MICROWAVE NONDESTRUCTIVE TESTING OF COMPOSITE MATERIALS (8 GHz TO 12 GHz) USING A FREE-SPACE TECHNIQUE

Thesis presented in partial fulfilment for the award of the Advanced Diploma in Electrical Engineering of INSTITUT TEKNOLOGI MARA

ABDUL HFIZ BIN AHMED
Department of Electrical Engineering
INSTITUT TEKNOLOGI MARA
40450 Shah Alam, Malaysia.
JULY 1996

ABSTRACT

The main objective of this experiment is to get the power absorption coefficients (PAC) when the reflection coefficients, $|S_{11}|^2$ and transmission coefficients, $|S_{21}|^2$ is obtained from the reflection measurements and transmission measurements. Using transmission and return loss (reflection) measurements, we have developed a method for microwave nondestructive testing of several composite materials in the frequency range of 8 - 12 GHz (X-band). The key components of the measurement system are scalar network analyzer and horn antennas. The dielectric constants and the loss tangents for each samples are formerly known.

ACKNOWLEDGEMENTS

Alhamdulillah, praise to ALLAH s.w.t the Most Gracious, Ever Merciful, who has given me the strength and ability to complete this final year project and report.

I would like to express my deepest gratitude to my advisor Dr Deepak Kumar Ghodgaonkar for his guidance, ideas and valuable advice which made possible this final year project.

I also like to thank from the bottom of my heart to the staff of Rank O'Connors especially to Puan Rafizah Budin and their colleagues.

I also would like to forward my special thanks to Encik Kamarul Zaman and laboratory assistants for helping and giving me full co-operations towards the success of this project.

Not forgetting also Puan Saidah for her kindness to help and giving me support towards of this project.

My special thanks to all the Advanced Diploma lecturers and staff who have sporting spirit and taught me to this level.

Finally, thanks to this green campus for teaching me the meaning of life.

MICROWAVE NONDESTRUCTIVE TESTING OF COMPOSITE MATERIAL (8 GHz TO 12 GHz) USING A FREE-SPACE TECHNIQUE

CONTENTS PAGE NO.

CHAPTER 1

1. INTRODUCTION TO MICROWAVES

Microwaves are electromagnetic waves of centimetric wavelengths. The frequencies and wavelengths of various bands of electromagnetic waves are listed in Table 1.

Table 1. The frequencies and wavelengths of various bands of electromagnetic waves.

	Frequency	**Wavelength λ**
Long Waves	30 - 300 kHz	10 - 1 km
Medium Waves	300 - 3000 kHz	1000 - 100 m
Short Waves	3 - 30 MHz	100 - 10 m
Very High Frequency Waves	30 - 300 MHz	10 - 1 m
Microwaves	0.3 - 30 GHz*	100 - 1cm
Millimeter Waves	30 - 300 GHz	10 - 1 mm
Submillimeter Waves	300 - 3000 GHz	1 - 0.1 mm
Infrared (including far - infrared)	300 - 416,000 GHz	10^4 - 0.72 μm+
* 1 GHz = 1 gigahertz = 10^9 Hertz or Cycles per second. + 1 μm = 10^{-6} m.		

Because of much larger bandwidths (compared to the commonly used communication bands of MW, SW, and VHF) and relatively smaller antenna sizes (on the order of 3 to 5 meters and smaller) for every sharp radiated beams (beam widths typically on the order of 1 - 5° and considerably smaller than those