Probing the World of Microelectronics

PROBE TIPS #7

A Technical Bulletin for Probing Applications

Edge Sensors for Fixed Pattern Probe Cards

BACKGROUND

Edge sensors were originally developed as a simple method for directing automatic prober step and repeat tables. The role of the edge sensor when applied to a step and repeat table is to tell the prober when to index to the next row. As a wafer is being probed, the wafer steps in the X direction underneath the probe card. At the end of a row, the edge sensor tip is no longer on the wafer. When the prober does not get a switch opening after a step, this is a signal to index in the Y direction one row. The prober will then step back across the wafer on the new row. When on the other side of the wafer, the step and repeat action occurs again. The programming of the automatic prober directs the prober to change the row of devices it’s probing and to change direction. Thus, one of the original applications of an edge sensor was to control the motion of the step and repeat table of an automatic prober.

CURRENT APPLICATIONS

As probing technology evolved and sensitivity to overdrive and probe pressure increased, the semiconductor industry realized that another application for the edge sensor could be useful. Modern automatic probers use the edge sensor to indicate through the switching point whether or not a semiconductor wafer is wedge shaped or otherwise curled. The test routine would cause the probes to exert more contact force on one particular device than another depending on where upon the wafer the probe card probes were contacting. These new probers call this ability to compensate for surface irregularity an auto Z stage capability. Basically, they use the edge sensor to track the surface irregularities of the wafer. Thus controlling the overdrive for each individual chip that is being tested on that wafer and minimizing potential damage by the probe card to the device on the wafer.

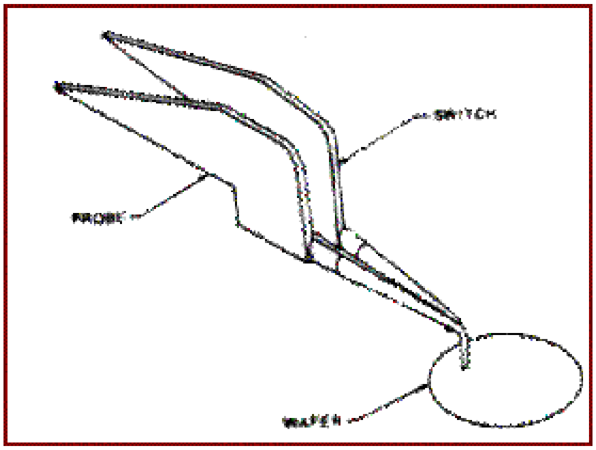
A third and significant use of the edge sensor is as a calibration tool. It’s used as a standard for people that maintain probe cards so that they can easily recognize the appropriate planarization depth of the probe card. This is done by looking at a light or other readily available signal that indicates the edge sensor is switching and at what particular planarization depth that switch occurs. Ideally, all probes would contact each test pad on a particular device simultaneously. With the addition of the surface tracking capabilities of the new automatic probers, all of the individual chips on a wafer will be probed with the same amount of contact force and probe pressure.

New semiconductor materials which are extremely fragile, such as gallium arsenide, benefit greatly from more precision control of probe contact forces. Edge sensors properly applied can help to minimize prober Z stage overtravel and the resultant contact force.

EDGE SENSOR TYPES

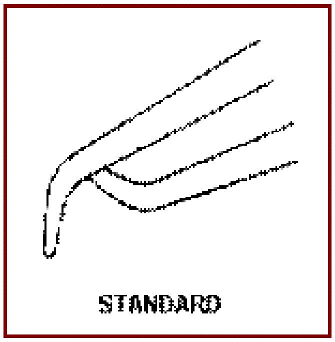
Edge sensors are typically made available as either isolated or non-isolated contacts. The isolation referred to is electrical isolation between the device being contacted and the parts of the switch.

Typically, the switch is a normally closed contact which indicates, when opened, that the test probes are in contact with the test pads. Each probe technology including epoxy ring, blade and Z adjustable offers a compatible edge sensor capability. Rather than compare probe technologies in this article, the principle reference in edge sensors as they relate to probe technology is that epoxy ring and blade probes require two or more PC card probe lands to implement an edge sensor. While Z adjustable edge sensors are single body probe and switch mechanisms and require only a single PC probe land.

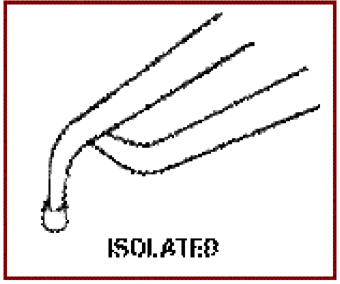


SWITCH CONFIGURATIONS

The switch is where the action is in the edge sensor and the switch configuration defines the applications.



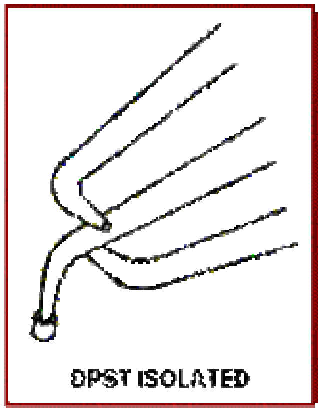
The standard edge sensor application is a simple SPST normally closed (NC) switch consisting of a probe and a switch portion. The probe needle (sometimes called a contact) is permitted to tough the device surface and if forced upward allowing separation from the switch.

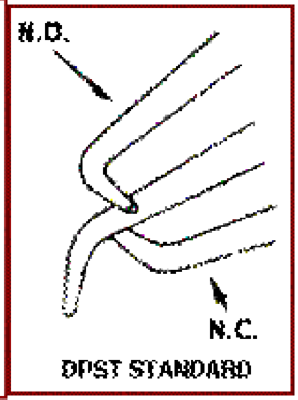


The isolated edge sensor is an SPST NC switch, which is electrically isolated from the device surface by a jewel bead.

The standard and isolated SPST NC edge sensor configurations are by far the most widely used configuration in the industry. The edge sensor probe is typically placed along a scribe line or in an inactive area of the circuit. When placement of a standard edge sensor becomes difficult due to high probe density or other active circuit limitations, an isolated edge sensor can be used. An isolated edge sensor provides placement flexibility since the jewel isolation bead distributes the contact force over a large "footprint " and can be placed in an active circuit area.

Some probers require DPST switches to both control penetration level (overdrive) and to signal the start test command. Here again, both standard and isolated edge sensor probes are used for the same application purposes.

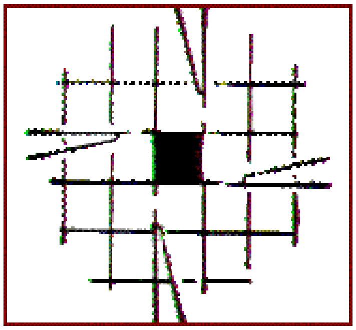

DPST ISOLATED



DPST STANDARD

MULTIPLE EDGE SENSORS

In many applications multiple edge sensors can reduce test time and/or save probes from potential damage. A single edge sensor placed anywhere on the device could cause some of the probes to hang off the edge of a wafer or substrate. Multiple edge sensors are wired in series such that any one edge sensor switch opening will signal the prober. Multiple edge sensors wired in such a fashion will eliminate a partial touchdown, speed the indexing in X or Y-axis and/or control overdrive on irregular device surfaces.



This illustration shows standard edge sensors positioned along the scribe lines approximately positioned at the mid point of adjacent dies to the device under test.

Isolated edge sensors in the same application could be positioned along the scribe line as shown or anywhere on the adjacent die. Isolated edge sensors could be used if the drive is an expensive circuit and if the device under test is sensitive to electrical damage.

A similar approach can be used when handling multiple hybrid devices using a step and repeat table. Test and trim time can be reduced through the use of edge sensors eliminating unnecessary movement of the device.

EDGE SENSOR CARE

Edge sensor contacts are exposed to the test environment and are susceptible to many forms of contamination, which could interfere with proper electrical contact closure. Contamination could result from ink if devices are marked for sorting. Laser trim debris could also affect contact resistance between the edge sensor probe and the switch. Routine edge sensor contact cleaning with aerosol electrical contact cleaner or suitable equivalent should become a part of a routine probe card cleaning procedure.

An edge sensor assembly is a precision electromechanical assembly and should not be tampered with. Typically, the edge sensor probe is stressed with a 3 mil pre load to provide adequate contact pressure and insure switch opening at the same moment in time when test probes make contact with their test pads. Therefore edge sensor assemblies should not be moved or manipulated unless performed on a probe card assembly machine, which is designed for the purpose.

CONCLUSION

Edge sensors are sensitive electromechanical devices that have numerous application possibilities for semiconductor testing. Contact configuration is determined by the application requirements and innovative applications can positively affect test performance. Low contact resistance and mechanical integrity of the edge sensor are key to optimize performance.