SESSION 23: MICROWAVE AND MILLIMETER-WAVE MEASUREMENTS

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This session covers a wide variety of measurement topics concerned with microwave and millimeter-waves. Papers will be presented on new methods, techniques and solutions that extend and improve the state of the measurement art.

Specific progress is described in several unique areas: A frequency response analysis of transmission line discriminators for FM noise measurements; A novel fiber optic technique for amplitude and phase detection of electromagnetic fields; A new method for pulsed network analysis, and; Techniques for determining the dielectric constant and complex permittivity of microwave and millimeter-wave materials.

In the first paper, Brozovich and Ashley describe their analysis of the a.c. bandwidth of transmission line discriminators for use in performing FM noise measurments. For two familiar transmission line discriminators, the simple delay line with and without carrier cancellation, the authors derive the bandwidth potential and computed curves. Equations are given to describe the response down to d.c. which has not been well understood.

Next, Avalos and Sega provide a study of amplitude and phase detection using an electromagnetic field sensor and fibet optic link. An InGaAsP laser diode, modulated by a time varying magnetic field probe, transmits light via a fiber optic transmission line, minimizing field perturbation. A P-I-N photodiode is used as a detector for the frequency band 2.0-3.0 GHz.

Then, Apel and Weber discuss a new method for measuring pulsed RF impedance, gain and phase information. Their method adapts an HP8505A vector network analyzer to the task by applying a burst of short pulses consistent with the limitations of the device under test and detector circuit response. Enhanced performance was obtained by making measurements in a low impedance system.

The three remaining papers are concerned with a common subject, dielectric measurements. The first two employ quasi-optic techniques at millimeter wavelengths (60-600GHz) while the last one uses a dielectric resonator placed in microstrip at more modest microwave frequencies.

First, Shimabukuro and Lazar describe a quasi-optic method for determining the complex dielectric constant of materials at millimeter and sub-millimeter wavelengths. In their method, the determination is made by measuring the power transmission of a perpendicularly polarized wave through a sample disc or dielectric etalon which is placed at various angles of incidence. Rotation of the sample produces a beat between surface reflections. The data is fitted to a theoretical response to obtain a better estimate of the real and imaginary parts of the dielectric constant.

Then, Afsar and Button offer a unique solution for those interested in obtaining accurate dielectric values of millimeter wave materials. The authors present unusually accurate curves for both the real and imaginary parts of the dielectric constant of common microwave materials. The results obtained, using a previously reported dispersive Fourier transform spectroscopic (DFTS) technique, provide both refractive index and absorption coefficient spectra. This leads to the determination of the real part of the dielectric constant to five or six significant figures although the loss tangent can still only be determined to an accuracy of about 1%. Most important, however, is that the authors suggest that due to the complexity and expense of performing these measurements, it is recommended that one rely on a "Center of Excellence" as a source of practical measured data. This is certainly a unique approach to satisfying those requiring the highly accurate data but lacking the sophisticated and undoubtedly expensive measurement facility.

In the last paper of this session, Maj and Modelski describe a technique for measuring complex permittivity by placing a dielectric resonator in a micorstrip line. Analysis of accuracy and measured results in the frequency band 1-12 GHz are presented along with a comparison with the results obtained by the rod resonator method. Overall accurances of relative dielectric constant are claimed to be better than 0.2 percent, while loss tangent accuracies are generally better than 1×10^{-4}.