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The Role of Pre-Heating in Electronics Rework

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The electronics industry, like any other, has been cyclical in its evolution. Through-hole, surface mount, single-sided, multi- layer, complexity and density have all changed and evolved and then changed again. Just as one methodology and approach seems to take root, the next big thing comes along and changes the game again.

Pre-heating of assemblies has been one such practice that has changed. In the early days, with single- and double-sided boards and through-hole components, rework and repair were fairly simple and straightforward. Soldering irons and extractors generally had enough power and heat capacity to perform most everyday tasks.

As the industry moved forward, the demand for more functionality out of smaller assemblies ushered in the common use of multi-layered assemblies, voltage and ground planes as well as a higher density of larger components. Suddenly, the soldering irons and extractors of the time struggled to perform the same everyday tasks they used to handle with ease. It became necessary to supplement the heat generated by these handpieces through the use of pre-heating the assemblies. Rudimentary "hot-plates" emerged and evolved into temperature-controlled versions and eventually products that not only could control a set point but also a ramp rate to get the PCB to the desired temperature.

Standard BGA system using IR Preheat.

Convective pre-heaters emerged as well as systems that provide both conductive and convective heat. And right about the time this practice became mainstream, the industry evolved again. In came surface mounted devices that could provide significantly more functionality in a much smaller footprint. This resulted in a much smaller PCB assembly that was lighter with less thermal mass. Just like that, the irons and extractors and tweezers and hot air jets of the day could handle most everyday tasks once again. Pre-heating retreated to the fringes and was largely used for niche segments of the market.

Tiny and Complex

Over the last decade+, we've seen incredible advancements in electronics technology. Laptop computers that can do more than rooms full of equipment once did, cell phones that can do the job of computers, personal music devices that hold more songs in a device the size of a credit card than any of us could have possibly imagined owning in the form of records, tapes and CDs. These are just examples of consumer electronics and the communications and military electronics industries have evolved, almost, beyond comprehension. Through it all, the PCBs that contain this technology have become highly complex, incredibly densely packed and range in size from the credit-card-size iPod, to a couple feet square or larger.

Because of this complexity and size, as well as the value and sensitivity of the components associated with these products, it has become necessary to perform standard rework and repair tasks as fundamentally correct and as closely matched to the original manufacturing specs as humanly possible. To do so, generally requires pre-heating of the assembly to ensure the rework and repair process continues to stay within the accepted guidelines for temperature settings and time spent above solder melt temperature.

Further, with the changeover to Pb-free solders, operators typically tend to increase the set temperature of their iron, tweezers, air pencil, and desoldering handpiece to compensate for the higher solder melt temperatures. Couple this with a thermally dense PCB or a PCB with heat sinks and the potential for dam-age is high. When a component is difficult to reflow, or takes more time than expect-ed, the typical reaction is to either crank up the set temperature of the tool, or to press harder — both of which are recipes for disaster. Introducing pre-heating into the rework process allows for successful reflow of lead-free solders at safe, low set temperatures and results in a much safer process.

Proper Pre-Heating

Proper pre-heating is an essential component of an overall successful process. Proper preheating:

Ensures homogeneous temperatures across the board and components.
Eliminates warpage, twisting, flex-ing, and bowing of PCBs during the process which is essential for maintain-ing planarity of the reflow site.
Allows for successful reflow at lower temperatures, ensuring the safety of the PCB and component.

It is critical when pre-heating an assembly, regardless of method, that the resultant temperature of the board is measured in multiple locations. All too often, surface temperatures in one location of a board only are measured to determine if the desired pre-heat temperature has been achieved. While measuring the temperature on the topside of the PCB indicates warming through the board, measuring in only one location does not ensure homogeneous temperatures across the entire board. In many cases heat sinks such as ground planes, shielding, video and communication connectors can pull heat from surrounding areas, creating cool spots which will result in warping or twisting and possibly, the inability to reflow the component needing to be replaced.

When creating a pre-heat profile, it is important to measure the topside temperatures at several locations including locations close to and away from known heat sinks as well as the area surrounding the work site. Only when the temperatures of all locations have a variation of less than 3 to 5°C and show signs of stability, can we say with certainty that the entire board is thoroughly warmed.

There are several options for preheating and assembly from the underside of a board that include conductive, convective and radiant.

Conductive methods are typically ineffective as they are difficult to con-trol and require a very close proximity of the board to the hot surface. "Hot spots" are often created at the contact points between the hot plate and the PCB.

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Convective methods are effective but are not necessarily efficient, as air is a poor medium to transfer heat and is very susceptible to environmental changes which can affect process con-sistency.

Large Boards

If preheating of boards over 10 x 10-in. (254 x 254mm) is required and convective pre-heating methods are used, large amounts of power are required. This typically means a dedicated 220V power supply. In addition, the effectiveness of convective heat application can vary easily as ambient temperature changes or if fans or other devices that can disturb air patterns (even people walking by) in the facility are present. This means that a pre-heat profile developed in one location in a facility, such as a laboratory, will not necessarily have the same results when run in another location, such as the pro-duction floor.

Radiant heating sources are efficient for pre-heating and are effective when used on large boards. They are control-lable, can be operated at 110V, 60Hz or 230V, 50Hz with average current draw and are an effective and stable medium for transferring heat as it is not dis-turbed by changes in environment, such as fluctuations in air patterns. As a result, it helps to ensure a repeatable process.

When working with double-sided boards, the distance between the heat emitter and board is usually increased which can make conductive and convective methods ineffective. Radiant emitters cover a larger area than either conductive or convective methods and are more effective over greater distances.

In addition, radiant media penetrate materials to a certain extent so in many cases pre-heat temperatures are reached faster and more evenly with-out subjecting the bottom surface of the board to high temperatures for longer periods of time as with convective methods.

Regardless of the method used, the same basic target parameters exist and generally will follow those of the preheat phase in a reflow oven. Target topside temperatures should fall between 95 and 105°C across the assembly and reach that point no faster than 1 to 5°C per second. By achieving these results, the rework or repair operation can generally be performed as normal, and with normal set temperatures and time allowances. It is important to note that once the rework or repair task is completed, the assembly should be allowed to cool naturally and within the guidelines set forth by the process.

There is a wide variety of benchtop preheating systems available on the market today, that are designed to meet or exceed virtually all assembly and rework requirements. The most common-ly used are either radiant or convective, and can be found to suit most assembly sizes. In addition, there are pre-heaters that have a single heat source, or plates, as well as ones with multiple plates that can be controlled independently of one another to ensure homogeneous temper-atures across large boards with varying degrees of density.

Rework and repair of electronic assemblies has long been viewed as a somewhat subordinate function within the overall manufacturing process. It is critical though, that we view this necessary segment on the same technological level as the original assembly of the board itself. We wouldn't dream of turning off the pre-heat phase in our reflow ovens or wave machines. Why would we ever consider reworking without it?

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