

Impact of PCB plating Finish on Elastomer Socket Technology

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Introduction

Today's electronic packages have high clock speeds (multi GHz range), fine pin densities (below 0.4 mm pitch) and high pin counts (over 2000). When these packages assembled onto a printed circuit board (PCB), they perform certain functions at certain speed. Attaching these packages through IC socket is one of the avenues to test the functionality of IC packages without damaging it. Connecting these high-speed and high-density IC packages requires an innovative solution to the challenges of designing a shorter signal path (less resistance), good electrical insulation (prevents signal loss), and proper thermal management. Design of the socket is dictated not only by the functions mentioned above, but also by the other parameters such as durability, power consumption, assembly methods and the environment in which the system will operate. IC socket using elastomer interconnect (Figure 1) provides a solution that is fast, dense and durable.



Figure 1

Socket Function

A socket can be defined as an electromechanical device, which provides removable interface between IC package and system circuit board with minimal effect on signal integrity. Removable interface is the major reason for using a socket and it is required for a variety of reasons, including ease of assembly, reworking, upgrading and cost saving. The cost advantage is saving the IC by not attaching permanently to PCB. The socket is semi-permanently (solder less) attached to the PCB, while the IC device can be inserted into or removed from the socket without disturbing the connections to the PCB. Socket helps to test, evaluate and inspect the complete system. Also, socket allows in the field for maintenance, testing, replacement or upgrades. This becomes a critical factor because of technology evolution. The PCB surface in which socket is attached needs to meet certain constraints (such as pad size, location, plating finish, etc.) to function properly. In this article, we are examining the impact of different plating finish on the PCB pads and how it affects testing IC devices using elastomer interconnect socket.

Elastomer is a contact technology that interfaces solder ball from device to contact pad in the PCB. The elastomer consists of a fine pitch matrix of gold plated wires, which are embedded at a 63-degree angle or 90-degree angle in a soft insulating sheet of silicone rubber. The gold-plated brass filaments protrude several microns from the top and bottom surfaces of the silicone sheet. Solder balls from the IC package come in contact with the top end of elastomer wire. The bottom end of the elastomer wire contacts the circuit board pad and thereby makes an electrical path for the signal. The number of wire filaments making contact depends on the solder ball and circuit board pad diameters. Typically PCBs manufactured with socket footprint area covered by solder mask in non-contact area. Contact pads

are either manufactured with solder mask defined or copper defined. Figure 2 shows cross sectional view of PCB with copper defined pad and mask defined pad.

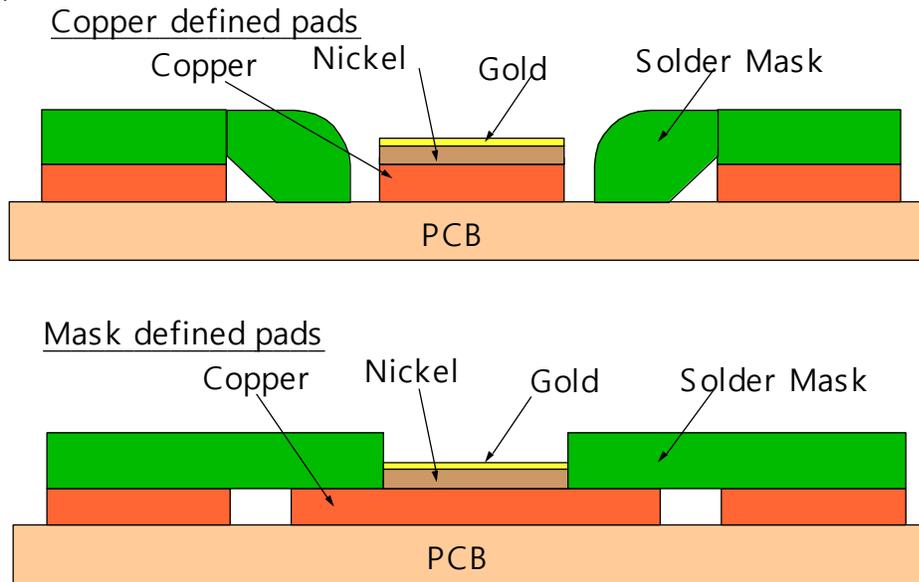


Figure 2

From the above pictures, it can be seen that copper defined pads are better than mask defined pads as it allows larger contact area specifically for the elastomer contact. This phenomenon becomes further critical when the device pitch shrinks to 0.4mm due to the contact pad sizes are 0.25mm.

In this experiment, copper defined pads were fixed as one of the parameter due to the reason mentioned above. The following four plating options, lead free plating, ENIG (Electroless Nickel Immersion Gold) plating, ENEPIG (Electroless Nickel Electroless Palladium Immersion Gold) plating, and hard nickel gold plating, were considered as variables in the experiment. We also fixed the solder mask thickness as per IPC-SM-840D which is 0.001" [0.025mm] minimum. Lead free plating is accomplished by dipping PCB in lead free solder bath and blow off excess solder using hot air manifold. This process typically accomplishes final plating thickness of 0.001" – 0.002". With lead free plating finish PCB pads are typically above solder mask height. According to IPC 4552, typical nickel plating is 0.0001" – 0.0002" and gold plating is 2 – 9 micro inches. Ni+Au will be 0.000102" – 0.000209". With ENIG plating, PCB contact pad will be always below the solder mask. For ENEPIG, typical nickel plating is 0.0001" – 0.0002", palladium plating is 10-30 micro inches and gold plating is 1 – 2 micro inches. Ni+Pd+Au will be 0.000111" – 0.000232". With ENEPIG plating, PCB contact pad will be always below the solder mask. Hard nickel gold plating is electrolytic process. Typical hard nickel plating is 0.0001" – 0.0003" and hard gold plating is 10 – 30 micro inches. Hard Ni+Au will be 0.00011" – 0.00033". With hard nickel gold plating, PCB contact pad will be always below the solder mask as well. Another variable used in the experiment is device pitch. Since the contact pads are proportional to device pitch, contact pad sizes increases or decreases corresponding to device pitch.

PCBs are manufactured with above mentioned specification. Three different devices (0.4mm, 0.5mm and 1mm pitch) were manufactured. Sockets with elastomer contact were assembled on to PCBs with different plating. Devices were placed inside the socket and actuated. Contact resistance was measured. If the contact resistance was below 50 mOhms, then it is considered "pass". The process was repeated for 50 cycles. If any one instance, the contact resistance is above 50 mOhms, then it is considered as "fail". Results are shown in Table 1.

It can be seen from the table that the PCB contact pad plating variation did not affect devices whose pitch is 0.5mm or large. PCBs with ENIG and Hard Ni/Au plating were not connecting well for the 0.4mm pitch devices. One of the factors is the 0.4mm pitch has a contact pad size of 0.25mm round. The other factor is that these two plating options

were well below solder mask height. Another inference is that the stiffness of elastomer causes very difficult to deform and contact such a small contact pad area which are recessed below solder mask.

Device pitch	Lead free	ENIG	ENEPIG	HARD Ni/Au
0.4mm	Pass	Fail	Pass	Fail
0.5mm	Pass	Pass	Pass	Pass
1mm	Pass	Pass	Pass	Pass

Conclusion

A primary concern to anyone utilizing the high density devices is that the socket must provide a high performance, low and stable value of contact resistance while meeting mating requirements specifically mating force and the number of mating cycles it must withstand without degradation. PCB plating finish plays a major role in meeting the functional requirements of the socket. Devices with high-speed, high-density, high pin count application needs special consideration in PCB finishes along with socket contact selection. The test results share the constraints of PCB plating finishes with respect to elastomer contact. When a specific contact finish is required by the application, then PCB contact pad plating thicknesses needs to be increased for smaller pitch devices.

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