Getting Ready to Rework Lead-free

By Ray LaFleur

Getting ready for lead-free rework requires a basic understanding of rework system design. Simply speaking, this relates to the capabilities and/or limitations of a rework system to achieve repeated satisfactory repair results for lead-free rework applications. All systems are not created equal, and this is especially true concerning the lead-free application challenge.

One typical production environment scenario goes something like this: "I have a high-mix or prototyping production environment; our assemblies are continually in a state of design flux. Maximized yield and reliability has always been top priority, but now with lead-free we are uncertain if our existing systems will be up to the lead-free task. If not, what do we look for when we buy?"

First and foremost is package size flexibility. A system should be flexible enough to handle both small flip chip packages and large (>50 mm) area array packages. Other key considerations include heating control, uniformity in heating being delivered, and soak time necessary for effective lead-free rework. Specifically, removal and replacement is complicated by the variety of parts, pastes, board thickness, board layering and composition. For each board, the user must develop a reflow profile that includes a given package and/or solder paste in the profile equation so as to create a profile nearly identical to the original manufacturing process. This is especially challenging if the rework system is not equipped with auto profiling software. Simplifying the rework process can be accomplished if the rework system has the following development processes integrated into its software package:

- *Minimize Initial Data Inputs.* Some systems require the user to input the board and part thickness information, flux activation times, start and end peak temperatures, and time, which can be tedious and time consuming.

  Other systems only require entering the pre-heat; ramp, soak and reflow time; and temperatures. The rework stations then will "learn" the amount of energy required to heat the solder on various board and paste thicknesses.
- *Auto Profiling.* Auto profile eliminates the need for trial-and-error methods and "automates" the rework profile process for the operator, allowing the user to attach a thermocouple to the board, enter the desired soak and reflow times and temperature, and hit start.
- *Profile Analysis Software.* Without profile analysis software to automatically determine whether the "profile" is acceptable, users must examine the profile charts or graphs and manually make the calculations to determine soak and peak time and temperatures. With the software, the input from the thermocouple showing the junction temperature of the component is graphed and displayed in real time.

"Getting ready for lead-free rework requires a basic understanding of rework system design."

System Hardware Design Considerations

Other system design considerations include adaptable board handling, reflow nozzle sizes/design/limitations, component and board heat source, sources for air (as required), and other variables required to handle a broad variety of components and boards.

Not only does the transition from eutectic to lead-free solder mean a melting temperature increased by nearly 40°C, but the peak temperatures increases to 250°C and a possible increase in the soak time at the peak temperature. The other challenge is to reach a liquid state at a lower temperature gradient across the part (approximately 4 to 5°) as compared to 5 to 10° for eutectic soldering. This narrow process window will require a significant change in the rework equipment, as well as the heating technology to be more efficient and maintain better control over ramping temperatures. It also must tightly control the maximum temperature to which the board and components are exposed.

Many rework systems today rely predominantly on 1,600 to 2,000 W convective top heaters and a 2 to 4 kW area array plenum hot gas bottom heater. The issue with these types of systems is that even though they have a lot of power, they cannot deliver it in an efficient, balanced manner. While this design may be adequate for eutectic lead processes, this type of system lacks the necessary heating efficiency and delivery to melt lead-free solder in the required time, or the uniformity necessary to repeatedly achieve satisfactorily repair results for lead-free rework applications.

The lead-free rework system must provide localized uniform top and bottom hot gas heating in combination with uniform board heating. Newer systems use a combination of hot gas and dark infrared (dark IR) heating to control and deliver uniform heating. This combination of hot gas and IR requires less power, typically <1 kW, for top and bottom heating, as compared with conventional top and bottom hot gas systems.

Conclusion

To address lead-free applications, the following considerations should be considered for existing equipment or when making a new purchase:

- Ability to provide uniform heating
- Ability to perform data logging
- Auto profiling and profile data analysis tools
- Ability to set heating ramp rates
- Flexible board and component handling
- Adequate board support
- Ease of setup and operation.

To perform rework effectively and safely, the above requirements should include a combination of the considerations discussed throughout this article. SMT

Ray LaFleur, product manager, may be contacted at FocalSpot Inc., 9915 Businesspark Ave, Suite A, San Diego, CA 92131; (858) 536-5053; E-mail: rlafleur@focalspot.com.