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PROBE TIPS # 21 A Technical Bulletin for Probing Applications

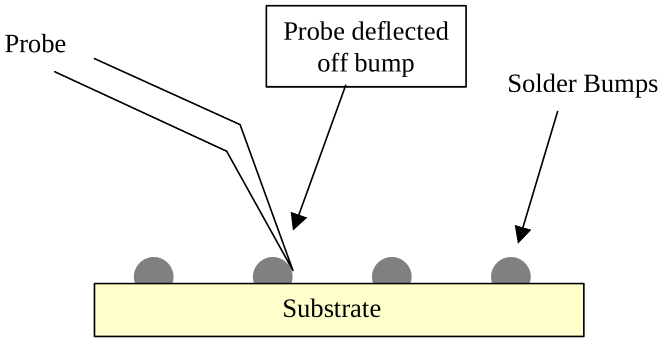
PROBING FLIP CHIPS AND BUMPS

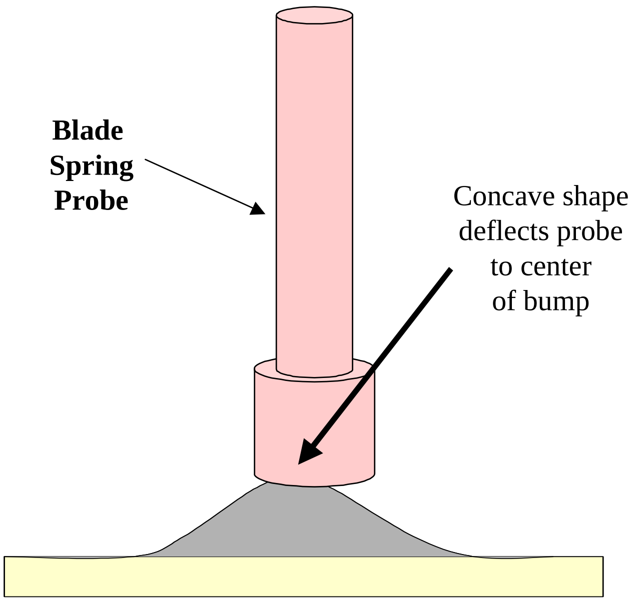
While wire bond technology has met the majority of the semiconductor industry's need for low cost and reliability, the increasing density of chips and the number of internal interconnections has led to the development of a number of advanced assembly and packaging technologies. One of the goals has been to reduce the number and length of interconnection links to minimize potential failure points and reduce circuit resistance and capacitance.

Flip chip packaging is one of the leading contenders for new packaging designs. This technique involves mounting the active side of the chip (with the surface bonding pads) towards the substrate. This package design provides the shortest path from the device to the substrate producing good electrical connection and facilitating high-speed designs. Bumps, typically formed out of tin/lead solder, are used to interconnect the chip bonding pads to the substrate. In the longer term, lead-free solder alloys will be used instead of tin/lead solder, for environmental reasons. Substrates can be ceramic or plastic based, using rigid printed circuit board or flexible polyamide circuit. The solder bumps are typically deposited on chip bonding pads at the wafer level using evaporation or physical vapor deposition (sputtering). Bump diameter has traditionally been 4 mils on a 10 mil pitch, however leading edge designs are approaching 100-µm pitch for very high density applications. The flip chip is attached to the substrate by aligning the chip to the substrate and applying standard reflow soldering techniques.

Flip chips typically use an area array for interconnection, where the solder bumps are placed in an x-y grid across the entire chips surface. This is in contrast to the standard wire bonding approach where a perimeter array is used with bonding pads around the die perimeter. The area approach allows many more interconnect points than the perimeter array method.

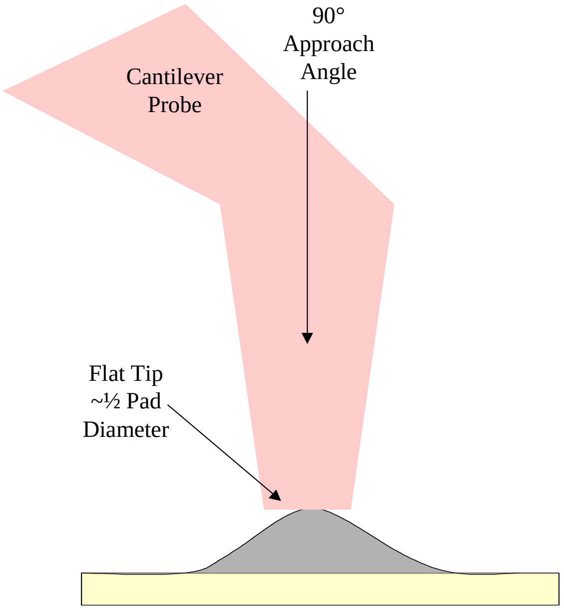
Solder bumps, especially those used to interconnect flip chips, provide a unique challenge for probing. Small bond pad diameters, dense pitch, as well as use of area arrays make probing a difficult enough proposition, without having to worry about the probe being deflected off the pad due to the presence of a bump.





One approach to probing bumped wafers is to use blade spring probes or pogo pins with concave probe heads. This technology ensures that the probe body automatically centers on the bump when overdrive is applied to the probe system. While quite effective, these probes are relatively large (21 mils diameter) and hence can only be used in lower density/pitch applications.

Bumped perimeter bond pads can be probed with cantilever beam probes provided the probes are configured to minimize the normal scubbing action. Please refer to technical bulletin, PT-20 Minimizing Probe Scrub. The departure angle and bend angle of the probe are very important to achieve the correct approach angle of the probe to the bumped pad. The objective is to make contact with the bump and utilize the contact force of the probe to make good electrical contact. The probe tip shape should be flat relative to the plane of the device. The tip diameter should be at least ½ of the bump diameter. The probe should approach perpendicular to the bump. The contact point for the probe should be at the apex of the bump and normal prober overdrive (2 to 4 mils) should be used to apply contact force.



While cantilever beam probes can provide an effective probing solution for perimeter arrays, high-density area bump arrays are more suitable to be probed by one of the wide range of vertical probing technologies available.

What can we say about needle types for flip chips? Tin/lead alloy bumps are best probed with tungsten needles?

Probe position accuracy is quite important in probing bumps. X/Y accuracy is critical to success and the probe must contact the apex of the bump. Probe to probe planarization is also important and should be maintained to normal wafer probe standards (± 7 to 8 microns). Accurate probe tip planarization will insure probe good contact with minimum prober overdrive and allow for normal bump height tolerances.

Summary

Flip chip bonding is an advanced packaging technique that facilitates an increase in input/output connections. Flip chip packaging is attractive for MEMS (micro-electromechanical systems) and other promising technologies due to this density and also to the improved signal characteristics over traditional wire bonding. The solder bumps used for device to substrate interconnect in flip chips provide additional probing challenges due to the potential for probe movement following touchdown on the target. Blade spring probes, traditional cantilever beam technology and vertical probes can be used to effectively probe a wide range of bumps providing the system is well designed for the particular device to be tested, and standard procedures for ensuring probe accuracy and maintenance are implemented.

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