Dual Preheater Rework System Prevents Damage to Dense Lead-free Assemblies

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By Ed Zamborsky and Paul Wood

Advances in PCB and component technology have created higher demands on the equipment used to repair and rework array components. It is no longer possible for the operator to simply increase the reflow temperature and expect safe and controlled component removal. These uncontrolled operators can damage the latest lead-free assemblies by utilizing older and less capable rework systems.

PCB Technology

The latest generation PCBs are becoming more complex as customer demand drives them to smaller and more compact footprints, one of the most common devices; the smartphone/PDA has increased its functionality while becoming more user friendly and much smaller. To design these devices, the industry has responded by increasing the PCB thickness to accommodate the increased I/O density of BGA and stacked BGA devices. In addition, to control the thermal energy they have been forced to increase the number and weight of the embedded ground planes. This results in high cost and high density boards with very demanding rework applications. As an example, current 3G and 4G phones are being produced with up to 12 copper layers, while larger server boards can have up to 24 layers of copper. This means that more heat capacity is needed to reflow and rework these PCBs, while the temperature maximums for the component lids remains the same at 260°C, which in turn is very close to the melting temperature of the internal materials used to assemble them.

Component Technology

The BGA solder ball pitch is constantly evolving downward. For example, a typical 35mm square BGA with 1.27mm pitch has a ball count of 680. Today that same package size with a pitch of 1.00mm now has a ball count of 1156 balls. This increase of package density requires 40-50% more heat capacity to safely rework the part. In the era of leaded solder, an operator would typically increase the top air temperature in an attempt to reflow the part. Today, with the lead-free solder the reflow temperature is very close to the maximum component lid temperature. The simple operator solution of temperature increase is disastrous for the component under reflow. These high topside temperatures can result in; die interconnection damage, component delamination and "dog ear" warping of the corners of the package which can cause catastrophic bridging.

POP or Package On Package components pack even higher densities into the component footprint. Aa simple 15mm BGA usually has 196 balls. The POP version, which has a smaller pitch and 3 layers, can have up to 1300 or more solder connections. These packages are very sensitive to top side nozzle temperatures, so the only practical solution is to provide additional heat capacity from the underside of the board.

New Packages Old Solutions

With existing models of single pre-heater rework machines, the operator is forced to rework these difficult applications by increasing the bottom heaters to very high and sometimes maximum heater output temperatures. This high output usually causes the adjacent underside components to be very close to solder melt temperatures.Tto prevent the bottom side components from falling off, the operator must raise the nozzle temperature even higher to achieve component solder ball melt, raising it to unsafe temperature levels. This temperature maxing, typically results in component rework processes that are not repeatable, which in turn equates to very poor rework yields. In addition, this technique frequently over heats the top of the component with temperatures in excess of 260°C.

New Packages New Solutions

The true solution for today's more complicated lead-free components is to provide a rework system with the versatility to allow the selection of different heating areas for the bottom of the PCB assembly. This dual heater design provides the option of heating the entire PCB during the preheating zones of the process and then automatically switching the heating area to concentrate the heater energy exactly where it is needed to rework the selected component. This redirection of energy allows the part to be reflowed at lower and safer nozzle air temperatures. The component and PCB are thus protected from excessive soldering temperatures while at the same time staying below the maximum component lid temperature of 260°C.

A simpler way to describe this system would be to imagine a large high capacity heater positioned to heat the bottom of your PCB, because of its size, you have no choice but to heat the entire board, but now in the center of this heater resides a separate smaller heater that can be activated to heat only a select portion of the board. This smaller heater is precisely positioned under the reflow nozzle, creating a virtual vertical reflow oven.

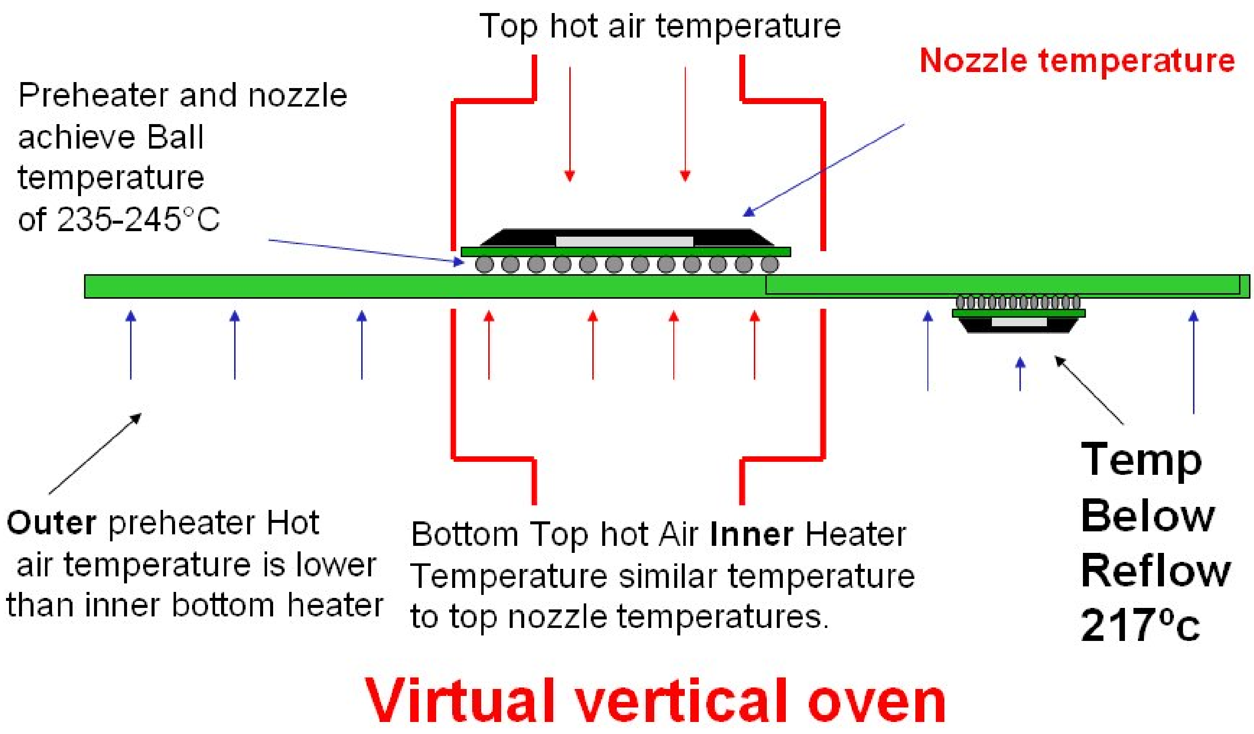

Figure 1

As you can see from the graphic above (figure 1) our objectives are simple; we want to achieve the reflow of the solder balls within the range of 235-245°C, the lid temperature below 260°C and the adjacent component solder joints well below the solder melt temperature of 217°C.

Key Benefits of the Dual Zone Pre-heater include:

- Increased productivity
- Increased rework yields
- Reduction of rework cycle times protects the component under rework from thermal damage
- Better management of the narrow lead-free process window without reaching excessive peak temperatures that damage components, connectors, adjacent solder joints and the PCB substrate

As you can see in figure 2 (below), during the reflow process the large bottom heater (subzone) is utilized in pre-heat 1(aqua) and pre-heat 2(yellow) zones of the profile, while at the same time the topside nozzle temperature is set well below the subzone temperature. This allows for a controlled warming of the PCB without worries that the topside nozzle temperature is causing damage to the component with excessive temperatures.

During the soak zone (gold) and peak zone (red)the system is programmed to switch the large pre-heater off and the smaller pre-heater on, this allows the overall board temperature to stabilize and the target area to safely reach reflow temperature. It can also be observed that the topside nozzle temperature remains set below the bottom subzone temperature; this means that a greater portion of the reflow energy is provided by the bottom heaters. This energy shift is important for the safety of the component, but it also allows the operator to achieve repeatable reflow of the most demanding lead-free assemblies which ultimately results in the high rework yields needed in today's competitive manufacturing arena.

Finally in the cooling zone (blue) both bottom side blowers are utilized while at the same time the topside heater is bypassed, introducing room air thru the reflow nozzle. This cooling zone creates a controlled cooling rate of approximately 4–6°C per second to achieve the best possible environment for proper solder joint formation.

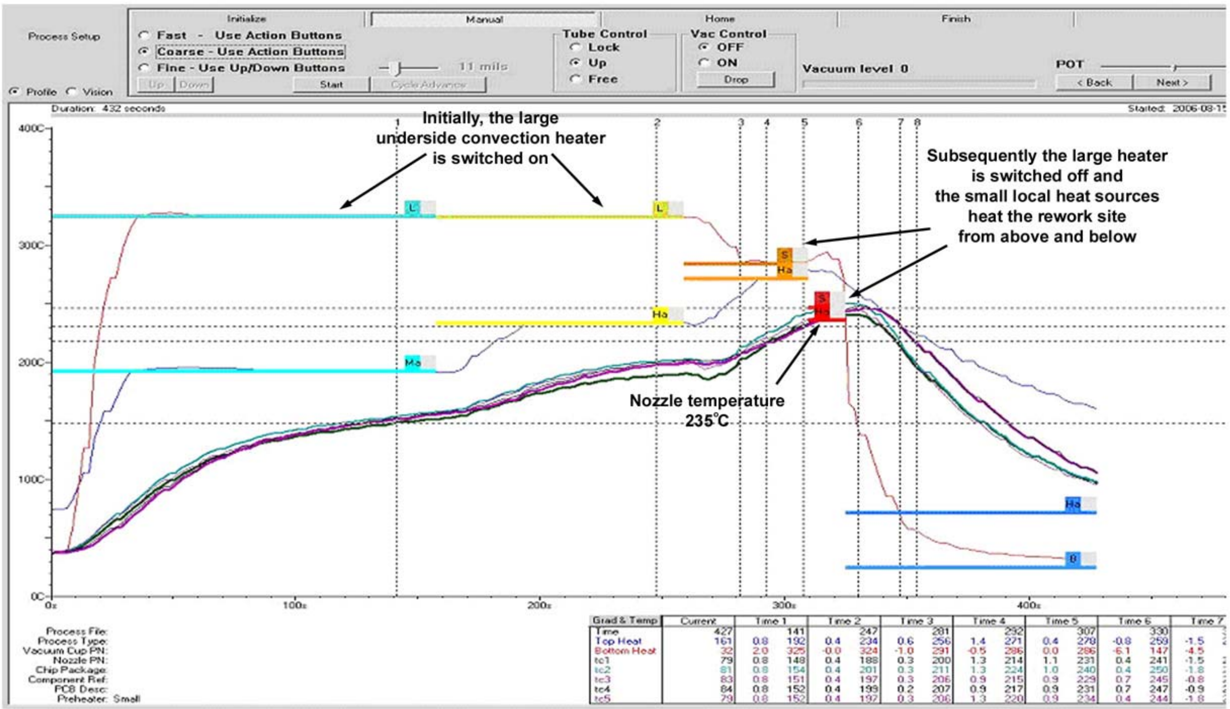

Figure 2

Conclusion

Component packaging and solder technologies have evolved, but until today the BGA rework system has seen only minor improvements. The reliance on older and possibly outdated rework equipment has finally reached the point where that legacy machine perceived to be saving money is actually costing more in reduced thru-put and damaged components. With the introduction of the dual zone bottom heating technology on the APR Series of rework machines we can meet the thermal demands of today's complicated and high value assemblies, while reducing the risks associated with rework and at the same time saving money by increasing assembly yields.

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1547 N. Trooper Road • P. O. Box 1117 • Worcester, PA 19490-1117 USA
Corporate Phone: 610-825-4990 • Sales: 800-832-4866 or 610-941-2400
Fax: 800-854-8665 or 610-828-5623 • Web: www.techni-tool.com