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Electric and Electronics Engineering Department

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Transmission Lines and Antennas, 2012-3
Project 1: Experimental Characterization of dielectric substrates.
Bogotá, D.C., 8 October 2012

Objective

Apply the concepts of transmission line theory in the electromagnetic characterization of a dielectric substrate.

Specific objectives

1. Acquire experience in the design and fabrication of microstrip systems and its connection to coaxial lines.
2. Get acquainted with microwave measurement equipment.

Problem statement and specifications

It is required to propose and test a procedure to compute the dielectric constant and the loss tangent of a dielectric substrate from measurements performed on microstrip lines printed on it.

The specifications are:

1. Frequency band of characterization: 2GHz-3GHz.
2. For the characterization students will have access to a Vector Network Analyzer (VNA) (according to availability we will use either the Agilent E5062A 300 kHz - 3 GHz VNA or the Rohde & Schwarz FSH8 9kHz-8GHz Spectrum analyzer with vector option). A constraint to be observed is that only measurement of the $S_{1,1}$ parameter will be allowed (one-port measurements).
3. The output desired includes: ϵ_r, $\tan\delta$ and their relative uncertainty considering dimensional tolerances and noise in the measurements assumed to have uniform phase distribution and maximum amplitude of 0.03.

Grading

Examination will consider the following items:

1. (20%) Microstrip prototype built.
2. (50%) Final report (see below for details on format and contents).
3. (30%) Individual (oral/written) evaluation on the theory and practical aspects of the project.

Final Report

Final report must have the official format of the IEEE Transactions, there are templates available in LaTeX and MS-Word in this link (select "template for all Transactions"):

`http://www.ieee.org/publications_standards/publications/authors/authors_journals.html`

The final report must include these sections:

- Abstract
- Background: describes the relevant theory and equations citing the original sources.
- Measurement technique: describes in detail the experimental and computational procedure to obtain the parameters sought. This must include validation via simulation and output tolerance analysis to assess robustness of the method against dimensional tolerances and measurement noise. It is a plus to cite at least one article in literature that describes a technique to measure the dielectric constant of substrates with the constraints given describing the procedure and pointing out any differences/similarities with the method proposed.
- Validation of the method with simulated bechmark data that will be provided by Monday October 15.
- Experimental results: Description of the procedure followed in the lab, the equipment and materials used and the results after processing the measured data. It contains also a discussion of the results, and possible explanations if some of these are unexpected.
- References.

The report is limited to an extent of four pages; note that additional pages will not be considered.

Schedule and products

- Prototypes will be measured on Saturday October 27 in turns to be defined. Note that you are required to have your system ready by the start of your time slot; failure to comply with this may make you loose altogether the opportunity to do measurements.
- Final report is due by Tuesday October 30 at 23:59. This is to be sent in PDF format to the jlaraqueq@unal.edu.co. You can have a draft of your final report proofread by sending a PDF to this e-mail no later than Saturday October 20.

References

[1] D. M. Pozar, *Microwave Engineering.* John Wiley & sons, 1998.

[2] R. E. Collin, *Foundations of Microwave Engineering.* IEEE press, 2001.

[3] D. A.R., R. Biljie, V. Likar-Smiljanic, and T. Sarkar, "Wideband frequency-domain characterization of FR-4 and time-domain causality," *Electromagnetic Compatibility, IEEE Transactions on*, vol. 43, no. 4, pp. 662–667, nov. 2001.