UNIVERSITÄT DUISBURG ESSEN

Fachgebiet Hochfrequenztechnik

H F T

Fachbereich Ingenieurwissenschaften
Abteilung Elektrotechnik und Informationstechnik

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Aufgabe der Abschlussarbeit im ISE Bachelorstudiengang

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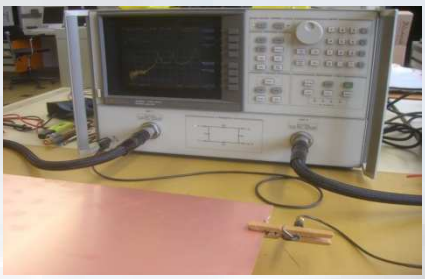
Thema: **Investigation of Measurement Techniques for the Determination of the Dielectric Constant of Substrate Boards for Microwave Circuits**

Beschreibung:

Conventional microwave circuits use microstrip-line technology on printed circuit boards (PCB) to integrate discrete components and transmission line components into complex functions. The boards for high performance microwave circuits are made of special low-loss material, so-called dielectric substrate material which is copper plated on both sides. The dimensions of microstrip-circuits are strongly dependent on the dielectric permittivity of the substrate and therefore the relative dielectric constant needs to be known quite exactly before the layout of a circuit. Manufacturers of substrate materials specify the relative dielectric constant of their production and deliver measurement protocols with every produced panel. However, it has been found that such measurements may be flawed and the circuit designer is well advised to check the data before using the material (incoming inspection).
The thesis task is to investigate some simple to apply methods of measuring the relative dielectric constant of double sided copper clad substrate boards at low and high frequencies and making comparisons with the manufacturer's data. The first two methods are completely nondestructive (without cutting or etching the board).The first method is the measurement of the capacitance of a large panel at a low frequency (typically at 1 kHz) and deriving the unknown from the measured capacitance, the panel size (area) and thickness; in this approach, the contribution of the stray electric field at the edges of the board has to be taken into account; suitable formulas are available in the literature. The second method is a high frequency evaluation of the resonance modes that a large substrate panel develops between the two metal plates and which can be measured as transmission peaks using a network analyzer; again, the stray field contribution has to be accounted for. The third method requires a piece of substrate to be cut from the large panel and is based on the evaluation of a simple microstrip line as a transmission line (testing the insertion phase) and as an open-ended transmission line resonator (testing the resonance frequency); the transmission line phase shift and resonance frequency can be compared to the theoretical values using well verified design formulas and the best-fit dielectric constant can be evaluated. The task in particular is to



- Formulate the theoretical basis for the three methods (from textbooks)
- Determine a correction method for the effect of the stray fields at the board edges
- Set up a Matlab program for the calculation of the unknown relative dielectric constant from measurement results
- Perform a series of measurements on laminate panels available at the department and using the measurement adapters available at the department
- Compare the results to manufacturer's data

At the end of the work, a public presentation of results is to be given.