StencilQuick™ Lead-Free Solder Paste Rework Study

BEST
Project #:1818-02

January 17, 2006

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BEST StencilQuick™ BGA Repair Study, Project #1818-02

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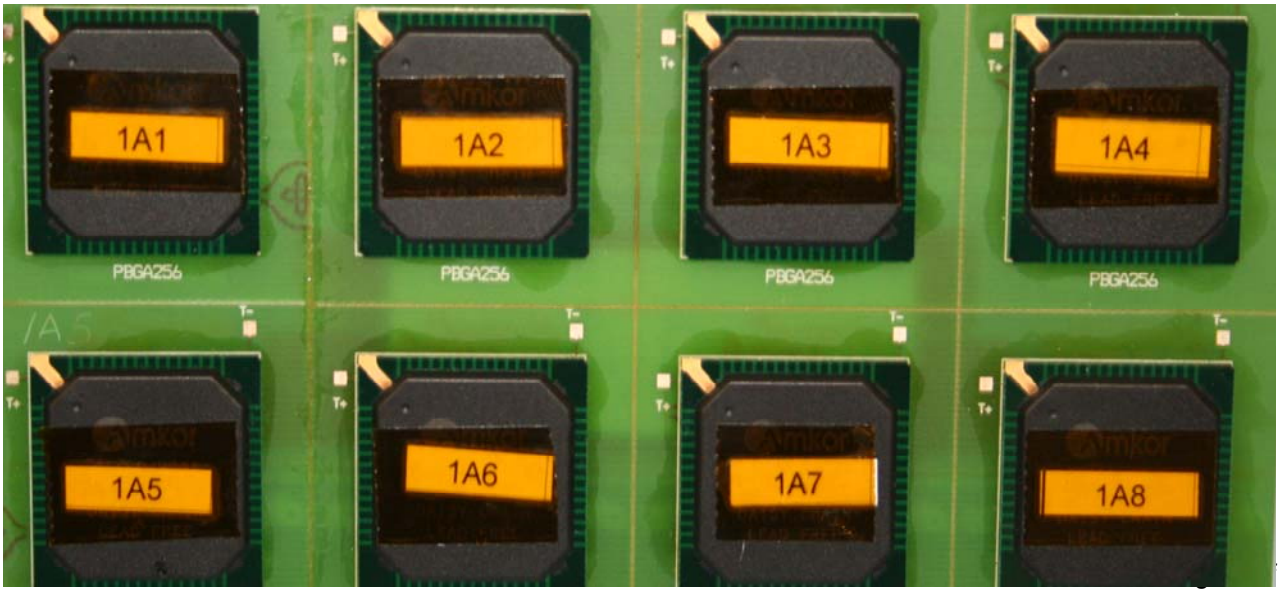
PROJECT GOAL

The goal of this project is to evaluate the reliability of lead-free BGA solder joints with a variety of different pad sizes using several different BGA rework methods. These methods included BGAs reworked with both flux only and solder paste attachment techniques and with or without the use of the BEST stay in place StencilQuick™. The daisy chained test boards were placed into a thermal test chamber and cycled between -25ºC to 125ºC over a 30 minute cycle with a 30 minute dwell on each end of the cycle. Each BGA on the board was wired and the continuity assessed during the 1000 cycles the test samples were in the chamber.

Samples were prepared using BGA Daisy Chain Test Chips from Amkor with 484 I/O and pads at a 1.0 mm pitch. The daisy chain test cards are a single sided FR4 material with 1 oz. copper and lead-free immersion silver finish. All of the solderable surfaces were tinned with a SAC-305 solder to duplicate the rework process for a lead-free BGA. The card pad sizes were .025 inches with a 1mm pitch. As the BGA is configured, 4 separate Daisy Chain circuits exist for each BGA and 4 BGA's are contained on each test sample card. This results in a total of 16 Daisy Chain circuits per card.

StencilQuik™ is a polyimide film with apertures corresponding to the BGA pads. A high temperature pressure sensitive acrylic adhesive is used to attach it to the board. The thickness of the adhesive is .004 inches and the film thickness is .004 inch for a total of .008 inches.

BGA Daisy Chained test board



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Sample Description and Process Histor

Three groups were created with four boards in each group (a total of 32 BGA's) with the following rework operations performed:

PCB prep	Print lead-free paste on all the pads. Reflow the PCBs. Use of wicking braid to remove all the solder from the BGA lands. Clean with IPA.
Samples 1A	Liberally apply no-clean paste flux to the BGA lands. Application can be made using a finger. Use BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.
Samples 1B	Use stainless steel mini-stencils (0.008" thick) to apply lead-free, no-clean solder paste to the BGA lands. Use the BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.
Samples 2A	Liberally apply no-clean paste flux to the BGA lands. Application can be made using a finger. Use the BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.
Samples 2B	Use stainless steel mini-stencils (0.008" thick) to apply lead-free, no-clean solder paste to the BGA lands. Use the BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.
Samples 3A	Use **StencilQuiks™** and the standard **StencilQuik™** application process to apply lead-free, no-clean solder paste to the BGA lands. Use the BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.

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Samples 3B Use **StencilQuiks** and the standard StencilQuik application process to apply lead-free, no-clean solder paste to the BGA lands. Use the BGA rework system for BGA placement on the 8-up array. Process the PCB through the reflow oven. Ensure that the reflow oven settings are for lead-free. Remove from oven. Do not clean. X-Ray and save images for each BGA. Perform continuity test for each daisy-chained BGA device.

Test Data - 4 Segments x 20 BGA's x 2 Sample Types x 6 Data Pts.
960 Total Data Points

Failure Criteria - 20% increase in Resistance of any Segment from Initial Measurement.

For assembly of Group 3, a polyimide film stencil is attached to the test cards with the BGA pads exposed through openings in the film. Solder paste (Alpha Omnix 305) is then applied using a .008 inch thick stainless steel rework stencil using a handheld squeegee, filling each of the apertures. The film stencil is not removed. A balled test BGA (.025 diameter / SAC305 Ball) is placed on the stenciled card and reflowed using the recommended profile from the solder paste manufacturer.

For Groups 1 and 2, where no StencilQuik™ is used, the same steps as above are used except for the application of the solder paste. The solder paste is applied by using a .008 inch stainless steel stencil and applying solder paste to the aperture openings. The stencil is then removed leaving the solder paste on the board. The balled test BGA is then placed on the circuit board.

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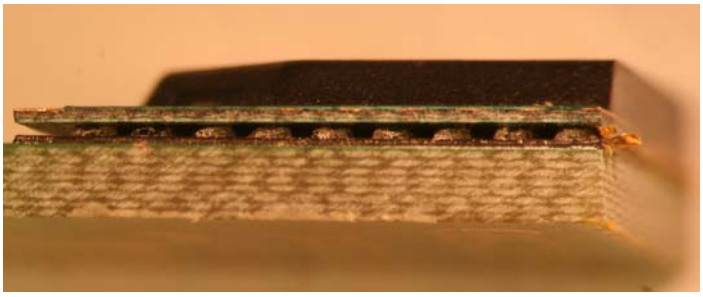
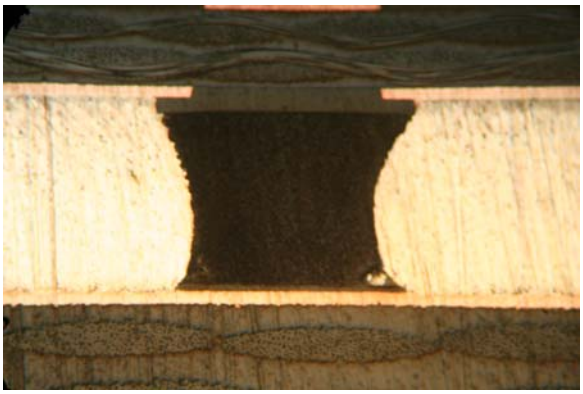
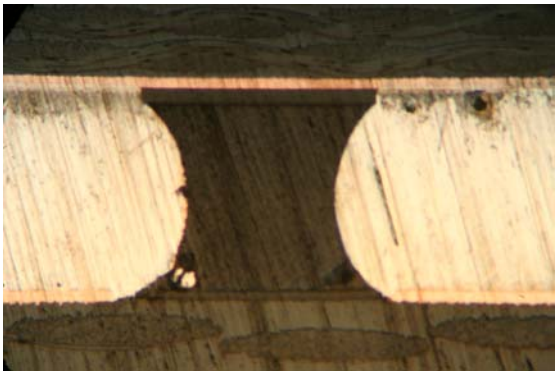


Cross Sectional view of the BGA's after 1000 cycles (No open joints)



Group 1 A (No StencilQuik™)



Group 1B (No StencilQuik™)

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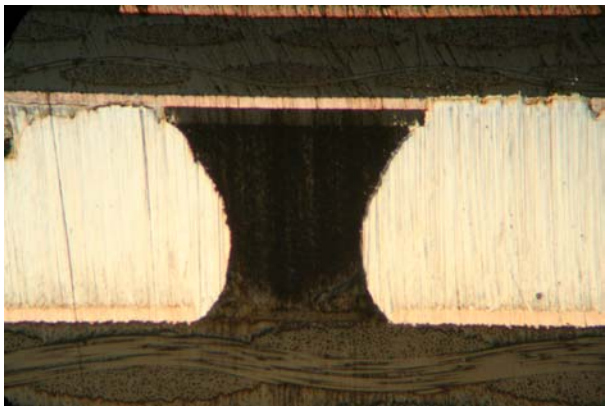
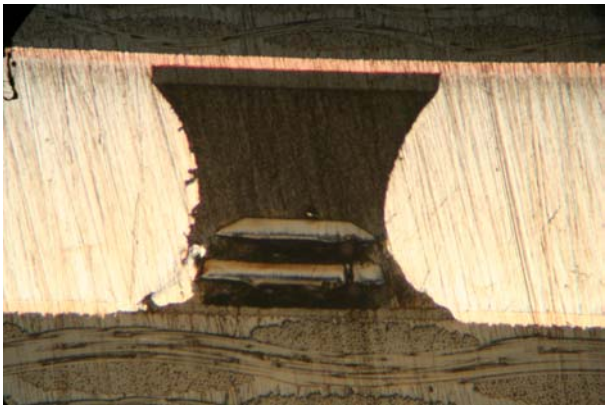


Group 2B (No StencilQuik™)



Group 3A (With StencilQuik™). Note the two layer constuction of StencilQuik™

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TEST RESULTS

BGA Site#	Grp 1A No SQ Small Pad Flux	Grp 1B No SQ Small Pad Solder Paste	Grp 2A No SQ Large Pad Flux	Grp 2B No SQ Large Pad Solder Paste	Grp 3A 2 SQ Small Pad Solder Paste	Grp 3B 2 SQ Large Pad Solder Paste
1	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
2	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
3	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
4	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
5	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
6	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
7	Open initially DNT	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
8	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
9	Open initially DNT	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
10	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
11	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
12	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
13	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
14	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
15	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
16	Open initially DNT	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
17	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
18	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
19	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
20	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
21	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
22	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
23	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
24	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
25	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
26	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
27	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
28	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
29	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
30	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles
31	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles	Pass 1000 cycles

DNT= Did Not Test

Conclusions– All test coupons passed the 1000 cycles of -25º to 125º C conditions with a 30 minute ramp and 30 minute dwell. First pass yield of 1A sample group (flux only, no StencilQuik™) was the lowest in the group.

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