

VNA Measurements in the 0.75-1.1 THz Band

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Abstract—The design, development and testing of a state-of-the-art 0.75-1.1 THz Vector Network Analyzer Extender will be presented. The extender consists of a series of multipliers and mixers that are used to extend the frequency of Microwave Vector Network Analyzers (with operating frequency typically below 50 GHz). The transmitter consists of a x27 multiplier chain generating an average output power of -24 dBm over the 0.75-1.1 THz band. This power is then fed into a bi-directional coupler that is used to sample the outgoing wave (reference mixer) and the test signal (measurement mixer). The coupler has an insertion loss of ~ 6 dB, yielding a test port power of -30 dBm typical. The receivers have a harmonic factor of 36, and consist of a multiplier chain driving a harmonic mixer. The conversion loss of these mixers is in the range of 20-25 dB. Transceiver measurements of the VNA system yielded a dynamic range of 60-70 dB over $\frac{3}{4}$ of the frequency band, with reduced performance at the band edges. The dynamic range measurements were performed with a 10 Hz measurement bandwidth.

The VNA Extender was used to perform calibrated measurements of a variety of one-port and two-port test pieces, using a Short-Open-Load-Thru calibration method. The open circuit was implemented using a $\frac{1}{4}$ -wave delayed short circuit, and the load was a precision load with expected return loss better than 50 dB. Measurements of a 1" straight waveguide piece indicated a return loss of 25-30 dB typical, with the reflections generated by mechanical misalignments at the waveguide interfaces. The measured insertion loss of the 1" straight waveguide piece matched the theoretical loss with a "roughness" factor of 1.4, which is consistent with losses measured at other bands. Additional measurements will be presented at the symposium.