



# Creative Solutions to Stencil Printing Challenges

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Too often we think of a stencil as a simple, single-thickness foil with apertures defining positions where solder paste bricks are to be deposited. In today's world of complex PCB designs, flip chip, and BGA assembly, a more versatile printing tool is required. It is important for SMT process engineers to understand the stenciling capabilities available to print solder paste, glue, and flux on PCB substrates. This article will explore some of these stencil capabilities and how they address specific printing issues.

## **High-density, Small SMT Devices**

Examples of challenging, small SMT devices include 0.4- and 0.5-mm micro-BGAs, 0.4- and 0.5-mm-pitch QFPs, 0.5-mm-pitch QFNs, and 0201 and 01005 discrete devices. Most small handheld electronic products contain some or all of the above devices. The required small apertures pose potential problems in achieving efficient paste transfer during the printing process. The inside aperture walls must be very smooth to promote efficient paste transfer. Electroform or laser-cut stencils with post-processing treatments of electropolish and nickel plating provide smooth inner aperture walls and are preferred for these printing applications.<sup>1</sup>

## **Intrusive Reflow of Thru-hole Devices**

Intrusive reflow is becoming popular as it eliminates the wave soldering or hand soldering process, especially with lead-free printing.<sup>2</sup> Stencils must be designed to transfer sufficient solder paste to achieve full solder fill between the component lead and the board hole, as well as

provide positive solder fillets. Step-up stencils that are thicker for the thru-hole apertures are sometimes required to achieve sufficient solder paste volume.

### **Components with Coplanarity Issues**

Coplanarity problems can occur with RF shields, surface mount connectors, and CBGAs. One solution is to use an electroform or laser-cut stencil with a step-up in stencil thickness in the area of the device with coplanarity issues. The additional solder paste height assures good paste contact to all planes of the component.

### **Raised Areas on the PCB**

Examples of this process challenge include raised vias, raised component reference designators (CRDs), board-edge hold-down clips, and additive traces. A stencil-based solution is to chem-etch relief pockets around the raised areas on the contact (board) side of the stencil.

### **Tall Obstructions on the Board Surface (>25 mils)**

Consider this example. Chip components or flip chip die (25-mils height) already are mounted on the PCB and paste must be printed on the SMT pads. The stencil solution is a 3D 5-mils thick electroform stencil with formed relief pockets 30 mils high for clearance of the mounted devices.

In another scenario, you may have two PCBs joined with a 100-mil-high flex circuit. The solution is a 3D electroformed stencil, 6 mils thick, that has a 110-mil-high relief pocket formed to clear the flex circuit. The stencil would have apertures on either side of the relief pocket.<sup>3</sup>

### **Squeegee Blades for Uneven Board Surfaces**

For the first case described above, the solution is a metal squeegee blade with a 1-mil-wide slit laser-cut at specific locations in the blade. This slit allows a portion of the blade to rise up and traverse the raised relief pocket while the remainder of the blade is in contact with the surface of the stencil, with apertures on either side of the raised relief pocket. Once the raised pocket is cleared, the full length of the blade remains in contact with the stencil to print through the apertures. There may be 1-mil-wide spacing in the blade as the blade travels across an aperture, but this causes little loss in paste fill and transfer for the aperture.

Now consider the second example. In this situation, a metal squeegee blade that has a 110-mil notch cut in the blade is used to clear the raised relief pocket in the stencil. An electroform blade is a good candidate for this application. The notched blade provides positive contact with the stencil on both boards on either side of the raised relief pocket, while preventing excessive paste build-up.

### **Conclusion**

SMT process engineers should remember that an SMT stencil is not simply a single-thickness foil with apertures. A variety of stencil technologies and stencil designs are available to provide solutions to difficult printing tasks. If raised features on the PCB are causing board-stencil separation, relief pockets can be created on the contact side of the stencil to resolve this issue. If small apertures for micro-BGAs and QFNs are not releasing sufficient solder paste, electroform or laser stencils with electropolish and nickel plating will provide better paste transfer. If components with coplanarity issues are causing a problem, a step-up stencil will provide higher

paste bricks to resolve this issue. Since electroform stencils can be constructed in 3D, process engineers should rethink printing applications on uneven boards. What used to be impossible now is possible. And, we can't forget the squeegee blade. Cutting small, 1-mil (25- $\mu$ m) slits at appropriate locations is helpful in improving print performance for large step-up or step-down stencils.

**REFERENCES:**

- <sup>1</sup>. Coleman, W. "Stencil Print Performance Studies," Conference Proceedings of the SMTA International Conference 2001, pp. 94-101.
- <sup>2</sup>. Coleman, W. & Oxx, G. "Intrusive Reflow of Lead Free Paste," Parts I and II, *SMT* November and December 2007.
- <sup>3</sup>. Coleman, W. "Step Stencils," Proceedings of the APEX Conference 2006.

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