

| Component ID | A.R. | T3-88.75% | T4-88.50% | T5-88.75% | T3-89.00% | T4-88.75% | T5-88.50% |
|--------------|------|-----------|-----------|-----------|-----------|-----------|-----------|
| C6 SMD | 0.50 | 39 | 38 | 47 | 44 | 43 | 51 |
| S6 SMD | 0.50 | 50 | 50 | 56 | 53 | 53 | 58 |
| C6 NSMD | 0.50 | 24 | 31 | 34 | 33 | 30 | 47 |
| S6 NSMD | 0.50 | 41 | 45 | 50 | 49 | 46 | 58 |

Transfer efficiency comparing 8mil circle vs. 8mil square aperture design

The area ratio for a 6mil square and 6mil circular apertures on a 3mil thick stencil equals 0.50. In comparing the two, however, the volume for the square solder paste deposit is greater (~108 cubic mils) than the circular deposit (85 cubic mils). The additional paste volume provided by the square aperture may help reduce the graping phenomenon. Of greater importance though, is the increased transfer efficiency provided by the square aperture. As shown above for both solder mask defined and non solder mask defined pads of the same area ratio, the square aperture design provides more consistent transfer efficiency, reducing the potential for the graping phenomenon.

CONCLUSION

To reduce the graping effect, it is vital to ensure an optimal printing and reflow process. Using the guidelines provided for the area ratio and good process/equipment set-up will ensure good transfer efficiency. From a reflow standpoint, decreasing the total heat input will decrease the likelihood of the effect. Using a RTP type profile with a ramp rate of ~1°C/second is suggested.

Material factors also influence the outcome, with an increase in the observance of graping as the solder paste particle size decreases and the area of surface oxides increase. Water-soluble solder paste chemistries do not provide the oxidation barrier that resins do for no-clean chemistries and are more prone to the graping effect.

Though the area ratio for circular and square aperture designs may be equal, the potential for the graping phenomenon increases with circular aperture designs due to decreased paste volume and decreased transfer efficiency.

Though not performed in this experiment, but observed with customer evaluations, the use of nitrogen does diminish or eliminate this effect.