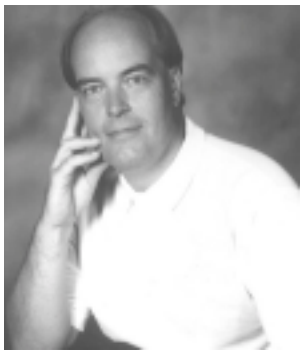
A, B, C of BGA Rework and Repair



The removal and replacement of Ball Grid Array (BGA) devices can be simple provided the correct equipment and fully training staff are used. With some little tricks of the trade and the attention to detail during design the equipment required can be fairly simple. The following procedure can be used for reference when training staff production staff and is the procedures used when ever the author conducts training classes.

The use of simple 1.6mm laminate dummy BGA components can increase the number of devices available for production trials and operator training prior to moving on the real thing. Often companies are loathed to buy many real BGAs for operator training due to the cost of the parts. Remember the only way to gain expertise is through practical experience so staff member need devices to experiment with. Its also another business opportunity as the parts have a similar thermal characteristic to a BGA. The same technique canbe applied to CSP and flip chip parts.

The key to successful rework is monitoring the process, BGA site temperature and time. This will allow simpler rework equipment to be used without the fear of damage to boards or parts.

BGA (Ball Grid Array) Component Removal

The following procedure may be used to remove and replace Plastic Ball Grid Array (PGA) components. It may also be used for Chip Scale Packages (CSP). In the example photographs laminate BGA dummy parts are illustrated. These were used on production features in exhibitions in different parts of the world and were an ideal vehicle to illustrate high volume manufacture.

Initially if the components are to be re-used or retained for failure analysis the board assembly should be baked to remove any moisture in the device. This will also prevent any damage to other BGA parts in close proximity on the circuit board.

To reduce the amount of solder spiking on circuit pads and BGA during component removal a liquid flux is flooded under the component using a fine needle dispenser. In many cases flux may be eliminated as all the solder on the surface needs to be removed. An uneven surface will make placement of BGA parts difficult this is particularly true if a mini stencil is to be used for paste printing.

A specially selected nozzle is applied over the BGA and hot air (220-230^{o}C) is applied. Hot air is forced into the nozzle and will, in time, cause the solder joints to reflow. Nitrogen may be used as an alternative to air for both component removal and replacement. The rework process is best monitored with a thermocouple lead noting pre heat, peak temperature and the time when reflow takes pace. The lead may be placed inside the nozzle or, better still, under the centre of the BGA using thin cable. When complete reflow has occurred a vacuum pickup is applied to the top of the device and the part raised from the board surface. If the centre of the device base has been at 200^{o}C for over 10 seconds all the ball terminations will have probably reflowed. Care should be taken in confirming reflow.

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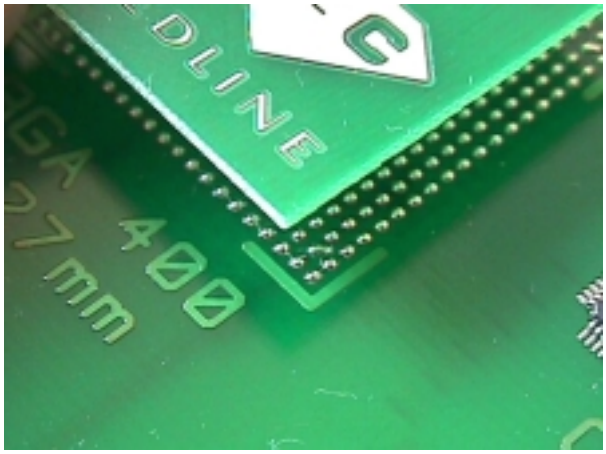
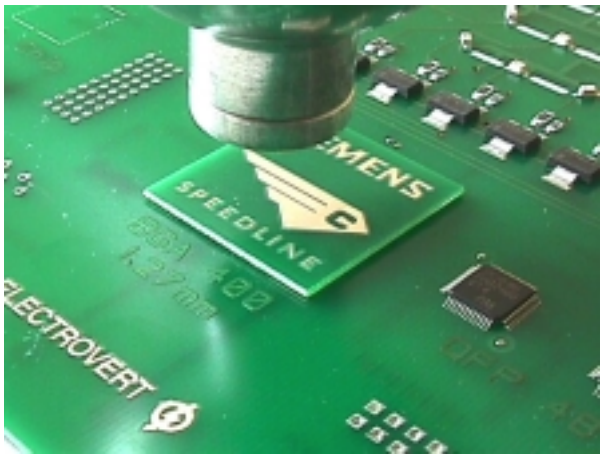


When all the terminations have reflowed and this has been confirmed the BGA can be lifted off the board using a vacuum pickup tool.

The same technique is used with infra red rework equipment, In this case the IR light beam is focused on to the device and surrounding board until reflow is detected. This may be determined by lightly touching the side of the device before lifting the component with a vacuum pickup tool. Touching the side lightly easily detects reflow of all joints just like traditional surface mount component removal. Both IR and air rework can be successful the key is monitoring the correct temperatures, after all both techniques can also damage a board.



Shows a hand held IR rework tool being used to reflow all the solder joints on the BGA prior to lifting the part from the board. This type of procedure is supplemented with under board heating to approximately 120-130^{o}C prior to applying top side heat. (image 180.jpg)

The pad surfaces should now be checked for any damage. Prior to cleaning the surface of the pads the surface should be allowed to cool for a couple of minutes.

<u>BGA Component Replacement</u>

As it is not possible to see the pad and terminations during replacement all the pads should be flat prior to replacement. Solder wick may be used with a soldering iron or a vacuum de-soldering tool with a flat ended vacuum tip. A flat blade soldering iron tip is also a good method for pad flattening.

If there is no evidence of spiking on pads due to the correct use of flux, solder removal may not be necessary. Removal of the solder to flatten the surface does make life easy.

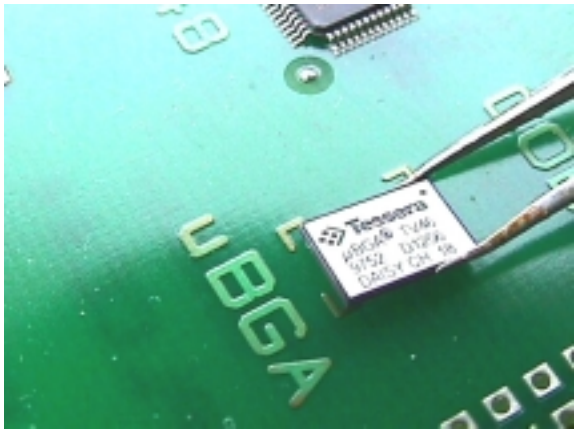
Pads may be re-coated with flux prior to placing the new part. A tacky flux gel can be used as an alternative to flux. When applied the flux gel holds the part in position even with board movement. The board should be cool when the flux gel is applied. As an alternative the gel may be applied to the component terminations which can be very successful.

Flux or gel may be used on boards for rework as there is already a coating of tin/lead left from the removal process. They should not be used on copper or gold board for prototype assembly.

Solder paste may be used as an alternative. In this case a mini stencil is used to print the paste on to the pad array. Small rework stencils have become very popular today and are available from a number of stencil manufacturers. The mini stencil consists of a 0.006" stencil with foldable side walls. The side walls are only partly etched to allow the four sides to be folded. This provides four side walls which prevent the paste moving off the stencil during printing and a surface to hold and position the stencil.

If a mini stencil is used without side walls Kapton tape may be placed around the edge of the stencil. This holds the stencil onto the surface of the board and it prevents paste spilling out and contaminating the board surface. Using paste may seem a little time consuming but it is the preferred process for replacement. It overcomes coplanarity issues, provides the fluxing agent and replicates the original process for assembly. Paste can also be applied to the ball array with a mini stencil in a small jig which overcomes the issues of space on many boards.

A new BGA part is placed on to the surface of the fluxed pads or paste deposit using the corner alignment pads on the board or using guide marks. The marks are invaluable for component positioning.



Shows the replacement of a 0.025" pitch component being manually placed with reference to the corner marks on the circuit board pattern. Corner marks are invaluable to aid the assembly operation and to assist during prototyping of BGA or CSP.

Special optical alignment systems are often used for part positioning. These image the pads and the base of the device and align them together. This is an expensive option and can be avoided if care is taken during design to add corner marks.

If alignment pads are not available on the board design they can be temporarily applied in two corners of the device with a pen prior to initial removal of the BGA. If special optical alignment is not available on the rework equipment this is a necessity. When the rework cycle is complete they may be cleaned off and no one will know how the alignment was achieved.

Shows the laminate BGA placed accurately using the BGA corner marks.

Shows a uBGA placed and reflowed in place with reference to the corner marks without vision.

The part is then reflowed using similar settings to those used during component removal, allowing an additional 10-15 seconds for complete wetting of the pad surface. Lightly touching the side of the device can demonstrate complete reflow and the surface tension will pull the part back into line. This is not a necessary part of rework but can be useful during operator training.

A full demonstration of the rework and repair of surface mount components and BGA parts is illustrated on training video tapes and interactive CD ROMs produced by the author. A separate video is available for x-ray inspection of solder joints either before or after rework.

Bob Willis is also a process engineer providing engineering support in conventional and surface mount assembly processes. He runs production lines for suppliers at exhibitions and also provides seminar and workshops world wide. Bob has one of the largest collection of training videos, interactive CD-ROMs and training material in the industry. Bob will be presenting four Master Classes at APEX in California, he will also be presenting classes at SMT Nuremberg in Germany for those engineers visiting the show. For further information on how Bob may be able to support your staff contact him via his web site **www.bobwillis.co.uk**