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Non-contact Characterization of mmW and THz Antennas and Arrays

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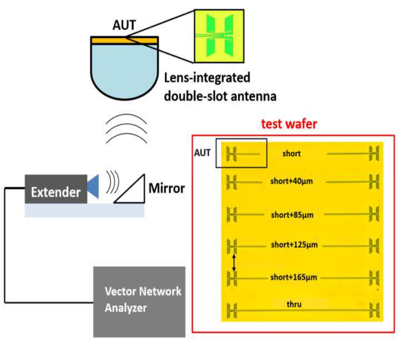
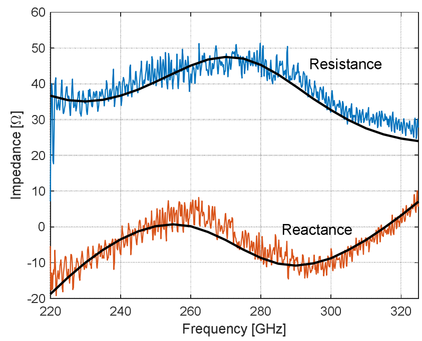
Due to the extremely-small antenna dimensions and non-standard antenna feed topologies at millimeter-wave (mmW) and Terahertz (THz) frequencies, antenna characterization presents unique challenges. Often, THz antennas are fabricated on electronic chips such as GaAs and Silicon, and mmW antennas incorporate feed lines that lack standard connectors to test instrumentation. Current state of the art in mmW/THz antenna impedance characterization is to rely on high-cost probe stations and contact probes. Moreover, pattern and gain characterization of mmW/THz antennas require precise control of antenna positioning for far- or near-field scanning techniques, neither of which can be conducted on available mmW/THz probe stations.

In this work, we demonstrate a novel, non-contact characterization approach which enables straightforward measurements of all relevant antenna parameters, such as impedance, gain, and pattern. Our approach is based on the principles developed by Sinclair et.al. [1] and later extended in [2], where the need for a direct connection to the test port is avoided. Akin to the aforementioned work, our approach is also based on scattered field measurements for various antenna port terminations. However, we treat the problem formally as an open-air-fixture and use a novel calibration technique which can readily yield to antenna port impedance and link gain. The proposed approach depicted in Fig. 1(a) is validated using a lens-integrated THz butterfly antenna. The non-contact measurement of the antenna input impedance for the 220-325GHz band (WR-3) is shown in Fig. 1(b).



(a)



(b)

Figure 1. (a) Non-contact mmW/THz antenna characterization setup using a 1-port VNA, (b) Input impedance of the on-chip, lens-integrated, butterfly antenna characterized without connecting to the antenna port.

As seen in the inset of Fig. 1(a), we conduct a series of measurement of the scattered signal using a single-port vector network analyzer for at least four identical antennas terminated by coplanar waveguide shorts of varying lengths. These set of measurements allow us to use the reduced-reflectometer calibration approach described in [3], which yields the antenna port impedance. Pattern measurements can also be achieved using two successive scans of the pattern cut of interest for two offset short termination, and will be presented at the conference.

References

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