

Wideband On-chip Antennas for Non-Contact Characterization of mmW and THz Devices and Integrated Circuits

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Device characterization in the mmW and THz bands is currently carried out using contact probes in conjunction with waveguide-based transceivers which have limited operation bandwidths (e.g., WR-2.2: 325-500 GHz, WR-1.5: 500-750 GHz, etc.). These state of the art probe systems are plagued by physical fragility and high costs due to the micro-machined components in the probe tip. Moreover, each waveguide sub-band requires a separate contact-probe which transitions the waveguide output of the transceiver into a ground-signal-ground probe tip. As such, it is not possible to use the same probe over multiple waveguide bands, leading to much increased instrumentation cost.

As an alternative to contact-probe testing, we recently proposed a non-contact on-wafer device characterization approach that is both low-cost and wear/tear free (Caglayan et. al, *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 11, pp. 2791-2801). Our non-contact method is based on radiative coupling of standard network analyzer test ports onto the coplanar waveguide (CPW) environment of typical monolithic THz devices and integrated circuits. Our novel approach is enabled by planar on-chip antennas integrated with the device under test. This way, the requirement for physical contact is eliminated. Our new non-contact probe system has the additional advantage of directly coupling into the CPW device environment through on-chip antennas. This flexibility essentially allows for much design freedom in terms of increasing the operation bandwidth of the non-contact probe system. In this work, we present new on-chip antenna designs that enable wideband on-chip probing of mmW and THz electronics over multiple waveguide sub-bands. With the new wideband antenna designs, non-contact probe testing over bandwidths more than 2:1 is possible while concurrently exhibiting high Gaussicity for efficient quasi-optical coupling into the on-chip CPW environment.