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High-Precision Copper Foil Stencil Based on Quad Flat Package IC

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Abstract
With the rapid development of semiconductor technology and integrated circuit technology,integrated circuit has had a higher integration and more various functions, which caused most of IC have been packaged with serried pins in quantity. At this time, traditional manual SMTSurface Mount Technology, that would cause pins conglutination and lack of weld become inapplicable. This paper described a kind of manufacturing method of high precision copper foil stencil based on Quad Flat Package IC which was ameliorated from traditional manual SMT. This high-precision stencil will cost little to easily made and applied. Surface mounting of QFP-100 IC for instance will be accomplished efficiently.

Keywords
Integrated Circuit;Surface Mount Technology;Quad Flat Package;Copper Foil Stencil

I. Introduction

Over the past decades,semiconductor technology and integrated circuit technology have developed at a high speed,greater and larger integrated circuit chips will be made and applied in a wider range. However,most of LSI,Large Scale Integration,and ULSI,Ultra Large Scale Integration,were packaged as QFP,Quad Flat Package, square flat packaging technology,one of surface mounting packages. The pins of this package spread from 4 sides of it as gull wing. Ceramic, metal and plastic materials are used as package basematerial. [1] Quantitatively, the majority of package base material is plastic material. Without special note, QFP are plastic packaged in most situation. PQFP, Plastic Quad Flat Package, is the most widely applied LSI package, which was not only used on microprogrammed control unit chips, FPGA digital logic LSI, but also on VTR and audio signal processing analog LSI. It has many center distance standards of each pin such as 1.0mm, 0.8mm, 0.65mm, 0.5mm, 0.4mm and generally more than 100 pins. The ratio of chip area and package area of QFP IC is pretty small that it was suitable for SMT. Expedient operation and high reliability make it easily to be applied in wide field. [2]

It is pretty hard to solder QFP chips by hand because chips were equipped with plenty of extremely gracile pins and the distance between each pin center is 0.5mm or less. Nowadays, industrially automatic chip mounter named SMT was used to surface mount, which is the most efficient and reliable at present.[3] However, SMT will cost so much that it's inapplicable for small scale production and scientific research in universities. Therefore, this high-precision copper foil stencil based on QFP IC is necessary and worthy.

II. Manual Surface Mounting

Traditional four manual surface mounting methods for IC chips are as follows, 1. Soldering with cutting head soldering iron and rosin. Firstly, melting soldering tin equably on the four sides of QFP chip with cutting head soldering iron. Then scraping needless soldering tin between each contiguous pin with cutting head adhered melting rosin. This mounting method is easily operated and smooth. While obviously it only suits for chips of which center distance of pins is less than 0.8mm. Meanwhile, the PCB could be untidy because of rosin. 2. Soldering with solder paste and thermostat soldering station. At first, putting the chips on PCB painted with homogeneous solder paste. Placing the board on 300,thermostat soldering station for four seconds. It is high-precision and high-efficiency, while pins conglutination and lack of weld cannot be avoided for serried-pins chips since solder paste on each pin is not able to be assured either. Further more, this drawback is nonreversible. 3. Soldering with general stencil. Commercially available general steel-stencil sculptured by laser engraving machine could solder chips properly without pins conglutination and lack of weld. Nevertheless, it will cost a lot to make a simple steel-stencil by laser engraving. This stencil,expensive and inflexible, was limited by several specifications. So it's also unsuitable. 4. General stencil made by PCB engraving machine. Besides laser engraving machine, stencil of which pins distance is wide enough also can be made by PCB engraving machine. This stencil has a high requirement to engraving machine and stencil base material. [7]

Although the four methods of chips mounting on above have advantages respectively, their drawbacks are also inevitable and non-ignorable. In this paper, a new high-precision copper foil stencil based on QFP IC was introduced. Through it, surface mounting with solder paste and thermostat soldering station for QFP chips will be efficient, high-precision and low-cost. Pins conglutination and lack of weld also can be perfectly solved.

III. Manufacture of Stencil

The new high-precision copper foil stencil based on QFP IC is effortless to manufacture. Manufacture process can be divided into three steps: PCB drawing, heat-transfer process and chemical etching. In those processes, Altium Designer, heat-transfer printing machine and etchant are required. Next, the manufacture processes of copper foil stencil for QFP-100 chip will be presented as an example.

Step 1: PCB Drawing

Above all, Altium Designer was used to draw PCB of QFP-100 chip, and the Altium Designer needs over *V.10.0* . Firstly, creating a new project, and adding PCB document to this project. Next, generating the package outline drawing automatically in PCB library by the tool of Altium Designer according to the package dimensions of QFP-100 chip shown as figure 1. Drawing the

outline of stencil as figure 2.

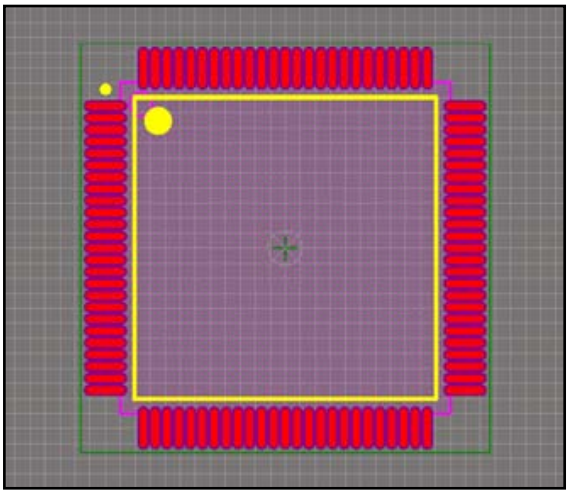

Fig.1 : Package Outline Drawing

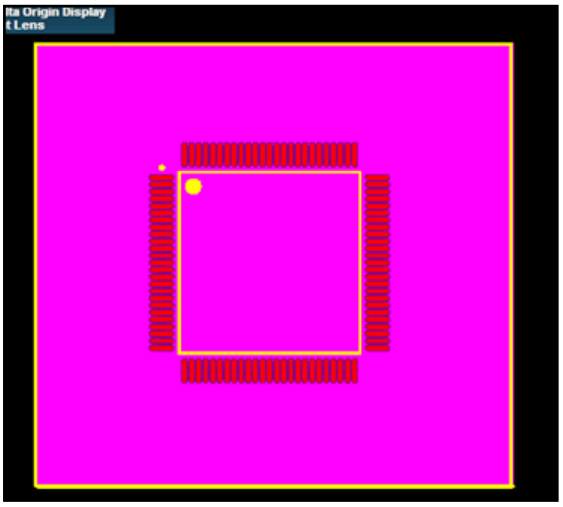

Fig.2 :Stencil Outline

Step 2 : Heat-transfer Process

Outputting the PCB outline drawing of stencil as 1:1 after inverting the color of it. Saving the PCB stencil drawing as a PDF, and then printing it on the heat-transfer paper as figure3. It is better to print the stencil drawing for twice to get a better display performance.

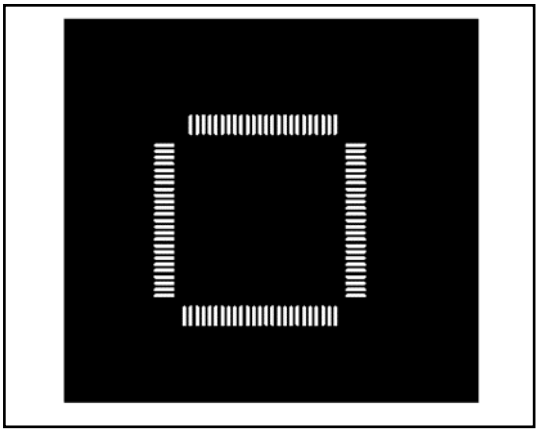

Fig.3 : Stencil Drawing

By experience, 0.1mm thickness copper foil is best choice for stencil base material. Then covering a piece of 4cm*4cm copper foil with that heat-transfer paper. After that□putting the copper foil into heat-transfer printing machineat 170□for twice to insure carbon was pasted on copper foiladequately.

Step 3 : Chemical Etching

First of all, etchant should be prepared. The most widely used etchant is blue environmental etchant compounded as following proportion.

Tab.1: EtchantProportion

70°Water	Etchant	Concentration
500ml	130g	0.26g/ml

It is alternative to compound etchant in a plastic basin showing in 80℃water to keep it warm for quickly etching. Etching time,about 20mins best,can not last too long, or pins could be broken. Hence the whole stencil is useless. Having etched, take it out and dry it. To this step, a high-precision copper foil stencil for QFP-100 has been made as figure 4. The picture shown in figure 5 is a high-precision copper foil stencil for QFP-64 also made by the method above.

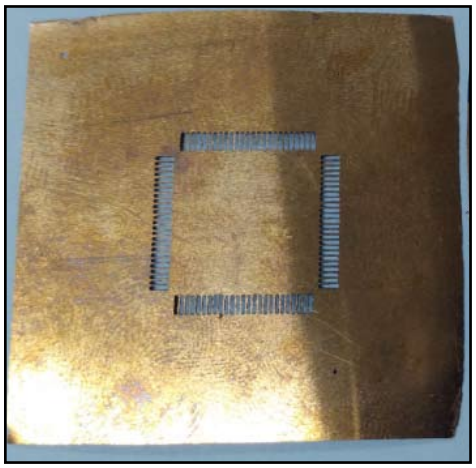

Fig.4 : Stencil for QFP-100

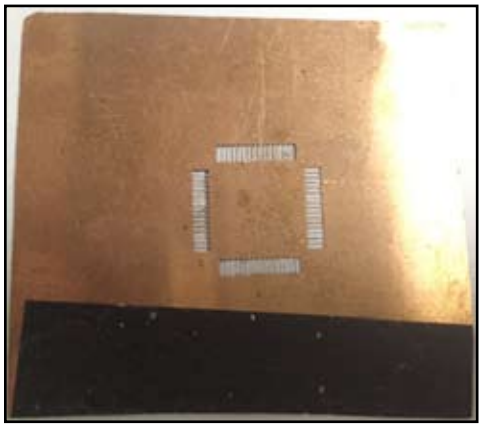

Fig.5 :Stencil for QFP-64

IV. Soldering with Copper Foil Stencil

A new high-precision copper foil stencil for QFP-100 chips is already prepared. How to mount the QFP-100 chip on the corresponding PCB is being shown as an example as follow. Making a PCB which one wants to mount chips on corresponding with the stencil as presented in figure 6.

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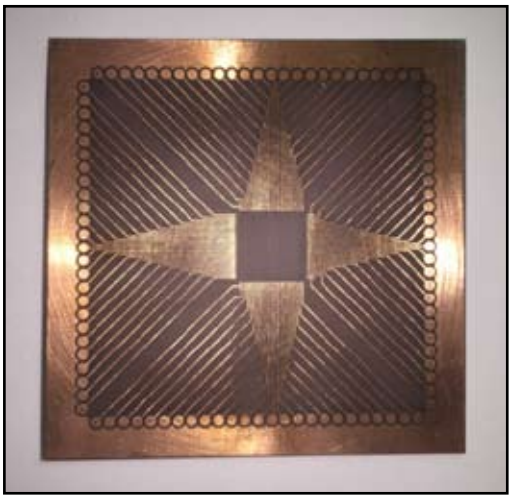

Fig.6 :A PCB of a QFP-100 Chip

The picture above is a pinboard for QFP-100 chip made by etching. And the chip of which center distance of each pin is 0.5mm would be soldered in the center of the PCB. Covering the PCB with stencil at corresponding position, and immobilising it with clamps. And then, painting soldering paste on pins of the copper foil stencil. Putting the chip on the pins position after taking the stencil down carefully. Finally, placing the whole board on the thermostat soldering station at 300℃ for four seconds. It is perfectly mounted within inspection. The well-soldered QFP-100 chip was shown as following figure 7.

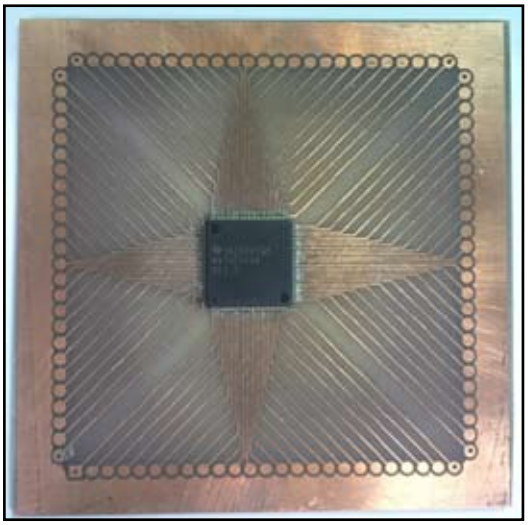

Fig.7 : Well-soldered QFP-100 Chip

V. Conclusion

As shown above, through the new high-precision copper foil stencil, QFP IC chipscould be mounted perfectly.The common problems of manual surface mounting such as pins conglutination and lack of weld have been solved efficiently. Meanwhile, it will just cost little to make a copper foil stencil which is suit for needed QFP chips. So the high-precision copper foil stencil as a new manual surface mounting method will be applied more widely.

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