SUPPORT NOTE

SN-120

PCIA Probe Pin Planarity Improvements

I) PCIA Probing Quality Problems

This note addresses a couple of problems with PCIA probing quality: planarity with high pin counts and connection to recessed card edge fingers with the latest probe card layout. Both problems led to intermittent probe pad connections. Design deficiencies have been addressed and a PCIA upgrade path developed.

II) Contacting the Probe Card

Analysis and subsequent probing investigations led to identification of several design issues described in this section.

A) Probe Card Does Not Bottom Out

A mistake was made in recessing card edge fingers because we assumed that PCIA probe cards bottomed out in the card edge connectors. However, that is not the case. Fortunately, the reliability problem with connection resistance could be addressed by adding 0.025" spacers behind the connector ears. This reduces the opening for the PCIA card, and does not prevent a straightforward insertion. Figures 1 and 2 show the spans and connector profiles for the PCIA.

B) PCIA Opening for Probe Card Insertion

Since PCIA probe cards are 5.2" long, the PCIA must permit card insertion without having to be extremely careful. As shown in figure 1, the PCIA opening measures 0.065" wider than necessary. To help with visualizing this, figures 4 and 5 are photos taken from the bottom of the PCIA.

C) PCIA in Closed Position

When the PCIA is closed, card edge connectors are 4.700" apart. While the 0.565" movement seems like a lot, it does not result in the card bottoming out in the card edge connector. If the design goal were to have the card bottom out in the connector, nominal travel would have to be another 0.190", or 0.755" in total. Then, to accommodate fabrication tolerances, nominal travel would need to be a little bit more. However, that is not practical given the limited room inside the PCIA mechanism. Thus, PCIA probing quality needs to be sufficient with the amount of travel shown in figure 1.

Unfortunately, there were problems with probe card movement when inserted.

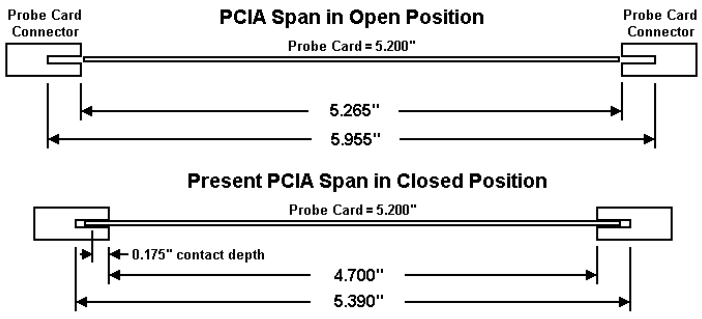

Figure 1 - Present PCIA Spans

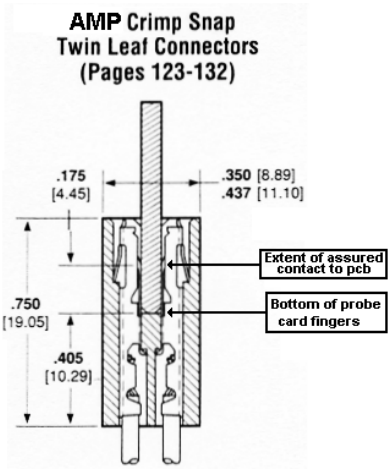

Figure 2 - Probe Card Connector Profile

D) Probe Card Alignment and Capture

The reason that the probe cards could be moved was that alignment post openings were 0.025" greater than the pin diameter. That made card insertion easier, but allowed probe cards to slide by as much as 0.025" after the card edge fingers enter the connectors.

That problem was addressed by adding non-skid tape to the bottom of the probe card support rails. To keep everything in alignment, the card rail thickness was decreased to accommodate the non-skid tape. This tape prevents movement of the card once enough pressure is exerted by the PCIA board clamps.

E) Contact Inside the Connector Block

Figure 3 shows dimensions inside the connector block that are close to scale. With the ability to slide the card 0.025" with the PCIA in a closed position, one can see that the pulled back position of the signal trace would make contact with the card edge connectors at one extreme, and would not at the other. However, with nominal positioning, signal traces on both ends of the card were contacted at the same time. By reducing the PCIA opening by 0.050", connections to the card edge fingers was reliably made.

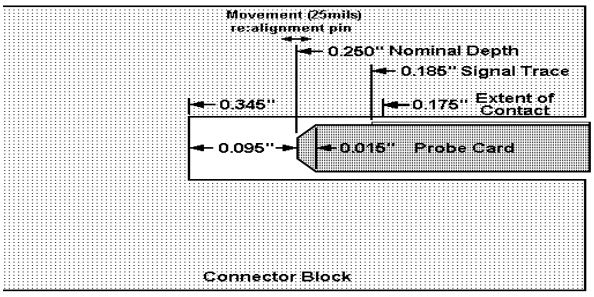

Figure 3 – Original Dimensions Inside Block

F) EG Probe Ring is Limiting Factor

Compatibility with the EG probe ring is a limiting factor in that the opening for the PCIA is too small to permit full engagement of 4.5" probe cards. Thus, it isn't practical to increase the travel beyond what is now available. The numerous factors/obstacles that would need to be taken into account in a PCIA redesign are shown in figure 4. Figure 5 shows location of the alignment pin from the bottom.

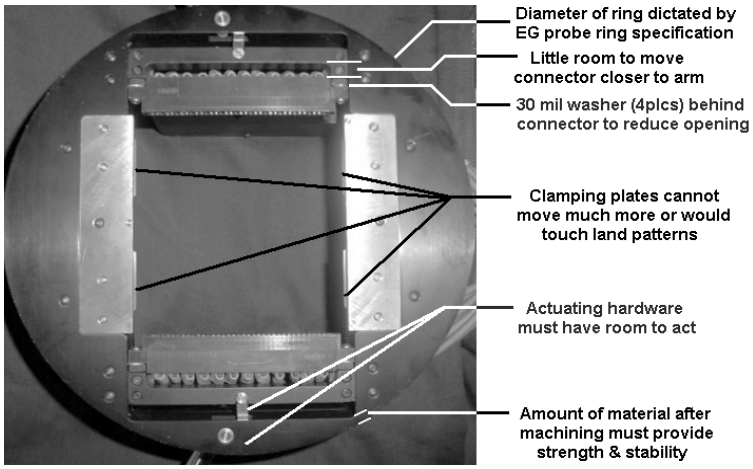

Figure 4 - PCIA in Closed Position

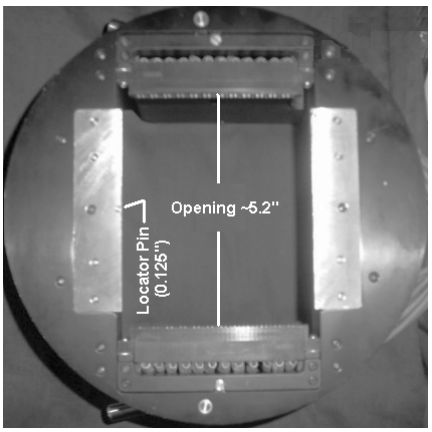

Figure 5 - PCIA in Open Position

III) Probe Tip Planarity

Resolving the planarity problem with Reedholm PCIA probe cards required changes in the PCIA. In addition, changes had to be made in blade mounting methods. Those were needed despite the 20+ years experience that Reedholm's blade mounting company had in mounting blades.

A) Probe Card Clamping

Originally, there was inadequate downward force on the probe card edges when the PCIA was engaged. As a result, probe cards were not clamped along the edges. Thus, cards with slight deflections were not forced into the same flat condition as when probe tips were aligned and planarity adjustments were made at the probe card vendor. As a result, planarity goals could not be consistently met.

To increase clamping force, these changes were made in the design and in the upgrade.

- Stronger springs were installed in the PCIA.
- Cards were made thicker by adding two layers of 10mil Teflon tape to the card edges.

Bending, or straightening, the contact finger edges dramatically affects planarity. To counteract the effect, the blade mounting vendor was provided cables built from the PCIA card edge connectors. Thus, alignment and planarity are now adjusted with the card edge connectors in place.

The blade-mounting vendor also designed a tool to clamp the cards flat during soldering. This is important since the unequal coefficients of thermal expansion cause probe cards to bow as they cool from soldering.

B) Changes to Probe Cards

Even with improved clamping force, other problems had to be addressed to achieve planarity assured by the blade-mounting vendor.

1) The most important one was making sure that blades are attached only in the region over the stiffener ring. Design of the blade ensures that the radii of blade attachment points are at least 0.1" less than the stiffener ring diameter.
2) Diameter and thickness of the stiffener ring was increased in order to reduce planarity changes induced by card deformation outside of the ring.
3) Several changes were made in the design and attachment of blades in order to maintain the same planarity in the PCIA as at the blade mounting vendor.

C) Larger Stiffener Ring

A 2.5" diameter, 0.030" thick ceramic stiffener ring was replaced by a 2.9" glass epoxy (G-10) ring that is 0.125" thick. Without changing the PCIA card design, a thicker stiffener ring was built quickly by the blade-mounting vendor from 0.125" thick circuit board laminate. The ring has an inside diameter of 1.35" (to match the probe card opening) and an outside diameter of 2.9" (as large as possible without covering the wire feed-through holes). Using a larger diameter stiffener required more care in assuring that the bonding agent did not go all the way to the edges without touching any guard land patterns. Although circuit board laminate is not as strong as ceramic, a 4:1 thickness ratio makes it sufficiently stiff.

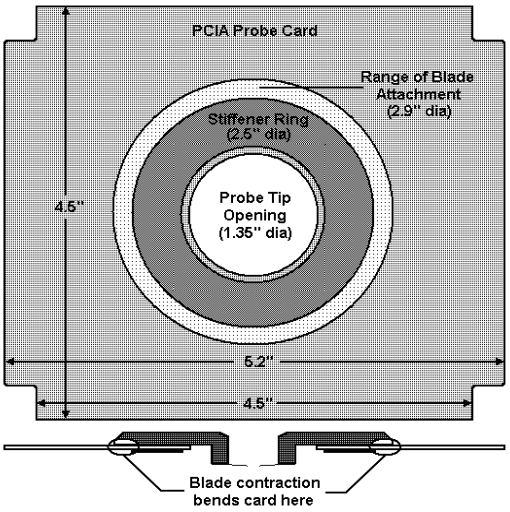

Figure 6 – Original Probe Card Dimensions

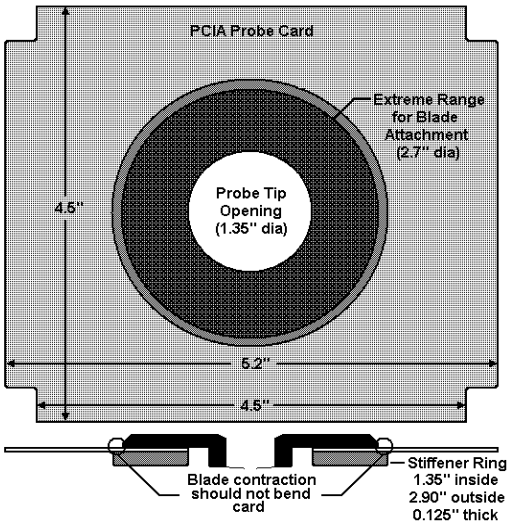

Figure 7 - Card with Thicker Ring

IV) Floating the Card Connectors

Even though the blade mounting vendor was attaching card edge connectors during blade attachment, and using those cables in planarity measurements, it was found that the slight vertical force exerted by the card edge connectors affected planarity on large pin count cards. Thus, the final PCIA design change was to provide card edge connections that did not provide vertical force. This solution was named "floating the card edge connectors". As a result of the changes described below, free movement of the connectors was permitted regardless of PCIA manufacturing tolerances or PCIA board deflection. Furthermore, planarity of the highest pin count cards was within the 0.001" specification.

A) Use of Thinner Screws

By reducing the diameter of the #4-40 screws used to hold the card edge connectors in place, it was possible to rotate the card edge connectors through a wide range before the screw bodies contacted the connector ears. As a result, no force was placed on the probe card as the connectors were engaged.

B) Changes to Make

Stainless steel washers (#4) were placed on each side of the connector ear.

1) The front one provides a low friction surface that prevents binding, and thus force on the probe card, between the screw head and the card edge connector.
2) The back one assures good contact to the probe card fingers.

So that the connector mounting screws do not lock the connector in place, their length causes them to bottom out on the screws used for attaching the hoods to the actuator arms. However, the heads of the standard attachment screws interfere with bottoming out of the card edge connector screws, so the screws closest to the card edge connector need to be replaced by 5/8" flathead screws.

Figure 8 illustrates where the various screws and washers are installed.

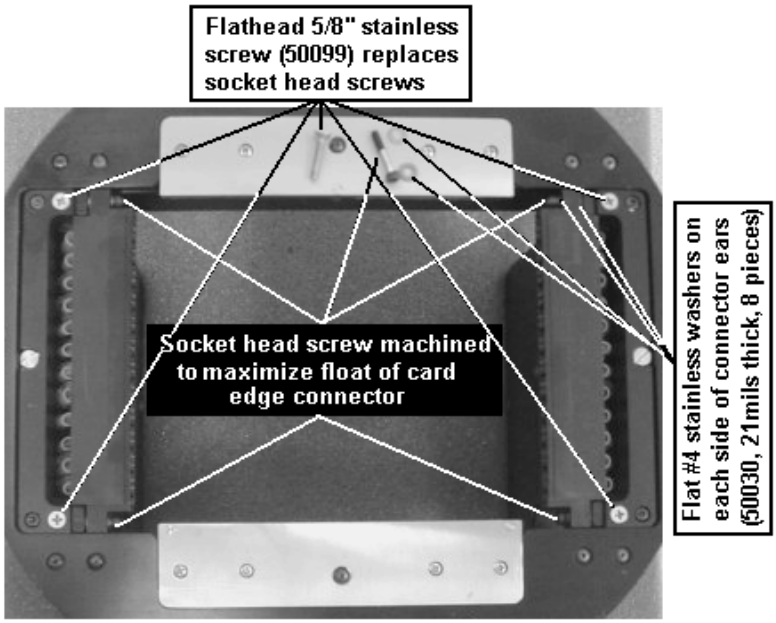

Figure 8 –Upgrade of PCIA to Float Connectors