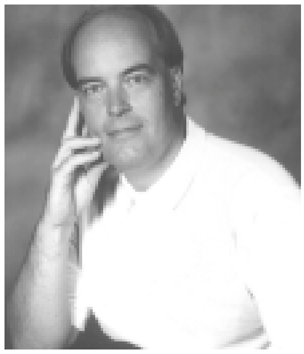
Through Hole Reflow Eliminates Wave & Selective Soldering



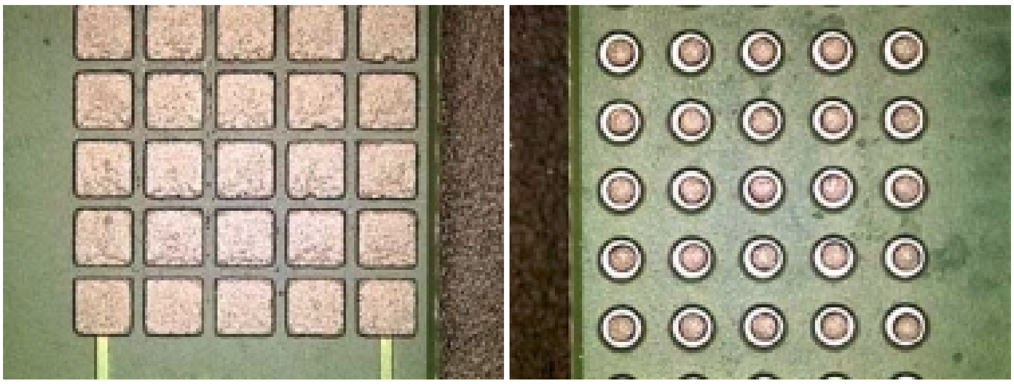
Pin-in-hole, intrusive, pin-in-paste and multi-spot soldering are all terms used to describe a reflow process that allows through hole components to be soldered without the need for wave soldering or purchasing selective soldering systems. With the growing interest in lead-free soldering there is also a need to simplify the process stages in manufacture, particularly with many companies in Europe looking to adopt an environmentally friendly process.

The complete Pin-In-Hole Reflow (PIHR) process was featured at the Productronica Exhibition in November, one of the largest electronic assembly shows in the world and a must for engineers to get updated with the latest technology trends. Here we illustrate the process used and the results obtained. This should help engineers implement the process correctly. Reliability has been discussed before and here we provide the latest details on the NPL lead-free joint testing project showing that you just can't break a good through hole joint.

The Harting Pin-In-Hole Process Line

The basic PIHR process starts with stencil printing the surface of the board with solder paste. Traditionally stencil printing is conducted for surface mount terminations but with PIHR solder paste it is also printed over the through hole pads and into the holes. On the production line an Alpha Metals tin/silver/copper alloy was used printed through a 0.006" 150um stencil. The OMNIX 310 paste flux system has also been designed to work with other alternative alloys like tin/silver, tin/silver/bismuth and tin/silver/bismuth/copper.

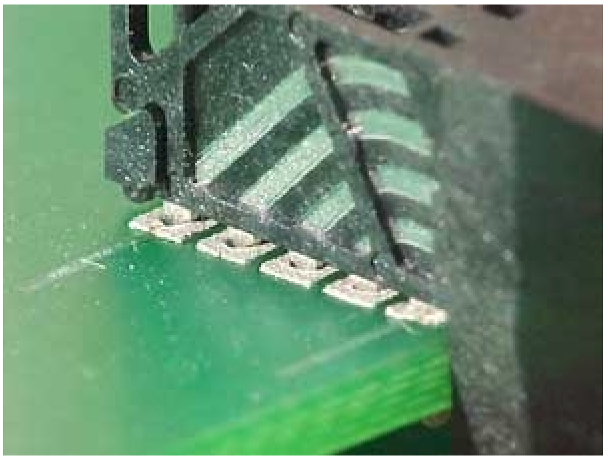
The paste volume printed on the surface of the board is determined by the pitch of the connectors and the standoff features of the connector body. The selection of the stencil thickness was also determined by other fine pitch parts on the board. Good design of the connectors allows the paste volume to be maximised on the surface of the pads and onto the surface of the solder mask. Guidelines on paste, stencils and paste volumes required were provided at the exhibition with PIHR process reports and technology updates.



The print deposits produced maximized the surface area on the topside of the board as well as through the holes as shown on the two examples above

The MPM 1500 printing process used on the line featured a Rheometric sealed print head which has the benefit of increasing the penetration capability of the paste into the hole as well as minimising the waste associated with traditional blade printing processes. The print penetration into the holes in the example photograph shows better than 80% fill. Standard blade printing can be used for through hole parts with a thicker stencil but a sealed head can markedly improve the hole filling capability.

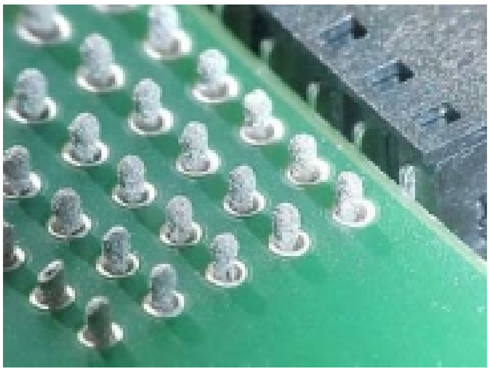
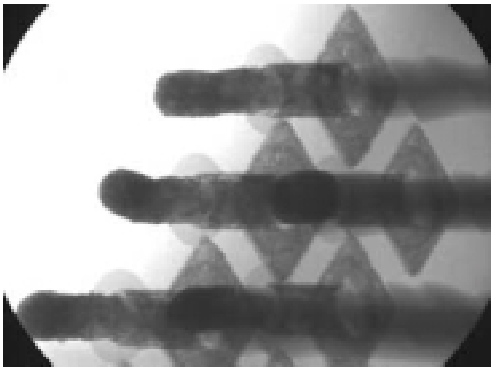
After printing, surface mount components may be placed on the surface of the paste prior to insertion of the connectors into the pasted through holes; depending on the design the connectors may be inserted first. It has often been difficult for engineers to automate the odd form assembly process due to the need to invest in additional odd form equipment. Now with selected placement machines like the Assembleon ACM having the capability to insert all the popular surface mount shapes and odd form parts it opens up the opportunity for greater use of PIHR technology. The printed board design on the production line featured three connectors, 0201 and 0402 chip components as well as BGA, Flip Chip and QFP parts.



The har-busHM+ is a 110 pin row connector especially designed to minimise temperature differentials on the surface of the board during reflow and remain designed for automatic assembly

A 96-way right angled connector, 16 pin post header and har-busHM+ were all assembled using a universal head. Vision checks were made on each part to accurately align the through hole leads with the plated through hole. It should be noted that accurate insertion requires vision systems to have the capability to check through hole position accuracy as well as the traditional fiducial marks associated with surface mount technology. It is well understood that drilling and photo imaging of printed boards can have a large tolerance, the base PCB materials can change their dimensions by 0.001" per inch.

Ideally all components are provided in tape and reel formats for production but on long parts like the 96 way they can take up valuable feeder space so versatility is also important on packaging selection for odd form parts. While running the line three formats of packaging were used. Tape and reel for the har-busHM+, stick feed for the IDC post headers and machined plates for the 96-way edge connectors. As the plates were being used in a automatic tray feeder part positions were also provided for the other two connector designs to give added flexibility.

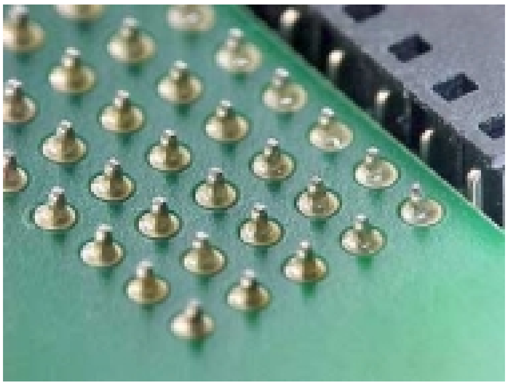
Two examples of the har-busHM+ connector after assembly and prior to reflow soldering. The first view shows the base of the board after insertion of the connector and limited paste displacement on the tips of the pins. The second view, and slightly more unusual, is the X-ray image of the board with the paste deposit visible on both sides of the board prior to reflow.

When automatic assembly was complete the board was conveyed to the reflow process to simultaneously reflow the surface mount and the through hole joints in one operation. The Bravo4 reflow system featured pin transfer conveyor to avoid contact with the pasted pins which protrude below the board surface. The size of the oven in terms of length and number of zones will be dependent on the throughput speed required. Basically an oven is selected for its throughput requirements and it compatibility of the product type and the peak temperatures required. The most popular lead-free solder pastes can be processed at 240oC or below. It is important to correctly profile the board assembly as the connector may be the largest component on the surface of the board in terms of mass so the through hole parts should be one of the areas selected to monitor and check the differential temperature on the surface of the board.

The profiles show selected positions on the board and the temperature variations across the board surface. The profiling was conducted using an ECD Mole profiling system.

Temperature profiling was conducted throughout the show to optimize the process. The temperature profile used had a peak temperature of 238oC with a liquidus time of 70 seconds.

In the case of a double sided surface mount assembly the connector side of the board would be processed second. However, it is also possible to process connectors and other through hole components on both sides of the board if required. The following are typical examples of solder joints produced with the PIHR assembly process on the har-busHM+ and 96 way right angled connector.




The solder joint strength and long term reliability are no different than with conventional wave or manual soldering operations. The joints also meet the visual requirements for national and international standards like IPC610. Harting have recently been co-operating with National Physical Laboratory (NPL) Teddington, London on a lead-free soldering project which allows customers to compare the results from production and from long term reliability testing. NPL has been running a DTI project in collaboration with industry to evaluate the solder joint reliability of various lead-free solders.

The NPL test board featured the 96 way connector included on the Productronica board using Pin-In-Hole Intrusive Reflow process. The design of the connector features and the stencil apertures were provided by Harting based on their own customer trials. The reliability project consisted of 145 boards with mixtures of the following lead-free alloys SnAgCu, SnAgBiCu, SnCu, SnPbAg and a standard tin/lead control. The test board consisted of a wide selection of surface mount components as well as the connector. To date the samples have been through thermal cycle testing of 2200 cycles of -55oC +125oC with dwell times of 40 mins. with no electrical failure. The final report on the NPL project will be presented at a future SSTC meeting with further details on their website.

A further feature of the NPL pin in hole reliability project involved the use of different stencil apertures in the printing process to obtain a range of solder joint volumes. As the optimum stencil/hole size/pin combination had been provided for the connector pins by Harting, it was necessary to both increase and decrease the final joint volumes.

Producing solder joints with varying volumes allowed a fair representation of joints that may be produced in production as well as covering the basic range of criteria of the IPC 610. This makes the final reliability results more meaningful when compared with visual joint quality used in the industry. As can be seen in the example photographs the joints produced on the Productronica line were at the optimum, but even where customers process or board designs do not allow this optimisation the reliability is not affected and has been demonstrated with the NPL collaboration.

For further information on the companies participating on the production line set-up by Bob Willis visit their individual websites:

Alpha Fry Technologies	***www.alphametals.com***
Assembleon	***www.assembleon.com***
Harting Connectors	***www.harting.com***
Merlin Circuit	***www.merlincircuit.co.uk***
Nutek	***www.nutek-europe.com***
Purex	***www.purexltd.co.uk***
Speedline Technologies	***www.speedlinetechnologies.com***

Bob Willis is a process engineering consultant working with Harting Connectors in Germany. He was responsible for co-ordinating the production line at Productronica; he produced the first video and interactive training products on Pin In Hole Intrusive Reflow technology. Bob has also set up lines in Germany at the Hanover Fair and Nepcon Electronics in the UK.

Bob Willis is 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**

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