MICROWAVE NONDESTRUCTIVE TESTING OF COMPOSITE MATERIALS USING A FREE - SPACE TECHNIQUE

Thesis is presented in partial fulfilment for the award of the Bachelor of Electrical Engineering (Hons) of
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SUHARDI B. MOHAMAD ALI YAKOP
Department of Electrical Engineering
MARA Institute of Technology
40450 Shah Alam
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ABSTRACT

The main objective of this project is to develop a microwave free-space measurement system in the frequency range of 8.0 to 12.5 GHz (X-Band) to measure reflection and transmission coefficients , S_{11} and S_{21} of planar samples such as Polyvinyl-Chloride (PVC), Polypropylene (PP), Nylon, Polyethylene (PE), Polyurethane and Teflon. The complex electric permittivity (ε *) and complex magnetic permeability (μ*) are calculated from the measured values S_{11} and S_{21} by using a C++ language program.

The measurement system consist of transmit and receive horn lens antennas, Wiltron Vector Network Analyzer, mode transitions and a printer. Diffraction effects at the edges of the samples are minimized by using spot-focusing lens antennas. Error due to multiple reflections between antennas via the surface of the sample are corrected by using a free-space LRL (Line, Reflect, Line) calibration technique.

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CHAPTER 1

1.0 INTRODUCTION TO MICROWAVES

1.1 Microwave Definition.

Microwaves are electromagnetic wave of very short wavelength. The wavelengths and frequencies of various kinds of electromagnetic waves are listed in Table 1-1. Microwaves extend over a range of 1m - 0.1mm in wavelength and 300 MHz - 3000 GHz in frequency. Microwaves lying in the extremely short wavelength region are called submillimeter waves. Some of these lie in the infrared wavelength region.

Table 1-1 Electromagnetic waves

Electromagnetic Waves	*Frequency*	*Wavelength*
Long Waves	30 - 300 KHz	10 - 1 Km
Medium Waves	300 - 3,000 KHz	1,000 - 100 m
Short Waves	3 -30 MHz	100 - 10 m
Ultra Short Waves	30 - 300 MHz	10 - 1 m
Microwaves	300 - 30,000 MHz	100 - 1 cm
Ultra Microwaves	30 - 3,000 GHz	10 - 0.1 mm
Infrared Rays	3,000 - 416,000 GHz	0.1 - 0.00072 mm