The experts of the Martin Company and their solution for component wetting issues

# Troubleshooting Shop-floor Difficulties

### Introduction

Recently a large global player approached us with a problem. They needed an initial assembly solution for brand-new components. Their boards and CSP specimens could not safely be soldered due to wetting problems at the solder joints.

In this case, the focus was a CSP (chip scale package) sized 10 x 13 mm, pitch of 1.0 mm, and 64 solder balls measuring 0.4 mm in diameter. This typical new-generation SMD (figure 1) has apparently been used by many companies worldwide in Europe, the U.S. and Asia. The component was about to be implemented in pre-production and prototypes.

The problem was that after the lead-free soldering procedure, the part did not rest evenly on the board assemblies. The solder joints were not properly reflowed due to poor wetting behavior of the solder alloy used for the CSP balls. It was initially just a cosmetic issue not showing any electrical malfunction. However, X-ray analysis **(figure 1)** revealed that many large voids were hidden in the solder joints. These voids were sure to cause failures months down the road. Some users had tried compensating for these irregularly inclined components by putting tiny weights on the part during the soldering process. But obviously this could only be a provisional answer.

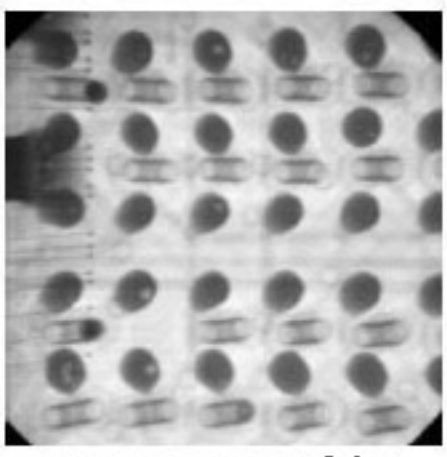

**Fig 1: X-ray image of the insufficiently soldered and irregularly positioned CSP. Note the elliptical outline of the soldered balls and the white spots (voids).**

### In search of the miracle cure

Using the client's existing board assemblies, PCBs and components, we analyzed their process step by step to determine the source of the problem. Was it the PCB, the solder alloy or the solder balls? Paste print, the component placement and the flux media used could all potentially be to blame.

In some cases the application of a more aggressive flux can remedy wetting problems. But we didn't feel this was the problem here. Nor, given the improved quality and reliability of semiconductor components over the last two decades, did we think the CSPs or the rework station were at fault. Maybe the PCB itself was the problem. To determine whether or not it was, we carefully examined the soldering profile's main parameters such as the volume of air stream, the temperature and the dwell time. Beginning with the normal soldering temperature profile for the usual lead-free SAC (tin-silver-copper) solder paste, we then tested all possible variations. We also applied different flux creams, and cleaned the solder balls and PCB pads with special glass-fiber pens. The latter is definitely not a good option on a shop floor, but was helpful in our investigation.

### Throw them out: inadequate solder balls

The PCB seemed fine. Then we shifted our attention to the solder balls used in reballing. When we applied new ones, the problem vanished. We also slightly modified the soldering tool used for the reballing procedure, in order to provide a more optimal stream of hot air to the CSP balls for reflowing. The new BGA/CSP solder balls were made from Sn96.5Ag3Cu0.5, providing solid, reliable and wetting-proven solder contacts. Additional X-ray analysis **(figure 2)** showed the sharp contour of well-reflowed solder balls, with no irregular level variations between the PCB surface and the CSP. This indicated that the small, constant gap required between them was maintained. The voids in the new reflowed solder balls were also virtually eliminated.

For the soldering task we used the Auto Vision Expert 09.5 **(see sidebar)** to remove of the old and inadequate solder balls, reball, generate the correct soldering profile and precisely reflow according to this new profile. The reballing system **(figure 3),** consists of a metallic frame (stencil) with a grid of holes imaging the ball array and a miniature oven. It can be used with all our rework units. Please see the sidebar for a more detailed description of the equipment, its functionality and the easy-to-understand workflow.

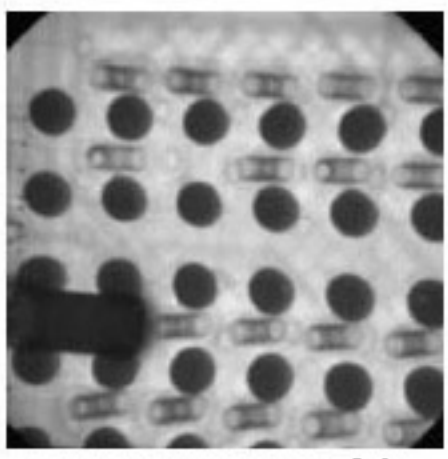

**Figure 2: X-ray image of the correctly soldered and regularly positioned CSP. Note the exact circular outline of the soldered balls, and that there are practically no voids.**

**Figure 3: The reballing set – the Mini Oven, the device and on top of it the mask for the solder spheres (balls), operated by the Hot Air Pen according to the reflow profile generated and stored in the Auto Vision Expert system.**

The cleaned and Flux Pen-coated CSP is placed in the tiny furnace and covered by the grid mask. Then the solder spheres are distributed over the mask and the closed Mini Oven is placed on the reversed Hot Air Pen (which, in turn, is controlled by the rework station). The suitable soldering program is then started from the Auto Vision Expert.

The Auto Vision Expert 09.5 is an effective and versatile device featuring a wealth of useful and practical tools and functions for the entire repair-task palette, as well as for special jobs in the pre-high-volume stage. All tasks can be easily, precisely and repeatably provided without extensive operator training.

### Safe rework with precision and intuition – whether lead-free or lead-bearing

The compact Expert 09.5 features a flexible PCB support and is suitable for assemblies up to 500 mm long. Background heat is delivered to the board by a fast-acting IR area underheater that self-calibrates each time it's switched on. On the topside an application-specific soldering tool supplies the patented Precision Hot Air system for secure rework. Adapting the workstation to differing board and component sizes takes just seconds. Featuring patented Auto Vision technology, a precision vision system monitors and controls parts placement, allowing easy management of even highly demanding repairs. The system employs Zero Risk Rework heating technology to fit into the extremely narrow lead-free process window without board warping or overheating.

**Autovision Expert 9.5**
**The complete Auto Vision Expert system encompassing the base unit with the moving camera arm and the PCB underheater, the control module with LCD (left), the monitor (right) with the interactive program Easy-Solder, and the quick change magazine for placement nozzles and soldering tools (foreground)**

The heat delivered at the top to the solder joints follows a very precisely controlled (± 1 %) hot-air stream, with no calibration necessary by the users. In order to comply with ISO 9000 and other quality-assurance directives, the Soldering Pen can be cost effectively exchanged or re-certified using the set Easy Cal III. The temperature is evenly distributed across a component within ± 4 K, resulting in virtually simultaneous reflow of all solder joints of a component. The proven asymmetric airflow avoids overheating the center of the components. The Rapid IR underheater transfers the background energy into the PCB within a few seconds without exceeding the maximum permitted ramp rate of 3.5 K/sec. This allows the reduction of hot-air temperatures for the top convection heating and provides for fast, smooth processing.

The intelligent application software for the PC-controlled Expert 09.5 system meets the requirements on clarity, ease-of-use and faster processing. It documents rework steps with visual and automated support. For control and traceability of work quality, the optional report function collects and records all relevant data and images in the background. The easy-to-use setup consists of three brief steps: selection of board, choice of SMD, and decision on the type of process. The program automatically establishes the process parameters such as cycles, temperatures and airflow rates in the different profile sections. The Auto Profiler and the Quick Profiler generate profiles for specific conditions.

The vision system can measure asymmetric SMDs, too, and place them with the required offset. The Auto Vision Placer receives the coordinates of the corner points of the component and the placement positions with just a few mouse-clicks. The system automatically calculates the precise movement coordinates, and with the help of the vision system all motion axes are continuously controlled. The reballing system is available separately for CSPs, QSNs and BGAs. The Mini Oven Set measures 27 x 27 mm and features Capton tape and cutter for preparation. The metal frames (stencils) for the distribution of the solder spheres can have dimensions from 5 x 5 mm to up to 20 x 20 mm, and others are also possible. The BGA reballing Mini Oven accepts assemblies from 15 x 15 mm to up to 45 x 45 mm.

**New Freestanding MultiReball 03 Reballing Station**

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