ANALYSIS OF BROADBAND ABSORBING NON-MAGNETIC MATERIALS

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

ARBA'IAH INN
Department of Electrical Engineering
INSTITUT TEKNOLOGI MARA
40450 Shah Alam , Malaysia

DECEMBER 1995

ABSTRACT

An analytical approach, through the lossy transmission line technique is used to design Wave Absorbing Non-Magnetic Materials (WANMMs). These WANMMs are made of several dielectric layers, usually on top of a conducting plane. The total absorption of the electromagnetic energy is done in the last lossy layer. Other layers are used to match the wave impedance of the WANMM to that of the incidence media for the normal incidence only at different microwave frequencies. The approach is easy, practical and flexible, allowing the design of WANMM for specific applications such as Radar Absorbing Materials (RAMs) and Wireless Local Area Networks (WLANs). A wide range of frequencies is considered to maintain a minimum range of reflection.

ACKNOWLEDGEMENT

In the name of ALLAH S.W.T, The Most Beneficient, The Most Merciful. It is with the deepest sense of gratitude of the Almighty ALLAH who gives me the strength and ability to complete this thesis .

All perfect praises belong to ALLAH alone, Lord of the world. May His blessings be upon Prophet Muhammad s.a.w and members of his family and companions.

I am personally indebted to my project advisor, Cik Zunairah Haji Murat who deserves most credit for her patience, inspiration and advice in guiding me towards the completion of this thesis.

I would like also to thank Dr. Riadh W. Y. Habash for the helpful discussions and explanations during this study.

My gratitude also goes to lecturers, technicians who were involved directly or indirectly in giving invaluable assistance during this project.

Finally, I would like to express my special gratitude to my beloved parents who have given me all the way this much of encouragement, understanding and support .

ANALYSIS OF BROADBAND ABSORBING NON-MAGNETIC MATERIALS

CONTENTS

CHAPTER 1

1. INTRODUCTION

1.1 General

The interaction of electromagnetic fields with material is determined by the electromagnetic properties of the material, characterized by the electrical permittivity ε, the magnetic permeability μ, and the electrical conductivity σ and the frequency of operation. For all non-magnetic media, μ may be taken to be equal to the magnetic permeability of free space, $\mu_o = 4\pi \times 10^{-7}$ H/m.

An exact mathematical description of the reflection loss performance of an absorptive material of known thickness on a metal structure requires only the four terms of complex magnetic permeability ($\mu = \mu' - j\mu''$) and dielectric permitivity ($\varepsilon = \varepsilon' - j\varepsilon''$) of the component materials. One version of an ideal absorber might comprise a single, thin layer of material having numerically equal values of complex permeability and permittivity and high loss tangents (μ''/μ' and $\varepsilon''/\varepsilon'$) over a wide range of frequencies. The former ensures efficient matching of the incident wave into the obsorber, and the latter promotes rapid attenuation thereafter [1].