NOVEL CONCEPT FOR A MODULAR MILLIMETERWAVE PROBE TIP

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ABSTRACT

A novel concept for a probe tip is proposed. The signal path along the probe is fully impedance controlled, resulting in lowest reflections.

INTRODUCTION

The carrier frequencies of communication services and radar systems are continuously shifted to higher frequencies, even up to millimeterwaves. This trend is driven by the need to allocate new frequency bands and by the recent availability of reliable millimeterwave technology, especially the development of dependable and reproducible MMICs. Due to this continuous emergence of millimeterwave applications, there is a growing need for flexible probing techniques in this frequency regime.

CONCEPT OF THE TIP

We present our concept for a millimeterwave probe tip which is not only suitable for testing in a laboratory environment with standard pitch and tip-configuration (i.e. GSG, SG,GS,...) but also in probecards where custom specific probe configurations have to be feasible. When testing RFICs, the contacting of the device by comb-like structures is possible. Thus, the idea to the structure of our tip is also applicable to a large variety of probing applications in mass production. By proper choice of a suitable material of the tips, optimum contact to a variety of materials of the contact pads is established. Care has also to be take to choose a material of the needles which withstands the abrasive impact of the pad material which is especially critical in the case of aluminium metallizations. Depending on the desired pitch of the tip, various fabrication techniques e.g. laser-cutting or microfabrication technologies (MEMS) find application. The schematic view of the tip is depicted in Fig. 1.

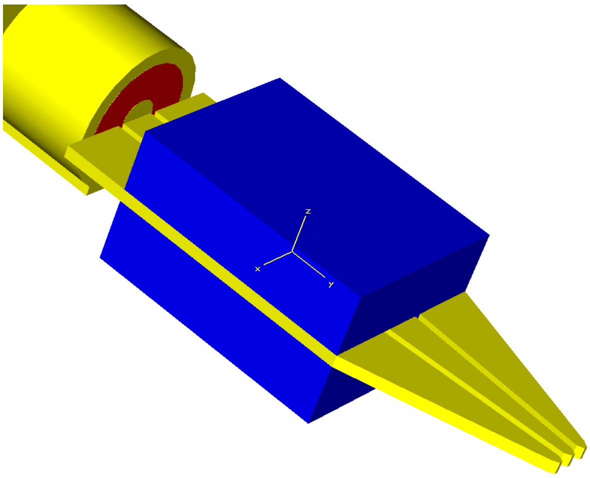

Fig. 1: Schematic view of probe tip

At every cross-section of the signal path along the tip, the structure forms a waveguide with a wave resistance close to 50 Ω, resulting in very low reflexions. Due to the very similar field pattern of the coplanar line, which is formed by the needles to the TEM-mode of the coaxial line, the transition to the coaxial waveguide exhibits lowest reflexions. Experimental investigations of the properties of this probe concept have been carried out by a probe with laser-cut tips. A 50 Ω microstrip line on a Rogers RO 4350 substrate [1] with a thickness of 10 mil has been probed. Ground pads close to the end of the microstrip line are connected to the backside-metallization of the line by vias. A detailed view of the GSG-probe is depicted in Fig. 2. Fig. 3 gives an idea of the matching which is realized with this transition. Matching of the tip is better 20 dB for frequencies up close to 15 GHz. It has to be noted that even the reflexions due to the transition from the microstrip line to the coplanar interface are included in the measurement. The pitch of the probe is 500 µm. The size of the dielectric support of the tips is 5 x 5 x 2.8 mm, which is rather big, compared to the maximum frequency of operation. This leads to the application of this probe concept up to millimeter-wave frequencies. When scaling the size of the tip, testing at frequencies up to 60 GHz and beyond is possible.

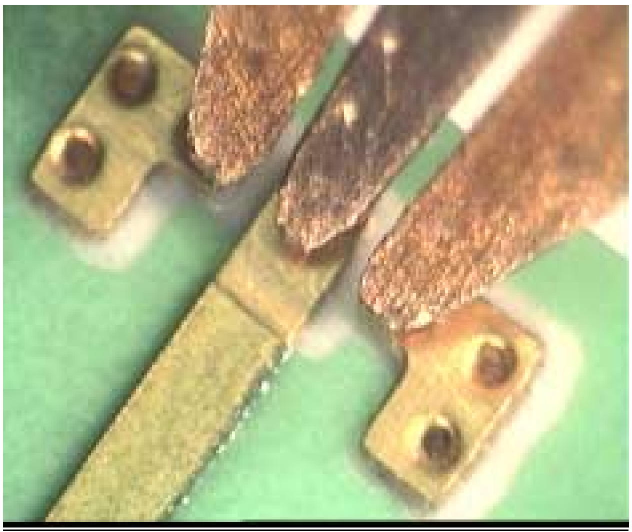

Fig. 2: Probe tip contacts microstrip line

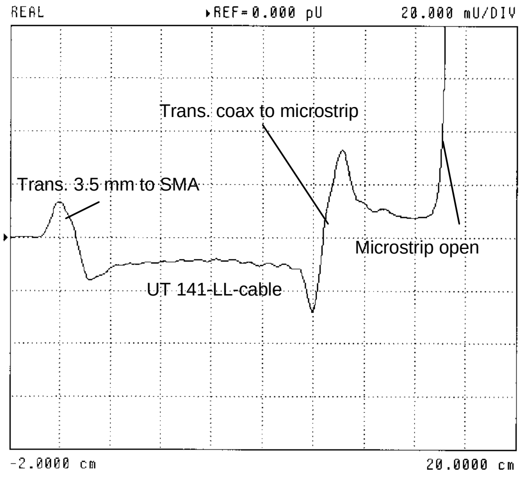

Fig. 3: Measured reflexions of transition

Fig. 4 shows the calculated matching of such a millimeter-wave tip [2]. The dips in the transmission above 50 GHz are due to the excitation of higher order modes inside the dielectric support. Photolithographic processes in combination with electroplating must be used to fulfil the demands on the geometrical accuracy of the tip. This issue is currently under investigation.

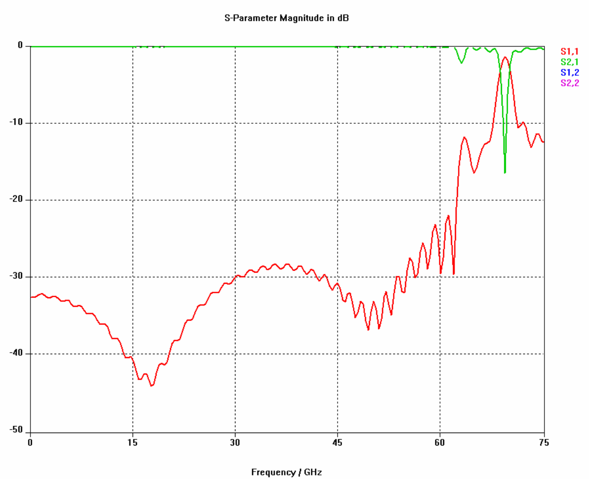

Fig. 4: Calculated matching of a millimeterwave probetip

Samples of the contacting structures have been realized by application of fotolithography in combination with electroplating processes. A thick resist is applied to fabricate contacting elements with thicknesses up to 100 µm. The detailed view of the tip is given in Fig. 5. A gap between the needles with a width of 50 µm is fabricated between the 100 µm thick needles.

Fig. 5: Detailed view of the probe needles

Similar to the laser-cut tip, a transition from the coplanar waveguide to a coaxial air-line is integrated with the housing of the standard tip. A schematic view of this transition is depicted in Fig. 6. Metallic structures are drawn solid, dielectric material and air are depicted by a wire mesh. Calculations show, that a matching of better –30 dB can be expected from this transition up to 60 GHz. The coplanar interface is also well suited for easy access to planar citcuits inside the housing of the tip. Only three bonds or solder joints are necessary for a broadband interconnect with low reflexions. This is very useful to realize active probes or to incorporate signal shaping and processing networks within the probe.

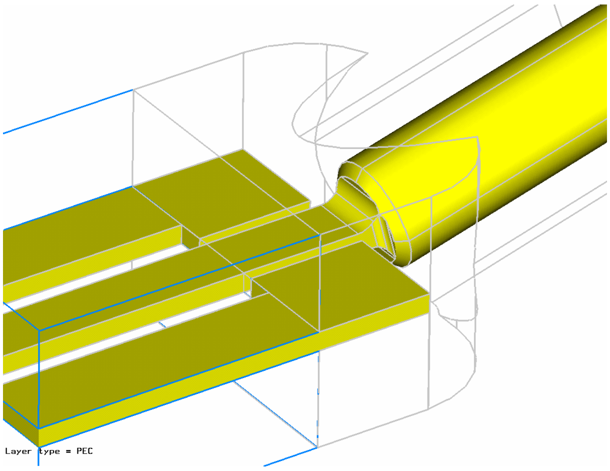

Fig. 6: Schematic view of the coplanar to coaxial transition

CONCLUSIONS

A novel concept for a millimeter-wave probe tip is proposed. Laser-cut probe needles find application on printed circuit boards with pitch down to 200 µm. For precision tips, narrow pitching and highest frequencies, MEMS-technology is applied. Due to the coplanar interface on both sides of the tip module, the integration of planar signal shaping and processing circuits inside the tip housing is very simple

REFERENCES

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