WXMP iron with GW tip

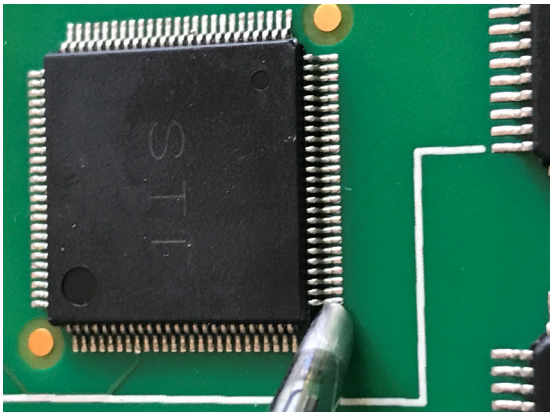

Figure 5. The quality of drag solder joints typically meet IPC Class 3 inspection criteria.

QFP Touchup and Rework: Point to Point (The Old Way)

Point-to-point soldering is a manual soldering process in which individual solder connections are soldered or reworked one connection at a time (Figure 2). Obviously, when using this method to solder or rework QFP connections, progressively smaller soldering iron tips and wire solder diameters must be used as the lead pitch decreases. Since a technician will be soldering each connection individually, this allows the technician to adjust their heat bridge, dwell time and solder volume to suit the particular connection. This gives the technician a lot of discretion with regard to the rework process, but also reduces the uniformity and consistency of the solder connections. This process is time-consuming and expensive – not only from a labor cost standpoint but also from a consumables standpoint. The smaller the solder tip geometry, the faster the tip burns out. This may not seem like a big deal but needs to be taken into consideration as soldering equipment and tips get better, more sophisticated and, therefore, more expensive.

QFP Touchup and Rework: Drag Soldering (The New, Better Way)

Drag soldering is a manual soldering process that uses a special soldering iron tip with a concave surface or "spoon" shape to hold molten solder (Figure 3). This ball of molten solder is then "dragged" across the leads of the QFP, letting the surface tension and natural wetting forces of the solder deposit the correct amount of solder on each lead (Figure 4). This is a similar process to wave soldering, only the assembly and the solder source are inverted. Instead of the assembly traversing across the top of a wave of molten solder, the assembly is stationary and the solder source is passed across the top of leads. The drag soldering tip often is called a "gull wing" tip for the old vernacular of the QFP being call a "gull wing device." Just as in the wave soldering process, drag soldering must be performed with external flux added to the lead/land interface. Since drag soldering relies on the physics of the surface tension of the solder to form the solder connections, it results in consistent, uniform solder volume and appearance. Typically, the quality of these solder joints will meet the requirements of IPC Class 3 inspection criteria (Figure 5). The variables to control are pressure (very light) and speed. You should glide across the leads with little to no pressure, and the speed is determined by the thermal mass of the board. Remember, solder will only flow to surfaces that are above solder melt temperature so the speed will be determined by how long it takes to get the PCB lands up above solder melt temperature or 217°C for SAC305. Because of this, it is imperative to have a good quality solder station and iron with active tip temperature monitoring and control (Figure 6). With the right tool, some practice and preferably a good instructor to show you the nuances, anyone can become proficient at drag soldering.

Figure 6. Weller soldering station; visit www.weller-tools.com for more information.

QFP Rework Methods Pros and Cons

Point-to-point rework and soldering of QFPs may be the best process if there are only a few leads that require rework. Typically, a defect such as a bridges, insufficient solder or cold solder on a small number of leads would be best remedied with a point-to-point process. If there are a large quantity of leads that need to be soldered or the entire device has to be placed and soldered, then point-to-point soldering will take too long. The use of external liquid flux is highly recommended, no matter which method you use. This means that the reworked component and all those around it must be cleaned, even if you use no-clean flux.

Drag soldering can be used for touchup or for soldering a few leads or an entire device. It is very fast, relatively easy with some practice and results in very uniform solder connections. The amount of solder that will be deposited at each connection is a function of the lead and land geometries (as well as placement accuracy and coplanarity). One potential drawback is the fact that drag soldering cannot be accomplished without the use of external liquid flux. As a matter of fact, more flux and higher solids typically result in greater ease of the drag soldering process and better results. This means that even when using no clean fluxes, it is necessary to have a robust cleaning process after soldering to ensure that no flux residues remain on the assembly. Remember, no-clean flux is not benign when not fully activated and, therefore, must be properly cleaned.

For QFP removal, hot air often is the best choice as opposed to conductive techniques but that's a separate discussion.

Summary

Rarely does one rework method work best in all circumstances and so it is with drag soldering. However, in most cases, drag soldering is the fastest, most consistent and most repeatable way to solder or touchup a QFP or any multi-lead SMD. Proper technique and training along with high-quality soldering equipment are imperative for high quality, high yield and low cost of the final product (Figure 7).

Figure 7. Circuit Technology Training Center