# MICROWAVE NONDESTRUCTIVE EVALUATION OF TIMBER USING A METAL-BACKED REFLECTION TECHNIQUE

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## ABSTRACT

Dielectric properties of timber are determined by its moisture content, slope-of-gain and density. So, they can be used for nondestructive evaluation of timber. Dielectric properties will be deduced from complex reflection coefficient measurements of metal-backed Malaysian timber specimens. A free-space microwave measurement system is used for reflection coefficient measurements in the frequency range of 7.5-14.5 GHz. The key components of the measurement system are a pair of spot-focusing horn lens antennas, the microwave network analyser and computer. The inaccuracies in free-space measurements due to diffraction and multiple reflections are minimized by the use of spot-focusing antennas and free-space LRL ( Line, reflect and line ) calibration technique. Experimental results will be reported for dry and wet specimens of different types of Malaysian timber. Also, dielectric constant and loss tangent values will be measured when the electric field is parallel and perpendicular to the grain direction.

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# CHAPTER 1

## 1.0 INTRODUCTION

There has always been a great deal of interest in nondestructive testing (NDT) of material such as timber, metals, composites etc. The field of NDT of materials covers many areas of science. When electromagnetic (EM) waves are used to nondestructively evaluate properties of materials media, an accurate theoretical model which descibes the interaction of EM waves with the material must be developed.

Timber is a natural material with a complex structure and composition. Interaction between the alternating electromagnetic field and timber makes it possible to elucidate specific properties of this material.Timber is highly variable material with some properties, such as strength, varying by a factor of more than 10:1 within the same tree. The two important structural properties are strength and stiffness. The strength and stiffness properties are much greater along the fiber direction than in the cross direction. As timber is semi-transparent at microwave frequencies, the loss, phase shift and polarization of microwaves transmitted through timber can be measured. Timber is also strongly anistopic both in its physical strength and in its electrical properties.

Under the action of an alternating electric field , the timber reveals its dielectric properties , which more often are characterized by two main indices: by the relative dielectric constant $\left(\varepsilon'\right)$ and by the dielectric loss tangent ($\delta$).