DEVELOPMENT OF SUBMILLIMETER-WAVE REFLECTOMETERS FOR TERAHERTZ COMPONENTS AND SYSTEMS

Weikle, II, R.M.[1], Liu, Z.[1], Crowe, T.W.[1]
, Lichtenberger, A.W.[1], Ulker, S.[2]
[1]Department of Electrical and Comp. Eng., University of Virginia, Charlottesville. VA 22904
[2]Girne American University, P.O. Box 5 Karmi Campus, Karaoglanoglu, Kyrenia/North Cyprus

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Scattering parameter measurements based on vector network analysis have played a critical role in the development of modern microwave and millimeter-wave components. Unfortunately, commercial network analyzers are typically available only up to W-band (75 to 110 GHz), with extensions to higher frequencies being both expensive and cumbersome. Over the past several years, a number of investigators have explored alternatives to the traditional four-port network analyzer based on the vector voltmeter. Much of this work has been motivated by the need to characterize new devices and components that are capable of operating far beyond W-band as well as to measure the properties of materials in the submillimeter-wave range.

This paper focuses on research at the University of Virginia aimed at developing six-port reflectometers for scattering parameter measurements in the submillimeter-wave band. The six-port architecture is attractive because it requires only a passive, linear network and four power detectors. The primary drawback of this approach, however, is the requirement for an additional calibration step and a more complex data processing algorithm. In this work, the passive network is realized with a single section of waveguide that is coupled to Schottky diode detectors through an ensemble of E-plane waveguide probes. In essence, the probes sample the standing wave amplitude in the guide and the complex reflection coefficient is calculated through a series of bilinear transforms. The Schottky detectors used in this work are discrete, planar GaAs devices that are flip-chip mounted to quartz probe circuits. These circuits include a broadband waveguide probe, low-pass stepped-impedance filter, and dc return-to-ground. Calibration of the reflectometer is done using a custom-fabricated sliding load and a series of offset waveguide short-circuits. The design and performance of two prototype reflectometers operating in the WR-10 band (75 to 110 GHz) and WR-4 band (270 to 340 GHz) are described and compared to results obtained from commercially available instruments. In addition, current efforts to integrate the reflectometer, apply it to two-port measurements, and extend the operating frequency further into the submillimeter-wave region will be discussed.

1. (a)
Robert Weikle
Dept. of Electrical and Compute
University of Virginia
351 McCormick Road, PO Box 4
Charlottesville, VA
22904-4743 USA
weikle@virginia.edu

(b) 434-924-3362

(c) 434-924-8818

2. D - Electronics and Photonics

3. (a) THZ

4. I - Invited Paper, Program chair: Aly Fathy

5. No special instructions