accupr✳be *Probing the World of Microelectronics*

PROBE TIPS #9

A Technical Bulletin for Probing Applications

High Frequency Probing

The evolution of semiconductor devices continues to push the limits of device performance. High speed/high frequency devices in either silicon or gallium arsenide continue to set the pace and define the test capabilities of the next generation of ATE equipment. The probe card and its respective tester interface represent a critical interconnection between the DUT and the tester. Probe and probe card performance become increasingly important as speed/ frequency increases. Conventional metal blade probes are suitable for use up to approximately 100 MHz. Beyond that point characteristics such as capacitance, inductance and propagation delay play an ever increasing role. The probe becomes an integral part of the circuit and is no longer merely an electromechanical contact.

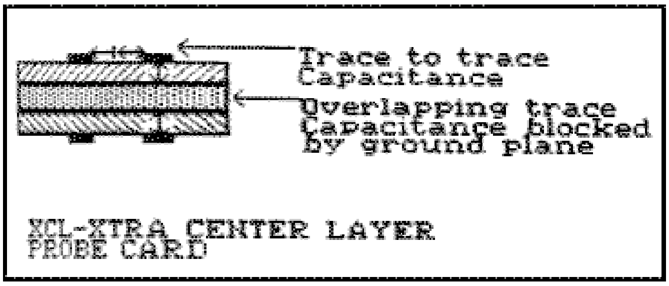
SIMPLE AC GUARDING

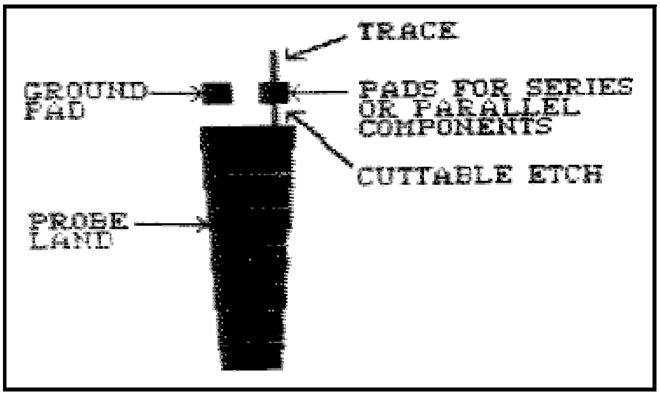
AC testing below 100 MHz may often be possible using conventional metal blade probes if care and thought are given to probe placement on the card and a few ground rules are followed. First, always try to separate critical signal paths from other active probes and traces by leaving a “guard trace” on both sides of the critical signal trace and probe. The physical separation that this provides will greatly reduce the parallel probe to probe or trace to trace capacitance. The “guard” trace serves to effectively shunt ant stray AC signal components to ground. In some cases, you may wish to mount a “guard probe” on ht e land between active signal probes to effectively shield the line out to the DUT. If there is no suitable contact on the DUT for this guard probe point, cut off the downward bend of the needle. These guard traces should then be strapped to system ground or driven to some potential, as you would a power plane, depending on your application. The net effect of this effort is a quieter probe card assembly with significantly reduced crosstalk.

THE PROBE CARD

The probe card plays a major role in AC testing. Again, capacitance, inductance and propagation delays are factors affecting the total performance of the probe card assembly. The spacing between traces, the thickness of the board and the layout all affect capacitance and other parameters identified above. A simple solution to again reduce crosstalk is to use wider separation of traces. This approach, however, is not practical due to density constraints to achieve the required number of signal lines. A more practical approach is to deliberately place “guard traces” between the active signal lines making the board surface appear like a maze. The guard traces are tied to ground and effectively reduce trace to trace capacitance. Many boards have wiring translation (patch wiring) areas. These require traces to be bunched together and the increased line density has the effect of increasing trace to trace capacitance. Patch wiring areas should be avoided for signal sensitive probing applications. If crosstalk is of concern, probe traces should be wired directly to the connector.

Accuprobe offers a unique feature for its generic probe card lineup, which is an extra center layer and identifies it with the added suffix of “XCL” to the card’s model number. This extra center layer provides a very effective ground or power plane which separates traces on both sides of the card. Parallel capacitance is significantly reduced between overlapping traces.



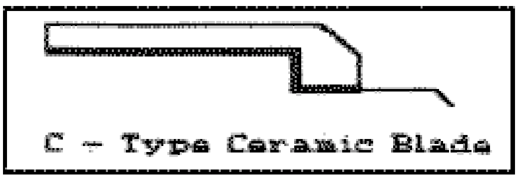


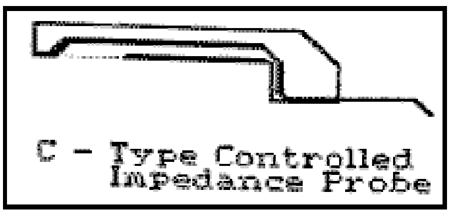
Some of Accuprobe's standard probe card layouts have pads located beyond the probe land which are connected to the center ground plane. These pads allow the test engineer to tailor the performance characteristics of the card assembly by mounting series or parallel passive components to condition a transmission line. As the performance requirement increases with frequency or speed, the layout becomes more critical.

The ultimate solution is the design of an application specific probe card. With the freedom to design from scratch, you can satisfy nearly every test need. A custom card can incorporate all the techniques above as well as multilayer construction, microstrip or stripline transmission line layout, matched impedance connector interfaces, calculated propagation delay lines and many more features.

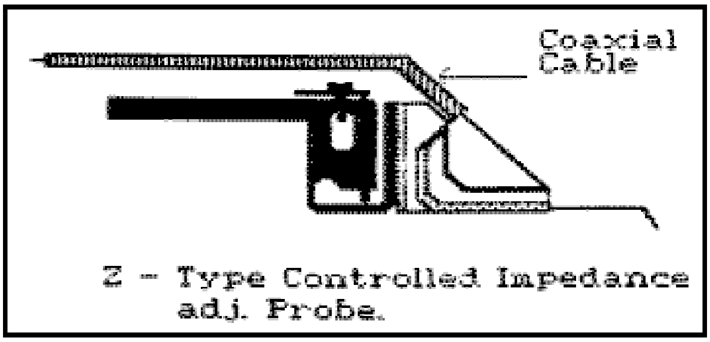
THE PROBE

As mentioned earlier there is no mystery in getting top performance out of a simple metal blade probe. There are limitations, however, and as mentioned earlier 100 MHz is the approximate upper limit. For high frequency analog measurements and high-speed digital (1-5ns) devices, a new understanding of probing technology is beginning to emerge. These are probes with very low probe to probe capacitance and transmission line characteristics. They first appeared as a variant on the metal blade with the metalization serving to connect the needle to the probe card trace. The minimum amount of metalization and resulting small cross sectional area effectively minimizes capacitively induced crosstalk. The evolution of the ceramic blade probe progressed with addition of a stripline transmission path to control impedance and further insure the integrity of the signal. Depending on the design of the probe layout, provision may be made for mounting passive components to further condition the line.





A natural extension of the conventional stripline technology applies to the Z adjustable probe. In applications where prober overdrive must be closely controlled, the Z adjustable probe provides a very delicate touch. Its planarization accuracy can be controlled to within ± 5 microns thereby permitting 1 or 2 mils of overdrive instead of the usual 3 or 4 mils. This is particularly important for delicate gallium arsenide devices.



The design illustrated above incorporates all the advantages of the Z adjustable probe combined with an unusual dual impedance front end. These probes are assembled as either 50 ohm or 100 ohm matched impedance paths and offer either single needle or co-planar needles to the DUT. These probes are supplied with a matched impedance coaxial cable especially selected for its small size and flexibility, which is important due to the effect cable stresses and movement may have on probe position.

CONCLUSION

High frequency/High speed probing is still more of an art than a science. There are many variables, which must be considered and tailored to each specific application. Probing microwave devices will bring about an entirely different set of challenges than probing ECL high-speed digital IC's. Each situation is different and requires a different set of solutions. As time goes on new probes and card techniques will evolve to meet the new test challenges. Developing an open and cooperative relationship with your probe card and material supplier will stimulate the creative application of the combined test talent to bring about the new solutions to complex testing requirements.

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