The Inside Line

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10 Solder Tips

By Maureen Brown –Technical Service Engineer, Kester Solder

As the industry continues to move away from through-hole technology, surface mount technology (SMT) has become the most popular mass-assembly technique in electronics. SMT offers new challenges and adventures for engineers to conquer. The industry has made available numerous resources to successful soldering for SMT. Consider these suggestions for overcoming obstacles.

1) Start with the right stuff

a) Always use the best tools and assembly materials available. There are always new product innovations to consider as well. For example, the latest solder paste can make a SMT engineer's job easier. New product innovations can yield longer idle times or relax/recovery times. Environmental resilience and extended shelf life are other areas of improvement. Profile robustness and high-speed printing have also been incorporated in new solder paste products.

b) Do not hesitate to have a "show down" to compare products or equipment. If you start out with the correct tools, then there is a greater likelihood the end result will be favorable.

2) Storage and Handling

a) When you get the right stuff, treat it well. Current technology allows unopened solder paste to be stored at room temperature conditions. However, the best manufacturing practice is to refrigerate solder paste upon receiving. Solder paste is a mixture of paste flux and solder powder. Essentially flux is a chemical that removes metal oxides and promotes spreading of the solder. When flux and metal are mixed to make solder paste, the flux will remove the metal oxides as described. To slow this reaction and to extend the useable life of the solder paste, it should be refrigerated. When the solder paste is needed, it should be allowed to warm up to room temperature naturally. It is best to remove the solder paste from the refrigerator 18-24 hours before scheduled use. Expediting this process by placing the solder paste on the reflow oven or in a warm environment is strongly discouraged. Warming the solder paste quickly will alter the physical properties and may promote defects such as slumping and bridging. Lastly, when working with cartridges or syringes of solder paste, store it vertically with the tips down.

3) Solderball Test

a) The solder paste was received and was left on the receiving dock over a hot weekend. Is it bad? The solder paste was left out on the manufacturing floor for an unknown time. Is it good? One of the best performance-related tests to judge the usability of solder paste is a modified solder ball test. This test is very simple and reveals a lot of information about the condition of the solder paste. Dispense a small dot of solder paste onto an unsolderable substrate then reflow. Unsolderable substrates are ceramic, glass, and FR-4. The solder paste deposit after reflow should form a large ball of solder with a pool of flux. This indicates that the flux is active enough to effectively remove the surface oxidization of the solder powder and allow the solder to reflow and coalesce to form a single ball. If moisture is trapped within, or the solder paste was improperly stored and handed, the solder may form a ball with numerous smaller balls at a fraction of the size in the pool of flux. This indicates that if the solder paste is used for assembly then defects are eminent. (See Figure 1.)

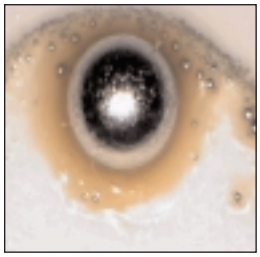
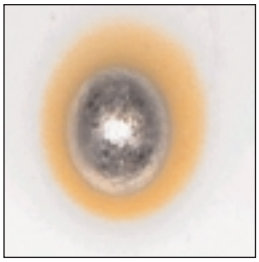


Figure 1: Solderball Test

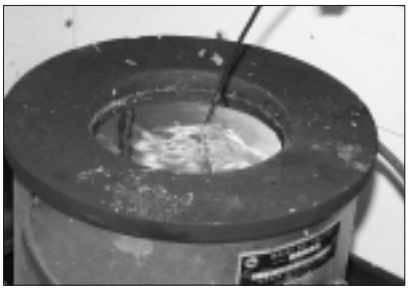
4) Profile

a) Profiling is not the most exciting task in electronics assembly, but it does assist in reducing potential defects. All reflow profiles consist of a reheat zone, soak zone, reflow zone, and cool-down zone. Each of these zones are important for a successful solder joint to be formed. Manipulation of any of these zones will alter the integrity and appearance of a solder joint.

b) The preheat zone is defined at the lower end by the ambient temperature, and the upper end by approximately 140-150ºC. The main purpose of this is to drive off the solvent carrier from the solder paste deposit. The ramp rate is fairly quick and should not exceed the component manufacturer recommendations of 2.5-3.0ºC/sec. If the ramp rate is greater, the components may be thermally shocked, warpage of the board may be induced, and the solder paste could slump. As the preheat zone ends, the soak zone begins. The soak zone is commonly bounded by 150ºC and the liquidus temperature of the alloy, for Sn63Pb37 the liquidus temperature is 183ºC. The soak zone has two main functions. The first is



Preferred example



to thermally equalize the assembly, and the second is to activate the flux. Activating the flux essentially allows the paste flux to "chemically scrub" the surface oxidation of the surface finishes on the printed circuit board and the component leads as well as the solder powder to promote wetting. This is accomplished within approximately 60-90 seconds. Next is the reflow zone. The reflow zone is commonly characterized when the solder powder changes phases from a solid to a liquid (also known as the time above the liquidus temperature of the alloy). The peak temperature is around 30-40ºC above the alloy liquidus temperature. The main purpose of the reflow zone is to form a metallurgical bond between the component leads, solder, and the lands on the printed circuit board. Excessive time within the reflow zone may lead to dark, dull, grainy joints. Insufficient time within the reflow zone may result in weak interconnects. Last is the cool-down zone. The cool-down zone begins as the alloy solidifies. The temperature of the assembly should not decrease too rapidly; this may lead to thermal shock of the components. Again, follow the component manufacturer's recommendations.

5) Compatibility

a) Do not try to mix and match flux chemistries. Use all No Clean products or all water-soluble products. Water-soluble flux chemistries are very active by nature in comparison to No Clean formulations. Due to this inherent difference, operators may be drawn to water-soluble flux products. No Clean flux chemistries are designed to have residues that are non-conductive and non-corrosive, whereas water-soluble flux chemistries are conductive and corrosive. If a water-soluble flux was used on a No Clean assembly, this would be an important reliability issue for the assembly and should be immediately addressed. Any residue resulting from the use of water-soluble fluxes should be completely removed from the assembly.

6) Printing Suggestions

a) Printing is the first process in surface mount assembling. Some general printing suggestions are offered to reduce defects and optimize yields. The bead diameter of the solder paste should be approximately the same size in diameter as a cigar (about 0.5" in diameter). When the squeegee is gliding across the stencil, the solder paste in front of the squeegee should be rolling. This will assist in proper filling and leveling of the apertures with solder paste in addition to achieving consistent solder paste deposits. Traditional solder pastes required kneading to establish a good roll, while current formulations do not possess this attribute. Clogging of the apertures is another problem within the printing process that is a common root cause for many defects. Innovative solder paste formulas release cleanly from the wall of the stencil apertures. Solder paste adhering and drying in the apertures reduces the quantity of paste transferred or deposited, resulting in a higher occurrence of defects in the form of insufficients or opens.

7) Avoid Humidity and high temperature situations

a) Solder paste can be a delicate blend of numerous chemicals to yield a specific rheology and consistency. Harsh environmental fluctuations will alter physical properties such as viscosity and tack. When the humidity begins to climb above 60-70%RH, the solder paste may entrap or absorb moisture, which will decrease the tack and promote solderballing. A common indication will be the solder paste sticking to the squeegee and forming a curtain instead of releasing from the squeegee. On the other hand, if the humidity is below 25-35%RH, then the solder paste will dry out quickly and the stencil life will decrease, resulting in additional scrap. If the solder paste dries out, the apertures in the stencil are easily clogged as well. Activity, tack, and viscosity are all properties of solder paste that are altered as the environmental conditions go to extremes, and the inclination is to add something to the solder paste to revive the material. This is strongly discouraged. Solder paste does not react in the same fashion and is unpredictable with additions. If the manufacturing facility is prone to these harsh conditions, then make sure the solder paste selected is robust; review Tip #1. Recent solder paste formulations are designed to be environment-resilient.

8) Double Sided Reflow Applications

a) As the electronics industry is driven by end products that are lighter in weight, faster, and less expensive, double-sided reflow applications are increasing. This application can be simplified with some useful tips. One common tip is to bias the topside preheaters of the reflow oven slightly hotter than the bottomside preheaters. This will direct more of the heat to the topside of the assembly than the bottomside. When attempting this, the temperature gradient should not exceed more than 15-20ºC, in case the oven isn't able to stabilize. If this tip is used, the same alloy can be used for both sides of the assembly. While reflowing the second side of the assembly, you may need to glue components so they do not fall off the assembly.

9) Troubleshooting

a) As experience with a specific process increases, the defects will be reduced and an expert will emerge. There are many ways of finding the root cause of a defect or failure. List the possibilities and eventually isolate the problem. Employ organized troubleshooting techniques to quickly resolve the problem. Involve other departments to facilitate the troubleshooting process. Engineering and troubleshooting are typically well accomplished with well-functioning teams.

10) Assistance

a) Do not be afraid to ask for assistance. There are several sources for troubleshooting, problem solving, and general question forums available. The electronics assembly community is a helpful, very informative bunch. Solder vendors have technical service engineers that are available to answer questions. Another very good source is forums. The Internet-based forums through Surface Mount Technology Association (SMTA) and the Institute for Interconnecting and Packaging Electronic Circuits (IPC) consist of industry professionals and consultants that are eager to share experience.

There are endless tips for successfully soldering surface mount applications, but these should help along the way. Again, do not hesitate to employ others on your adventure through surface mount assembly. Industry trade shows are great sources for the latest and greatest research, as is the Internet. Another useful source for information is reference texts. There are many industry professionals who have recorded their vast experience to help others embarking on the same journey.