Considerations for Printing Lead-free Solder Pastes

Abstract

SMT printing will require reexamination and process adjustment when lead-free soldering is implemented. If a high quality solder paste is used and standard rules for SMT printing are followed, consistent stencil life, aperture release, print definition, high-speed print capabilities and print repeatability may be expected.

Introduction

As compared to tin-lead solder pastes, lead-free pastes should exhibit similar features on the stencil and many equipment set points should transition well. However, implementation of lead-free solder paste does necessitate some adjustment, as well as providing an opportunity to review and fine-tune several key printing parameters.

Many manufacturers currently use reduced aperture-to-pad ratios to prevent bridging and solder beading. Due to differences in the solderability characteristics of lead-free circuit board finishes and the inability of lead-free solders to spread as well as tin-lead, reduced stencil apertures may need to be opened up back to a 1:1 aperture-to-pad ratio. This ratio should not result in bridging because density differences between lead-free and tin-lead solder pastes results in less slump with lead-free pastes.

Print cycle times may need to be slowed, because some lead-free solder pastes tend to stick to squeegee blades after each print stroke. By slowing the print cycle time, any solder paste sticking to the squeegee blades should fall back onto the stencil prior to the next print stroke. Squeegee speed is the traverse speed of the squeegee during the print cycle. These typically range around 1 to 3" per second, with many printers capable of 0.2 to 8" per second. When setting up a printing process, the print cycle should first be adjusted to an on-demand cycle rate, where the printer is printing "just in time" for the placement equipment.

The faster the squeegee speed is, the higher the squeegee pressure generally must be. As squeegee speed and pressure increase, so does the amount of friction generated at the squeegee/stencil interface. This can promote greater paste shear, possibly resulting in slumping, under stencil bleed-out, and pad-to-pad bridging.

Squeegee pressure is the downward pressure exerted by the squeegee blade onto the stencil surface during the print cycle. A typical starting point for squeegee pressure for a lead-free solder paste is 1.5 to 2 lbs. of pressure per linear inch of printable area. Squeegee pressure should be adjusted to just high enough to achieve a good, clean, topside wipe of the stencil surface. Leaving paste behind on the stencil surface can promote poor aperture release, torn prints, insufficient solder coverage and premature paste dry out.

Separation distance is an adjustable distance to which the printed circuit board (PCB) and stencil separate at a controlled speed at the completion of the print stroke. Working in conjunction with separation speed, this controlled parting continues until the separation distance set point has been reached, at which time the speed of PCB and stencil separation increases to its maximum. This function allows for controlled clearance of the solder paste from the stencil apertures, providing for more uniform and repeatable paste deposits.

Separation distance should be enough to allow all deposited paste to clear the stencil apertures prior to the increase in separation speed, which occurs when the separation distance set point has been reached. In general, the greater the separation distance and slower the separation speed, the more reliable and repeatable the paste deposition, the more reliable and repeatable the paste deposition.

Snap-off is the programmable distance between the topside of the PCB and the bottom side of the stencil. It can be used to aid the release of solder paste from the stencil apertures, as well as to increase paste volume on an assembly.

If equipment is calibrated correctly, board thickness is properly set, and snap-off is set to zero, this should result in on-contact printing. This setting allows for full "gasketing" of the stencil to the component pads during the print cycle, thus preventing bridging related to paste bleed-out, even on ultra-fine-pitch components. On-contact printing also provides for a more uniform paste deposition and more consistent paste height.

Conclusion

High-output, repeatable lead-free SMT printing is taking place at many manufacturers. While printing results significantly depend on the specific solder paste being implemented, it is equally critical to ensure that the appropriate print settings are understood, instituted and verified. Issues such as aperture-to-pad ratios, print cycle times, squeegee speed and pressure, separation distance and speed, and snap-off should be examined closely and adjusted in accordance with the solder paste in use and the specific application.