

## Improve Solder Scavenging of Large Area-array Sites

### SUMMARY

When an area array component is removed for repair, there typically is an excess of solder remaining on the board side, which can cause short circuits by bridging between adjacent joints and/or open circuits by preventing the complete collapse of all joints. It is imperative that the excess solder be removed to present a uniform surface across the site for proper component attachment, as BGA rework can be both time consuming and costly.

Using a multi-channel thermal profiler with a high sampling frequency and a high-power soldering iron, we show that the thermal uniformity across the pad array is improved when using ultra-wide tips, resulting in reduced process time and fewer thermal excursions for the PCB during the repair process.

We are not concerned with the component except in those rare instances where the component is to be reballed. In those cases, we can simply view the component as a smaller PCB, and repeat the scavenging process of choice.

This article explores ways to improve that repair process. Thermal uniformity across the pad array is improved when using ultra-wide tips.

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selection of alloys, giving less of a safety margin between the necessary reflow temperatures and the thermal damage thresholds for the material sets. New material systems that were introduced, as a result, demanded more careful attention to the thermal profile during repair, and the need for further sophistication of the solder scavenging process increased.

### Response to the Challenges

The industry responded with new and improved tooling and processes to help processing engineers minimize the opportunities for further damage during repair. Examples are the development of thermal profilers with higher temperature resolution and greater sampling frequency, and the introduction of wide soldering iron tips in more geometries. Careful thermal profiling of the scavenging process develops a process that minimizes the peak temperature, as well as the extent, duration, and repetition of these thermal cycles that constitute a successful repair process.

### Experiments

In this instance, we deployed a multi-channel thermal profile with a high sampling frequency\* to capture the data from 16 thermocouples embedded across a 34-mm<sup>2</sup> pad array as the solder is scav-

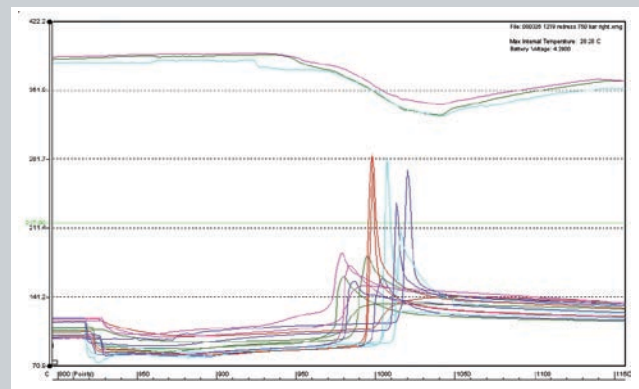


Figure 1. Thermal profile of scavenging process using 35-mm ultra-wide tip.

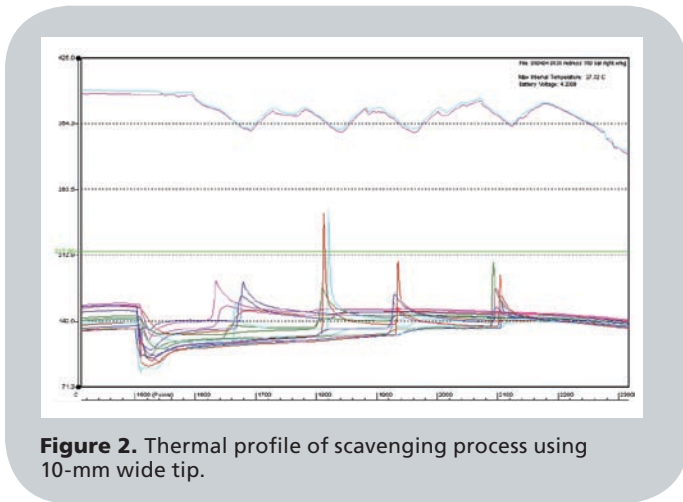
enged by 1) a 10-mm wide and 2) a 35-mm ultra-wide soldering iron tip.<sup>20</sup> The thermal profiler sampling frequency must be high enough (0.1 Hz) across all channels to capture the sudden changes in temperature that take place as the tip passes over the pad.

A series of sixteen 40-ga. K-type thermocouples were flush-mounted across an array of BGA pads on a 0.060" thick lead-free PCB by first removing the BGA, then drilling selected pads out from the top side of the PCB with a #79 (0.0145") carbide via drill.

Thermocouples were then mounted within the hole and backfilled with a suitable epoxy to prevent thermocouple motion during the exercise. This also stops impinging hot air or radiation from the back-side preheater skewing the readings.

The epoxy serves to immobilize the thermocouple in a position where the bead is nominally at the surface and exposed to the same thermal profile as a pad on the array. To best accommodate thermocouple placement, an epoxy with excellent capillary flow properties that also snap cures at a low temperature is used. Beads are registered against a flat surface adjacent to the soldermask side of the board prior to curing, in an effort to ensure accurate registration of the bead. A 40-ga. K-type thermocouple was also mounted in holes drilled in each end of the solder iron tips to monitor the tip temperatures throughout the process.

SAC305 alloy solder paste was stencil printed onto the array of pads and reflowed prior to scavenging. A 400°C soldering iron tip temperature was selected for both wide and ultra-wide tips. A 0.060" wide no-



**Figure 2.** Thermal profile of scavenging process using 10-mm wide tip.

clean braided copper solder wick was used with the 10-mm wide tip, and 0.080" wide no-clean braided copper solder wick with the 35-mm ultra-wide tip. The thermal profiler was set up to capture the profile from all 18 thermocouples in the PCB and in the tip, at a sampling frequency of 0.1 Hz. Boards were preheated to a bottom-surface temperature of 130C using an infrared board preheater.<sup>\*\*\*</sup> An RMA-type high-rosin liquid flux was applied across the site with a brush during heating and prior to scavenging.

## Results

A single pass across the pad array with the 35-mm ultra-wide tip was required to scavenge the solder from the BGA site. Using the 10-mm wide tip, four overlapping passes of the wick were required to completely scavenge the extra solder from the site. It was necessary to use a new section of wick for each pass of the tip, with a corresponding increase in process time.

The height of the residual solder on the pads relative to the solder mask surface and the overall warpage of the pad array were characterized simultaneously using Shadow Moire interferometry. On the first inspection, both methods yielded an equivalent, planar surface suitable for a replacement BGA.

As can be seen from the thermal profile of the process using the 35-mm ultra-wide tip (Figure 1), there is a single pass across the site, and the pads undergo a sharp thermal cycle as the blade passes over the array. Thermocouple temperatures vary greatly for a small vari-

ation in the mounting depth in the board. Using a high number of thermocouples as a hedge against variations in placement depth has the added benefit of yielding a profile of the temperature across the board section, from the mask inward to the cores.

For the 10-mm wide tip (Figure 2), there are four separate thermal excursions seen, resulting in repeatedly subjecting the board to sharp thermal cycles as each pass is completed.

An increase in the number and severity of the thermal cycle can degrade PCB lifetime with varying degrees of severity, depending on the board design and resin system. Excessive thermal cycling of a PCB can lead to premature failures resulting from pad cratering, barrel cracking, and other board-related issues. Further study is being performed on the impact of the various thermal profiles experienced in the course of solder scavenging on the reliability of the PCB.

## Conclusion

In the process of scavenging the excess solder from the board after removing an area array component, significant thermal challenges arise that call for increased monitoring. While improvements in thermal profiling equipment allow for higher temperature resolution and greater sampling frequency, other opportunities arise to minimize the chances for damage during repair. Sudden changes in temperature that take place as the soldering iron tip passes over the pad make it of great benefit to minimize the number of those passes. We found that the use of an ultra-wide soldering tip, in conjunction with an enhanced thermal profile, permits one-pass scavenging. Use of a single iron tip pass keeps the number of thermal excursions and process time to a minimum, preserving PCB life as a result. Benefits are immediate in terms of process improvement and — by extension — time, money, and product saved. **SMT**

\*Unovis researchers used the MEGAM.O.L.E 20 thermal profiler with MAP software.

\*\* The CFV series ultra-wide soldering iron tips and MFR series power supplies were used.

\*\*\*Board preheat was performed with a VJ Electronix system.

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