SUPPORT NOTE

SN-112

Alignment & Movement of Probe Card Pins

Probe Pin Specifications

Reedholm PCIA and rectangular probe cards are built with ceramic or metal blades to which tungsten needles or pins are brazed at a precise angle. The needles are 0.010", or ten mils, in diameter before being tapered to a point. Then they are bent to a precise angle and the tips are sanded to a flat point with a diameter of one mil. The diagram below shows the dimensions of a typical pin. The documentation delivered with each probe card contains the actual dimensions.

Scrub and Over Travel

The action of raising the wafer to contact the cantilevered probe pin causes the tip to bend upwards and dig into the surface of a metal pad as the tip slides across the pad. That digging and sliding, called scrubbing, breaks through the natural oxide on a metal pad. Without scrubbing, good ohmic contact could not be made. Each mil of over travel causes a maximum of 0.33 mil of scrub, so three mils of over travel creates a scrub mark approaching one mil in length.

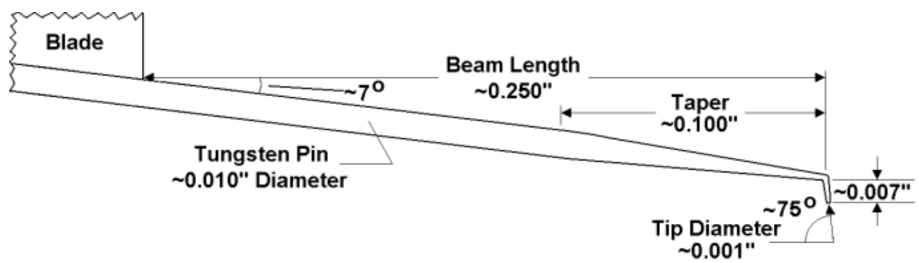

Figure 1 - Typical Pin Dimensions

Probe Tip Alignment

Probe tips are set to the center of target pads, or an alignment mask, within a certain tolerance. Alignment is specified after a certain amount of additional vertical movement (over travel) once the last probe pin on the card touches the wafer. Although actual alignment is usually much tighter, Reedholm specifies that all probe tips be within 0.5 mils of the centers of respective pads.

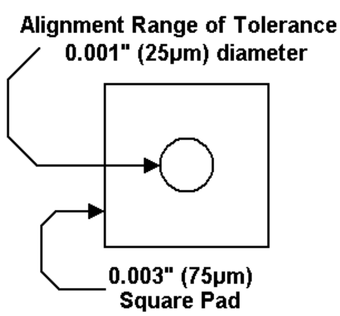

Figure 3 - Typical Pad Target

Planarity

Planarity is measured by the difference in over travel between touch down of the first pin and the last one. Maximum planarity errors of Reedholm cards is specified at one mil. In the illustration below, as the tips move to the left, four of five probe tips would contact the wafer considerably before the fifth.

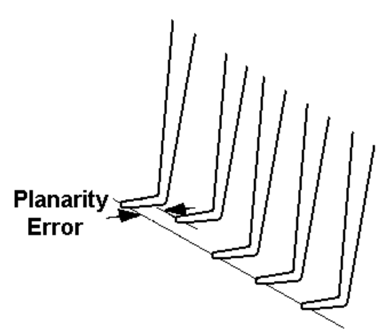

Figure 2 - Planarity Illustration

Assuring Probing Quality

In order to be confident of test data quality, it is important that the quality of the probing process be controlled. There are three main factors involved:

- Alignment
- Planarity
- Contact resistance

With simple test structures, all three of those parameters can be addressed with electrical tests that can be performed quickly enough to justify testing on every major site.

While such tests can confirm probing quality, they do not provide much information on what to do when failures occur, or what to do to prevent failures. Thus, to maximize productivity, electrical tests need to be augmented with tools and procedures that isolate or prevent problems. For instance, sanding the tips of probe cards on a regular basis removes the insulating particles that become embedded in the fibrous tips of tungsten needles (which leads to high contact resistance). The disadvantage to sanding is that it increases the diameter of the tip, and thus decreases the force per unit area leading to less effective breakthrough of oxidation and higher contact resistance.

Another tool used to prevent problems is camera based alignment checking. Some probers now have cameras that permit measurement of probe tip alignment from beneath the probe card. In addition, the camera can be used to monitor the size of probe tips and thus permit reworking of probe cards before resistance becomes too high. While there are distinct advantages to using camera based alignment checking, some care is needed in setting up the pass/fail parameters. Otherwise, properly built and properly performing probe cards will be rejected.

Off-Wafer Probe Tip Alignment

Since alignment for probe cards with cantilevered pins is specified when probe tips are in contact with the wafer, it is of interest to compute the worst-case alignment when the tips are off-wafer. In doing that, two independent factors need to be considered.

1) Misalignment when probed down
2) Amount of scrubbing

Opposing Pins Analysis

The simplest situation for computing worst-case alignment is when pins are alternately attached to opposite sides of the probe card. To further simplify analysis, one can assume that the pins are perpendicular to the row of pads.

In such a case, adjacent probe tips that are within 0.5 mil of the pad centers after scrubbing move in the opposite directions by a maximum of one mil as the over travel (three mils) condition is removed. The diagram below shows the probe tips in a worst-case position after both tips off-wafer. Note that the tips are three mils apart in this position.

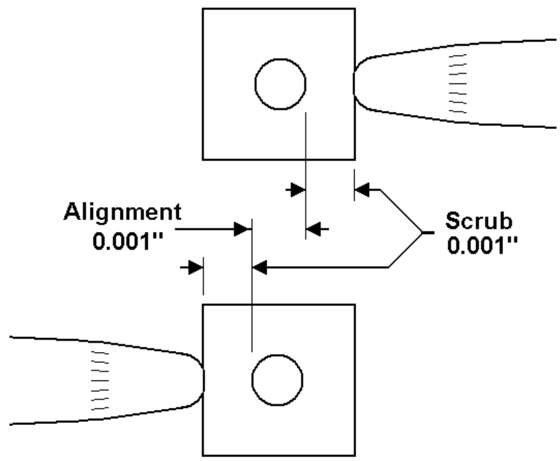

Figure 4 - Probe Tip Position Before Touchdown

Analysis When Pins Are On Same Side

When pins are brought in from the same side, off-wafer alignment is better, but the worst-case analysis needs to take into account differences in scrub length.

The largest discrepancy occurs when the tip with the longest reach relative to the pad center is also the last one to touch. For a planarity difference of one mil, two tips that are one mil apart when touching the wafer could move apart by another 0.33 mils as they lift, resulting in a misalignment of 1.33 mils when the tips are off-wafer.

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