A Membrane Quadrant Probe for R&D applications

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ABSTRACT

Membrane probes are known for their applications to production probing and their ability to integrate RF lines, matching networks and good power supply bypassing for known good die testing on-wafer. Nonetheless, they require die-specific design and are not reconfigurable. In this paper, we discuss a quadrant probe based on membrane technology which offers this alternative with lower loss than membrane probes and better DC bypassing capability than any other quadrant probe.

INTRODUCTION

Membrane probes [1] are in general suited for production type applications. They are rugged, have the ability to withstand over a million contacts, and have higher risetimes and better bypassing than needle probes. Nevertheless, they suffer from higher loss and non-reconfigurability compared to their single-line probe counterparts such as Cascade's Air Coplanar Probe (ACP) [2]. A membrane quadrant is an amalgation of the coax-based ACP and the membrane probe technology in the sense that the head and body resembles that of an ACP and the tip is made out of a membrane as depicted in Figure 1.

(a)

(b)

Figure 1: (a) A four-port membrane quadrant probe with (b) a blow-up of the membrane tip section

The assembly process entails laser ablation of the membrane probe tip to remove the polyimide before the tip fingers are bent. The back of the membrane is attached to a shelf cut on the coaxial cable. The probe then undergoes standard planarization and colinearizing processes before being used on a probe station.

PROBE DESCRIPTION

In Figure 1, a four-port membrane quadrant is displayed. A quadrant can have 1 to 8 ports depending on the testing requirement. In this design the four port quadrant consist of two DC lines on the outside with two RF lines in the middle. The tip configuration in this case is power-ground-signal-ground-signal-ground-power. The RF lines are microstrip lines with solid ground lines embedded in a meshed ground plane as shown in Figure 1 (b) and 2. The latter diagram exhibits the layout of the probe, where the coaxial cable attachments are made at the top and the nickel alloy bars at the bottom are bent to make contact with the pads. The probe has four transitions which are designed to maintain a

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continuous 50 Ω transmission line. First is the coaxial cable and the K-connector interface. Second is the CPW membrane interface with the coaxial shelf. And third, is the internal membrane transition from CPW to microstrip at the coaxial end. Fourth is the transition from microstrip to CPW nickel fingers at the tip.

Although, hardly noticeable in Figure 1(b), there are two chip capacitors for DC bypassing mounted on edge between the two nickel alloy bars close to the tip of the probe. This bypassing is superior to traditional needle technology and even the best membrane probes. The width of the DC lines can be adjusted to handle high currents and have low characteristic impedance.

Impedance matching networks can also be implemented in a membrane quadrant probe. We are currently working on membrane quadrants that integrate Wilkinson combiners at Ka, Q, and V bands and intend to extend this technology to W band.

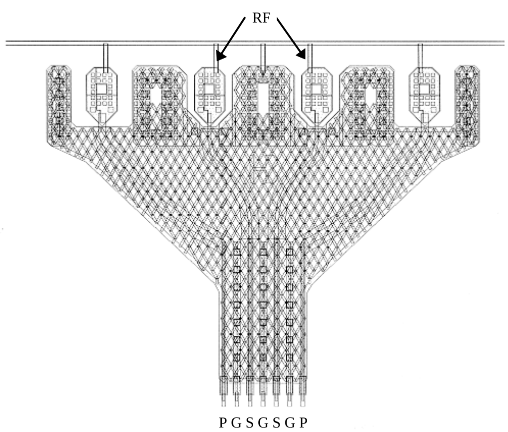

Figure 2: A membrane quadrant probe circuit layout showing two RF lines at the center and two power lines on each side of the membrane. The tip has a PGSGSGP configuration where P,G, and S stands for DC Power, Ground, and RF Signal.

RESULTS

The S-parameters of the probe are shown in Figure 3. The insertion loss is less than 2 dB at 40 GHz. This is about 3 dB less than in membrane probes. The return loss is below 17 dB over 40 GHz showing excellent 50 ohm transitions at the K-connector, membrane, and tip interfaces.

One of the DC ports was shorted and the impedance looking into the tip of the corresponding DC line was measured by setting the probe down on a signal-ground thru standard and probing at the other end with a signal-ground ACP. The measured reflection coefficient is shown in Figure 4. At 6 GHz, the inductance is barely 0.1 nH. At higher frequencies, the capacitor standing on its edge look more like a low impedance open stub in parallel with a shorted DC line. Moreover, the capacitor dielectric losses increases significantly in conjunction with the conductor losses of the DC line; their parallel combination pull the S22 curve inward.

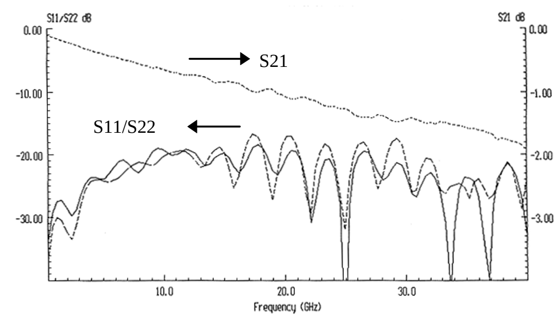

Figure 3: S-parameter response of one of the RF lines in the membrane quadrant probe.

CONCLUSIONS

We have shown that membrane quadrants, by virtue of their being a hybrid of the ACP and membrane technologies, have lower loss and better DC bypassing than membrane probes, and partial reconfigurability which is particularly suited for R&D applications.

ACKNOWLEDGMENT

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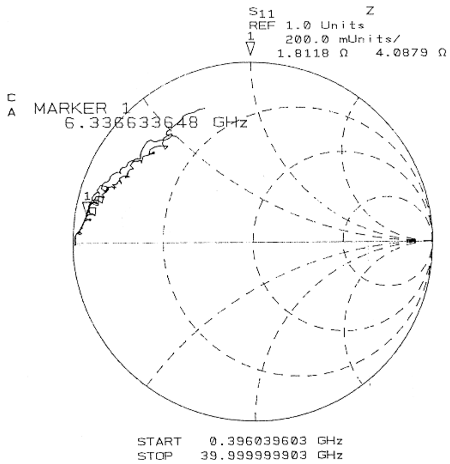

Figure 4: S22 response of one of the DC lines of the membrane quadrant probe with the connector end shorted.

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