Reworking QFN's Newly Developed Cost Effective Approach
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The Quad, Flat, No-lead or QFN (Figure 1) package is a lead-less package with low profile

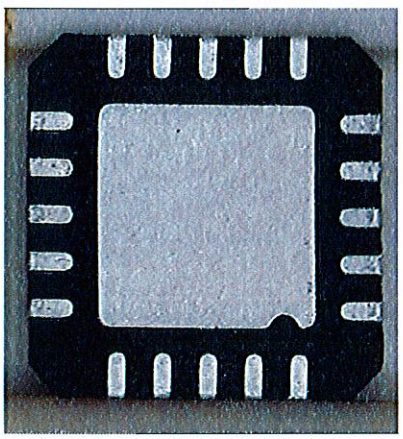

Figure #1-QFN picture "Typical QFN Package"

(1.0mm and less), moderate thermal dissipation and good electrical performance. Its SMT device leads are located on the bottom and sides of the package. QFN's are generally a challenge to rework as they are typically smaller in size and are beginning to be used in place of many QFP packages parts. Their use has steadily increased in recent years so much in fact that it is projected to soon supersede both area array and leaded QFP type packages[1] , especially as the proliferation of smaller multifunction handheld devices continues.

These leadless packages are used in tight spaces where it is difficult to use conventional solder paste printing rework methods (stencil and miniature squeegee). Other techniques such as device printing or paste dispensing where capital equipment is required to control the rework process requires a sizeable upfront investment.

This paper describes a new rework process for leadless devices where the devices can be manually placed without relying on capital equipment.

Current Processes Pasting onto the Component or Substrate – Automated Rework System

Let's review the most common rework processes for a QFN.

As with any rework process, the pasting of the component is a sequential process. Each step is designed to minimize the risk of a smeared solder paste pattern. A typical pad size for a 0.5mm pitch QFN is 0.25mm x 0.4mm and therefore the printing of solder paste

using a micro metal rework stencil requires extreme patience and a high degree of skill and experience.

The component to be reworked is fixtured into a holding module with the component pads exposed. An appropriately sized micro stencil is selected and placed into the alignment arm of the rework system. Next the stencil and component are viewed through split-vision optics for pad to aperture alignment. (Figure 2)

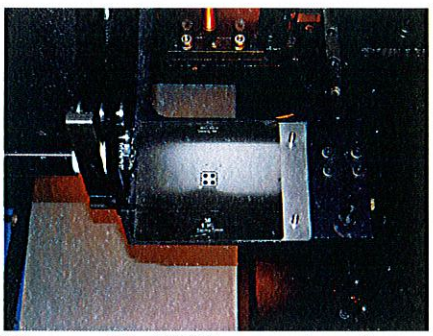

Figure #2- QFN rework using a split vision system and micro stencil/fixture <courtesy Mini Micro Stencil Inc>

After lowering the stencil into place both the stencil and component are locked into position with vacuum pressure and the stencil alignment are is detached from the stencil and moved out of the way of the work area. Solder paste is rolled into the apertures in the typical fashion. Once the paste is printed the stencil alignment arm is reattached to the stencil, the stencil is lifted from the surface of the component. The component is then flipped, exposing the body of the component to the pick-up nozzle. Split-vision optics is again used to align the component with the pads of the substrate. Next the component is lowered into position and reflowed using an appropriate profile.

The process for printing onto the substrate is similar to printing onto the component. with the major difference is being the paste and stencil are applied to the board. The use of a rework system with split-vision optics, vacuum capability, custom stencils, and a reflow heat source are all required.

There are several disadvantages to using micro stencils for the rework of QFN devices. Generally, the lead-time associated with the fabrication of new patterns and fixtures can take longer than is practical. In addition, these stencils can be fragile and bend easily which makes getting a good paste print via a uniform snap off from the land areas difficult to achieve. In addition the stencils need to be residue free and therefore require rime-consuming cleaning prior to each subsequent use in order to have the greatest likelihood of good solder paste release.

Paste Dispense onto Substrate

Another option currently in use is a solder paste dispensing system. A programmable gantry or board holder is programmed to dispense paste onto specific locations onto the substrate. (Figure 3)

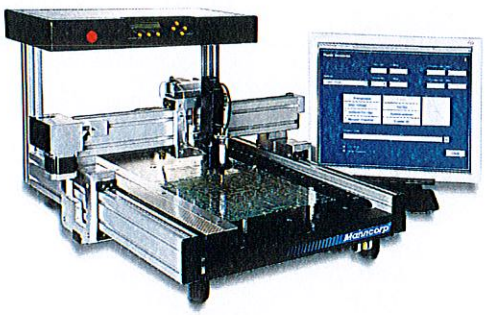

Figure 3-Paste Dispense System (Paste Dispense on QFN) <Courtesy Manncorp>

The substrate is placed into a holding fixture and locked in place. The programmed dispensing head moves to each designated location to dispense a consistent, preprogrammed amount of paste volume. Depending on the rework system in use, the program can also include a pick and place operation for the component. In these automated systems the component is placed onto a holding stage where a vacuum nozzle can retrieve it and place it onto the correct PCB location.

There are some advantages and disadvantages to this technique. Dispensing onto the substrate does offer flexibility by allowing the same equipment to be used for a variety of component configurations without custom stencils or fixtures. In addition the paste volume is consistent. However, one drawback to this technique is the time which must be invested in programming each component and substrate configuration. Dispensing can also be a time consuming operation limited for high IO count devices as the viscosity of the paste and nozzle size limit throughput.

Manual Soldering

In some cases a manual soldering technique can be employed for QFN rework. A hand held hot air rework tool is used in order to reflow the center ground plane. For this approach to work the QFN IO pads have to have a solderable toe surface to allow soldering iron access to each of the individual terminations.

This technique represents some difficulties for many devices. The process of using a handheld hot air unit lacks the control found in the other techniques. In addition manual soldering is highly dependent on the skill of the technician performing the work and on the design of the component.

New Solution – New technique

The latest addition to the rework technician's available technique is the "Stay in Place Stencil Bump" (2SB) of QFN rework[2]. Many of the concerns and drawbacks of the other methods discussed herein have been addressed and eliminated with this new technique.

The 2SB method employs the use of polyimide stencils, one temporary stencil to match the component and one to match the substrate. In the new 2SB method either the device or the both the device and the PCB have stencils placed over the land patterns to control the area where the solder is deposited. Firstly, the component is prepared by cleaning the pads of any residual solder, debris, or residue with solder wick and isopropyl alcohol. Next the precision component polyimide stencil is aligned and applied to the bottom of the component. (Figure 4)

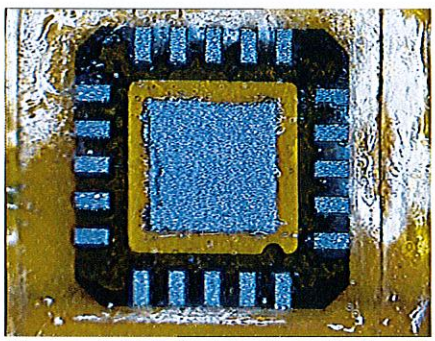

Figure 4-Polyimide Stencil Applied with Solder Paste Rolled into Apertures

Solder paste is applied with a manual squeegee. The component is reflowed according to the paste and component manufacturer's profile using any reflow oven or programmable heat source. After reflow the polyimide stencil is removed from the component and now has solder bumps instead of paste deposits or flat pads. (Figure 5)

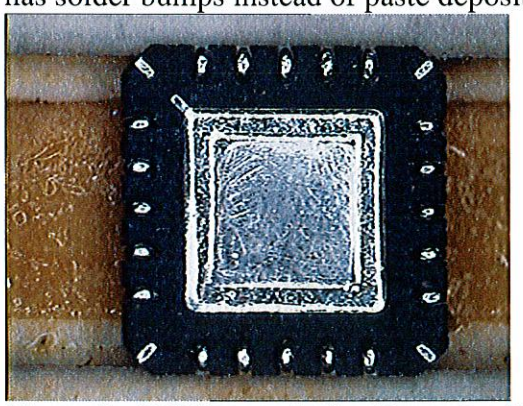

Figure 5- QFN bumped after Paste Application with Polyimide Stencil

The solder "bumps" are inspected for uniformity and consistency. Next apply solder paste to the substrate by first cleaning the substrate with solder wick and isopropyl alcohol. Align and place the semi-permanent polyimide stencil to the substrate. Roll the solder paste through the apertures of the stencil and wipe any excess paste from the surface of the stencil with a lint free cloth. (Figure 6)

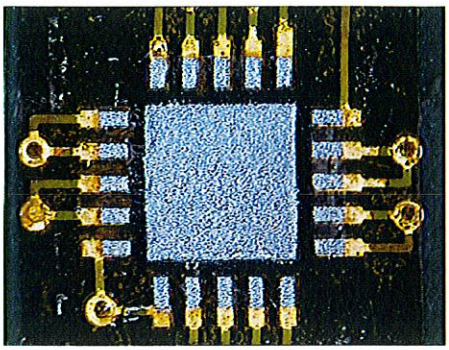

Figure #6-Solder Paste Applied on PCB with Polyimide Stencil

Manually place the QFN into the solder pasted apertures on the substrate stencil. As the solder bumps on the QFN align with the apertures the rework technician will be able to "feel" the solder bumps on the device slide into the wells of the stencil apertures. Reflow the component according to the appropriate profile. (Figure 7) After reflow, clean and inspect[3] the assembly to the appropriate standard.

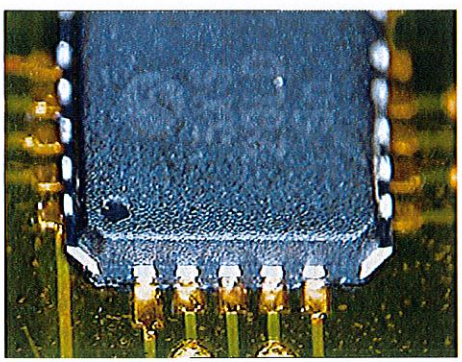

Figure #7-QFN Post Placement and Reflow

There are several advantages to this new method including:

- There is no need for the capital investment of a split vision rework or dispense system of U$20,000 or more.
- This approach does not require a highly skilled rework operator.
- This technique has a high throughput
- The rework process for QFNs becomes more reliable as the semi-permanent substrate stencil aids in maintaining electrical clearance of the paste and solder connections during reflow.

With the 2SB QFN rework method, the rework process is greatly simplified. Magnification, a steady hand, paste flux, solder paste and a squeegee and a

programmable heat source are all that is required for the proper rework of even the smallest QFNs.

References

1. Prismark November 2006 Addressable Market Study by Package Offering
2. US Patent pending BEST Inc
3. IPC A610 inspection guidelines for QFNs 8.2.13