DATA SHEET

DS-11800

PCIA and Rectangular Low Leakage Probe Cards

- **Fast, sub-pA Measurements in Production**
- **Drop-in for Automatic Probers**
- **No Test Head to Get in the Way**
- **Robust Strain Relief**
- **Leakage Guaranteed to Probe Tips**
- **Guarding from Bulk & Surface Leakage**
- **Up to 48 Picoammeter or 96 Matrix Pins**

Effective probe card fixturing is a critical step in making sub-pA measurements at the wafer level. Without it, data has to be taken slowly—if it can be taken at all. Fortunately, Reedholm low leakage probe cards can be used for applications up to 48 probe pins with the PCIA card. If currents below 100pA are not needed, the top loading PCIA card can be configured to the full 96-pin capacity of Reedholm parametric testers.

Probe Card Design Features

Reedholm multi-layer probe cards prevent the dominant sources of printed circuit board leakage current from affecting low current measurements.

- Proprietary layout methods connect the top and bottom surfaces on the cards. Otherwise, through-hole plating methods that leave conductive salts trapped inside probe cards seriously degrade current measurement performance.
- In addition, bulk leakage through the probe card is shielded by internal foil layers.
- Guard traces provide surface leakage protection by completely surrounding the force and measurement traces out to, and around, blade placement on the card.

As fingerprints are a significant contributor to surface leakage, provision is made to hold the cards on their edges or card handles without requiring gloves. Probe cards can be cleaned in isopropyl alcohol to removes inadvertent contamination that might bridge surface guarding.

Force and sense lines are connected at the card edge connectors, so the only resistance in series with the probe needle is a few milliohms on the card.

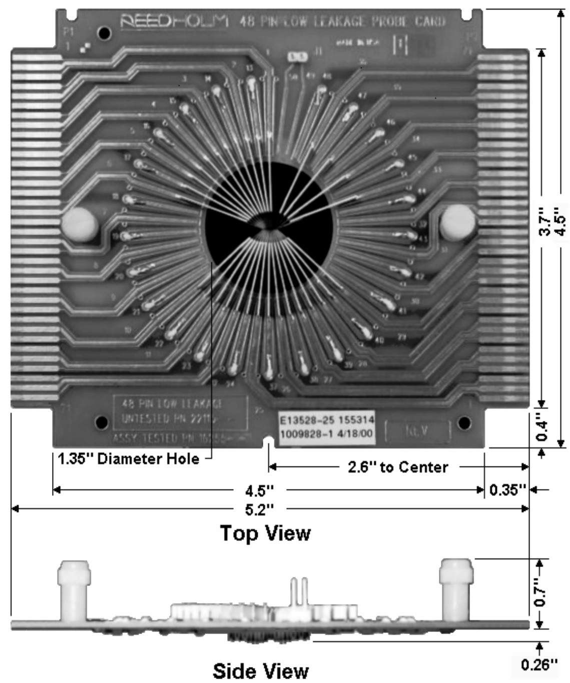

Figure 1 - PCIA Probe Card

Top Loading PCIA Probe Cards

Unlike probe cards that plug into bulky test heads, the probe card shown in figure 1 drops into the PCIA interface from the top. After the card is placed on the PCIA card rails, simple rotation of a pair of handles secures the card and simultaneously pushes card edge connectors onto the card from each end. The PCIA can be installed in any prober that has an opening for an RC2 probe ring insert.

Hoods on the left and right side of the PCIA shield the low current cables from incidental equipment noise. Cable clamps inside the hoods prevent fatigue failure of solder joints due to cable movement. Use of stress-free clamps eliminates piezo-electric currents that otherwise obscure low-level measurements.

The probe card mounting rails on the bottom of the PCIA are quite thin so that probe needles do not have to extend far below the card.

PCIA with 48 Pins

Figure 2 is of a PCIA configured with 48 PAM pins, so each of the six cables contains 8 PAM pins. The black, striped shroud covers a ground shield on each cable.

Most customers have settled on 24 or fewer pads for test structures. In those cases only three of the 8 pin cables would be needed.

Figure 2 - 48-Pin PCIA Ready for Prober Installation

Rectangular Probe Cards

Rectangular probe cards can be used in many applications, and offer the benefit of being lower priced since they can be plugged into standard card edge connectors configured low leakage measurements on up to 24 pins. Surface and bulk guarding as well as low noise cabling are identical with those of the PCIA cards.

Since these cards do not plug into the PCIA, the interface cost is lower. Card insertion is more difficult, and different length cards may be required to probe 100mm, 125mm, 150mm, and 200mm wafers.

Figure 3 - 24-Pin Card

Cabling and Termination

Analog cables that connect test system resources to the probe card interface are a critical factor in quality low current measurements. Reedholm worked with a leading cable manufacturer in development of the guarded twin-axial cables used in picoammeter measurements. A semiconducting surface on the internal cable dielectric eliminates tribo-electric effects due to inevitable shield movement. Although Teflon has the highest resistivity of commonly used cable dielectrics, it has considerable piezo-electric effects, so an insulator with small dielectric absorption was used. Since guarding is used to prevent leakage, resistivity can be several orders of magnitude lower without compromising performance. To minimize pick-up for AC power line and other noise sources, a ground shield shrouds all of the cables from the test system cabinet to within a few inches of the probe card.

Termination to the probe card connector is also an important consideration. Heat shrink tubing does not provide adequate pin-to-pin shielding for currents in the sub-pA range. Teflon tubing at the connector eliminates leakage currents and is captured so that its at piezo-electric effects are not a factor in making sub-pA measurements.

Guaranteed Performance Probe Cards

When blade mounting is ordered through Reedholm, the low current specifications are guaranteed. The starting point is to fill out a blade mounting form to make sure the right probe card is built. This includes:

1) Device: Name assigned by customer. Usually is the name of the test structure to be probed.
2) Alignment Target: Type of target used to align pins (wafer, film, glass mask, etc.)
3) Card Quantity: Quantity of cards to be built to the specified pattern.
4) 1st and 2nd Probe Card ID: Identification assigned to probe cards by customer.
5) Edge Sense: Whether or not to use the pair of edge sense pins.
6) Probe Pin Assignment: Lines connect non-crossing connections between pads and pins.
7) Test Structure Orientation: Test structure orientation is shown relative to probe card.
8) Wafer to Test Structure Orientation: Test structure orientation relative to wafer flats/notches.
9) Pad Layout: Rough drawing with pad dimensions, spacing, & other defining characteristics.
10) Coordinate List: Some blade-mounting vendors require pad spacing in table form.

Superior Performance

Few customers measure current leakage at 100V as illustrated by the plot in figure 4 from the Keithley™ White Paper, "Optimizing Low Current Measurements on the S600 Parametric Tester". Time responses are shown for three voltages, 0.1, 1.0, and 10.0V. Note that current is >2pA after 1 second with a 10V step. Reedholm cards require <1pA with a 100V step, or 20 times better performance.

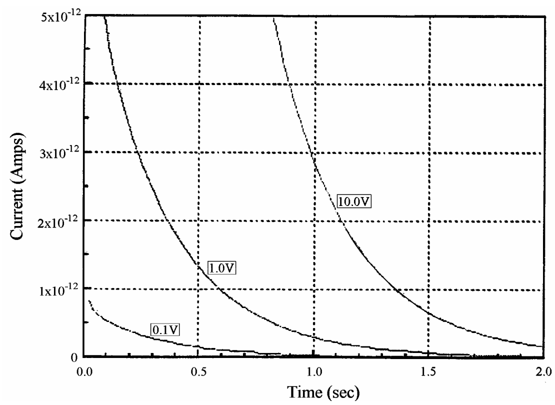

Figure 4 - Keithley S600 Leakage Response Times

To provide an apples-to-apples comparison, data was taken with a Reedholm card. With the same linear scale factors, sub-pA data was ready within 200msec at 10V and within 100msec with lower voltages.

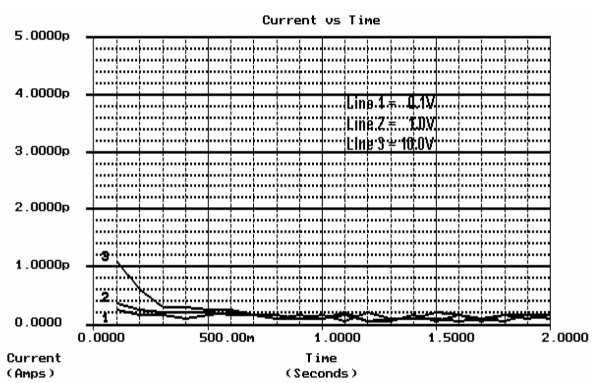

Figure 5 - Reedholm LL Probe Card Response Times

Probe Card Verification

Test software at Reedholm is used to confirm low leakage performance prior to shipment. This utility measures open circuit leakage current on each pin after application of a 100V step on all other pins in the matrix. Data is taken linearly, and must show current <1pA within a second. Capacitive displacement current initially overloads the PAM, but recovery is quick such that picoampere measurements are made within 100msec of the step. Test results are output as plots of leakage current vs. time for each pin tested with failures flagged. The utility software is part of Reedholm distribution software.

Specifications

1) Pin-to-Pin Leakage: < 50fA/V within 1 second. This is really a dielectric absorption specification since the important criteria is to be able to measure low currents as quickly as possible.
2) Maximum Current: ±5A
   PAM and CPM relays are limited to 2A, but higher currents can be put through the probe card.
3) Dielectric Strength: ±1000V between pins
   PAM and CPM relays are limited to ±600V, but higher voltages can be applied between pins on the probe card. This is addressed when a high voltage option is ordered.
4) Service Temperature: 23°C ± 10C°
5) Storage Temperature: -40°C to 85°C
6) Humidity: <55% R.H.