Key Process Issues for Lead-free Selective Soldering

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Abstract

Selective soldering is a flexible, adaptable process increasingly applied to an ever-widening range of soldering tasks, but it has become increasingly complicated especially since the transition to lead-free solders. This paper examines many of the process concerns, technology features, requirements, and suggestions for a manufacturer to implement successful, robust lead-free selective soldering.

Selective soldering is a flexible, adaptable process that is increasingly applied to an ever-widening range of soldering tasks. Indeed, selective soldering has moved beyond the role of being a problem application solution and into the soldering production mainstream. Flexible innovations, better user interfaces and simplified programming have now made selective soldering a more reliable, consistent, and faster replacement for most production hand soldering or wave soldering in custom pallets. Selective soldering systems now have a relatively fast ROI and compare favorably to the labor costs of using multiple hand-soldering technicians for any given job.

However, the soldering process itself is a complex one. Many assemblers are still soldering with lead-bearing solders; many are lead-free only soldering; yet others are doing both. There are many selective soldering machines available on the market, ranging from expensive automated machines to smaller benchtop models with limited automated capability, and the price spread between the low end and high-performance models is broad. Most users fall somewhere in the middle, seeking semi-automatic machines or machines with in-line capability and some medium degree of product handling capability. There are many additional features and options available, which should be considered based on the

demands of the application. Some of them are described below, with their uses, to give the prospective selective soldering systems user an idea of what might be advantageous to specify when looking at selective soldering machines.

Wave height monitoring

One very important process control feature is a wave height monitor and its attendant control module. These typically should be able to maintain solder wave heights to within +/- 0.005", which is critical when selectively soldering the smallest, tight pitch components in high volume automated production environments. They are particularly effective when working with the smallest wave nozzle sizes, under 6mm down to 1.5mm, and selectively soldering tight pitch component areas. The monitoring methodology incorporates resistive measurements of wave height relative to a known reference. This is performed at programmable intervals during extended production runs, and closed-loop feed-back is then used to automatically adjust solder pump speeds and therefore wave heights.

Top side preheating

Large, high-mass assemblies are a challenge for any soldering process, but are particularly troublesome for selective soldering, where process heat is applied only to the bottom side of the assembly. The ability to apply continuous, real-time top-side pre-heating during the selective soldering process is critical to achieving good soldering results when processing such assemblies. With high-mass assemblies, top-side (internally mounted or installed) integral preheating promotes the draw of the solder through the barrel to the top side of the board, enhancing the formation of solder fillets on the top side. The implementation of internal continuous pre-heat, during the selective soldering process, improves thermal distribution and solderability of difficult assemblies. This function is not practical or possible on machines that grip and robotically move the PCB, since the pre-heater would need to travel with the board and the gripper simply is in the way. Thus it is usually implemented in machines that keep the PCB stationary

while the flux and solder stations move beneath. Usually an optical pyrometer reads the actual PCB temperature with real-time closed loop control.

Solder delivery and inert atmosphere control

Special emphasis needs to be given to the need for efficient and capable solder delivery and inert atmosphere control, both of which are essential for good lead-free selective soldering. Look for features including a nitrogen flow monitor that uses nitrogen pressure levels to indicate the level of solder in the solder pot, and a super-heated nitrogen path. A nitrogen flow monitoring system provides accurate solder pot capacity information, which is then used to initiate and control solder replenishment to keep the pot level exact for high repeatability and process stability. This is a better method than the traditional mechanical probe system that is still used by some suppliers. It is also important for any lead-free system to be able to ‘super-heat’ the nitrogen supply within the solder pot. This enhances the performance of the flowing solder by introducing preheated nitrogen to the entire travel path of the solder from the pot to the wave, and thus to the final solder joint. Prior to the development of the super-heated nitrogen path, selective soldering performance had been somewhat vulnerable to the effects of the nitrogen temperature on the solder nozzle wave, especially the smaller nozzles. This development removes that variable, and together, these new developments enhance the overall stability and robustness of the selective soldering process.

Nitrogen peel-off jet

A nitrogen peel-off jet improves fine pitch selective soldering results. Even though significant advances have been made in the metallurgy of lead-free solders, they still have wettability and bridging issues that make them more difficult to work with than traditional tin/lead solders in wave and selective soldering systems, and fine-pitch spacing only exacerbates them. Tight spaces, small gaps between adjacent components and very fine pine pitch devices drive the need for a nitrogen peel-off jet, a directional jet of pre-heated nitrogen (N2)

to assist in minimizing the accumulation of solder on specific solder joints that, due to design or configuration, might be more susceptible to accumulation. By applying a jetted pulse of N2 at a critical moment in the soldering process, the resulting surface will be wetted with the minimal amount of solder required for a quality solder joint.

Dual head fluxers

A Dual head fluxer option facilitates quick changeover of flux types. Dual flux heads usually involve one spray head and one drop-jet fluxer. A dual head fluxer is especially designed to meet the needs of selective soldering applications that demand quick changeover from leaded to no-lead solders. The addition of a dual head fluxing system makes it possible to change flux types quickly. The spray head should offer controllable spray point size, pattern and deposition volume and be controllable down to a spot size of 2mm.

Drop-jet spray head technology allows the generation of a large number of drops with a well-defined size; these types of fluxers are especially useful for applying precise amounts of flux to very small areas. Use of the drop-jet is mandatory for top side fillets (Class III) on thicker boards with high copper content. Since the flux is forced to the top side of the board, preparing the surfaces for solder to follow.

Swappable solder pots for lead-free

When looking at smaller selective soldering units with smaller solder pots or those of a manageable size, quickly swappable solder pots can be a major time-saving advantage for assemblers (such as EMS) who alternately may be manufacturing both lead-bearing and lead-free assemblies, but who do not choose to invest in separate, dedicated selective soldering machines for both due to volume or price considerations.

For machines capable of the swappable pot option, customers generally order two solder pots, one for lead-based, one for no-lead, to prevent cross-contamination. The pots should be clearly marked and color-coded to prevent mix-ups that can result in cross-contamination. Each pot should be equipped with its own solder pump and solder delivery systems, with extra nozzles.

Larger nozzles

Larger (typically 3") nozzles can increase throughput as well as close the gap between selective, or secondary soldering, and full wave soldering. The 3" wave enables the quick conversion from a leaded soldering process to a no-lead solder process. By "painting" the solder side of a circuit with the 3" wide wave, for example, a selective soldering machine can deliver productivity that approaches that of the standard wave soldering tools commonly available.

Certainly there are many other options and features available on various machines for the prospective user to choose from, but these are a few of the more significant ones that can enhance productivity and extend the range of applications to which the selective soldering system may be applied.

About ACE Production Technologies

ACE Production Technologies is a designer and builder of simple, affordable selective soldering systems suitable for lead-free electronics assembly. ACE's line of rugged, reliable selective soldering systems includes the KISS 101, KISS-102, KISS-103, and the KISS-104 models. All of these flexible systems feature lead-free compatible solder pots and are ideal for low to medium volume assembly, prototyping, and rework, post-reflow offline assembly, and other soldering applications such as odd-form devices. For more information about A.C.E., including sales and technical, contact ACE Production Technologies, INC., 3010 N. Industrial Park, 1st Street, Spokane Valley, WA 99216; Tel. 509-924-4898, e-mail sales@ace-protech.com; www.ace-protech.com.