Probing the World of Microelectronics

PROBE TIPS #12

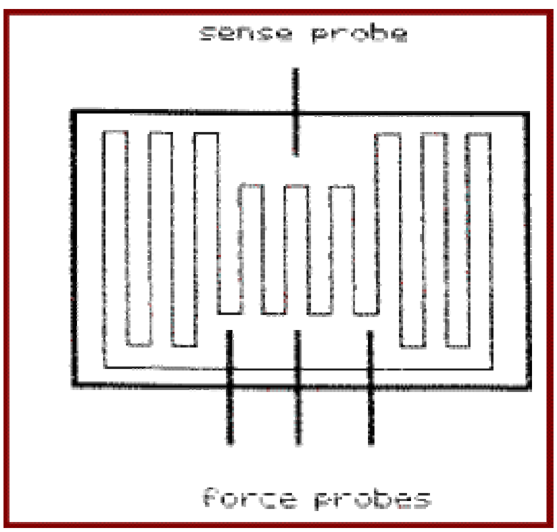
A Technical Bulletin for Probing Applications

Probing Power Devices

The probing of power devices with fixed pattern probe cards has come of age in recent years. Automation for high volume production has moved the technology from simple manual probes and spring loaded probes to fixed pattern probe arrays similar to those used in today's wafer probers and hybrid substrate handlers. The device handler and prober advances have brought about a whole new approach to power device probing. Today's probers are designed to accommodate standard 4.5 and 6.5 inch wide probe cards as well as a wide array of tester based dedicated high performance cards.

There are many variations of power devices in wafer, hybrid and discrete forms and testing each variety will bring its own unique set of test and handling challenges. However, there are universal concepts which apply to the broad range of device types that will affect test performance.

TYPICAL APPLICATION



A typical application would involve a device similar to that illustrated. In this case, it may be a power transistor tested in wafer form with a common collector connected to the test system via the rear surface of the wafer. In the illustration, the force or power probes are connected in parallel. Several dual probes are used to spread the current density over a larger surface area to avoid the possibility of damaging the device by blowing holes in the emitter. A single needle probe is placed on the base serving as a sense probe to measure voltage. Generally, pulsed DC HFE testing is well understood whereby pulse duration and current are set to stress the device to assure device quality and conformance to performance specifications.

TIP MATERIAL AND CONTACT RESISTANCE

The best possible contact between the probe needle tip and the device is fundamental to successful probing. Accuprobe offers a wide range of probes with either tungsten or BeCu probe tips. Tip material selection is an important consideration. A clean tungsten probe tip will have a typical contact resistance of 250 milliohms. In daily practice, the contact resistance could become considerably higher. The test current through a power device could easily be 10 amps or even more. For a test current of 10 amps and a contact resistance of 250 milliohms the dissipated power is $P=I^2R$ or 10 x10x.250 or25 watts. If the contact resistance is higher, the dissipation requirement will considerably increase and conversely, if the resistance decreases, the power will significantly decline. Tungsten is subject to tip contamination and contact resistance buildup. Although tungsten is widely used for probing, BeCu should ALWAYS be used to insure the lowest possible contact resistance. BeCu is an ideal low contact resistance material (100 milliohms typical on gold) which tends to clean itself with the normal scrubbing action during overdrive. A good stable contact prevents thermal runaway on the power (force) probe tips and reduces oxidation due to arcing.

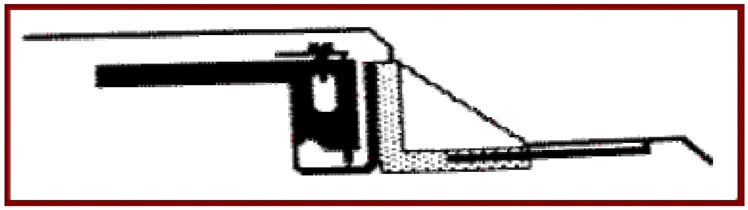
PROBE AND PROBE TIP SIZE SELECTION

Almost any probe can be used for power device probing providing it can reliably and repeatedly dissipate the power produced. Accuprobe designed a Z-adjustable probe with two contact needles.

The dual contact probe effectively cuts in half the contact resistance and doubles the current handling capacity. As an example, in the test situation described earlier, the 10 amps would flow through two needles with the dual probe. The power dissipation would be $P=I^2R$ or 5 x 5 x .250 which equals 6.25 watts per needle. THE POWER DISSIPATION IS 75% LOWER! In application where the size of the test pad will allow, several dual probes connected in parallel will likewise reduce the power dissipation per probe. The Z-adjustable feature allows the probes to be conveniently adjusted in the Z-axis to ensure that all probes are precisely positioned so that all probe tips touch the contact material simultaneously to uniformly distribute current flow. The size of the bond pad determines the maximum size of the probe tip to be selected. Generally, probe tip size should be no more than one half of the bond pad size. When probing power devices, select the largest diameter needle material and probe tip size which can comfortably be placed inside the probe contact area. The objective is to provide sufficient size to handle the power encountered during the test. Again, one half to three-quarters of the test pad is a good rule of thumb to use when selecting tip size. If two or more probes are used in parallel, be certain to have all probe needles and probe tips of the same size to evenly distribute the resulting contact pressure during overdrive.

THE ROLE OF THE EDGE SENSOR

Although edge sensors were originally developed for another application, they can have an important place in testing power devices.



The edge sensor is used to mechanically sense when the probes have touched and after overdrive has been applied. When the switch contact opens it signals the tester to begin the test sequence. To prevent contact arcing and oxidation it is important to insure contact BEFORE power is applied to the device. Two edge sensors can be wired in parallel to provide redundancy in the event of failure of one of the switch contacts.

CONCLUSION

Testing power devices in a production environment with fixed pattern probe cards will produce repeatable performance, high throughput and long probe card life.

See Probe Tip-18 for more information on current carrying capacity of probes.