ELECTROMAGNETIC BAND GAP (EBG) FOR MICROSTRIP ANTENNA DESIGN

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To my beloved mother and father

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ABSTRACT

Microstrip patch antennas became very popular in mobile and radio wireless communication. This is because of ease of analysis and fabrication, and their attractive radiation characteristics. However, they have some drawbacks of low efficiency, narrow bandwidth and surface wave losses. In order to overcome the limitations of microstrip antennas such as narrow bandwidth (< 5%), lower gain (-6 dB), excitation of surface waves etc, a new solution method; using electromagnetic bandgap (EBG) materials, as substrates has attracted increasing attention. Unlike other methods, this new method utilizes the inherent properties of dielectric materials to enhance microstrip antenna performance. These periodic structures have the unique property of preventing the propagation of electromagnetic waves for specific frequencies and directions which are defined by the shape, size, symmetry, and the material used in their construction. Some EBG structures include drilled holes in dielectrics, patterns etched in the ground plane, and metallic patches placed around microstrip structures. The aim of this project are to design, simulate and fabricate the new EBG structure operating at 2.4GHz frequency and study the performance of the rectangular microstrip antenna with and without EBG structure. Those designs were simulated with Microwave Office software and tested with the Network Analyzer. Both, simulated and measured data were compared and contrasted.

ABSTRAK

Antena mikrojalur menjadi semakin popular dalam bidang telekomunikasi tanpa wayar bergerak. Ini disebabkan kemudahan dalam analisis, fibrikasi, dan mempunyai karakter radiasi yang menarik. Walaubagaimana pun, ianya mempunyai beberapa kelemahan seperti kecekapan yang rendah, jalurlebar yang sempit dan kehilangan gelombang permukaan. Untuk mengatasi masalah ini, satu penyelesaian baru, iaitu penggunaan bahan jalurcelah elektromagnet (EBG) boleh digunakan. Berbanding cara yang lain, cara in menggunakan sifat semulajadi bahan dielektrik untuk menambahkan keupayaan antenna mikrojalur. Struktur yang berkala ini mempunyai sifat yang unik iaitu menghalang perambatan gelombang elektromagnet untuk frekuensi dan arah yang tertentu berdasarkan bentuk, saiz, dan bahan yang digunakan untuk membinanya. Sesetengah struktur EBG ini termasuklah menebuk lubang pada dielektrik, mengukir corak pada permukaan bawah dan tampalan logam di sekeliling struktur mikrojalur. Tujuan projek ini ialah untuk merekabentuk, simulasi and fibrikasi struktur EBG yang baru dan beroperasi pada frekuensi 2.4GHz dan mengkaji kebolehan antenna mikrojalur dan antenna mikrojalur dengan jalurcelah elektromagnet. Kesemua rekaan ini disimulasi menggunakan perisian Microwave Office dan diuji menggunakan Network Analyzer. Keputusan kedua-dua rekaan ini dibanding antara satu sama lain.

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mm	-	millimeter
dB	-	decibel
Hz	-	hertz
K	-	kilo
D,d	-	diameter
H	-	height
L	-	length
W	-	width
Γ	-	reflection coefficient
Z_0	-	characteristic impedance
λo	-	free-space wavelength
ε_r	-	dielectric constant of the substrate
h	-	patch thickness
c	-	speed of light $3x\ 10^{-8}$ m/s

CHAPTER 1

INTRODUCTION

1.1 Introduction

Microstrip patch antennas have been an attractive choice in mobile and radio wireless communication. This is because they have advantages such as low profile, conformal, low cost and robust. However, at the same time they have disadvantages of low efficiency, narrow bandwidth and surface wave losses.

Recently, there has been considerable research effort in the electromagnetic band gap (EBG) structure for antenna application to suppress the surface wave and improve the radiation performance of the antenna.

In this project, it is proposed that the microstrip antenna having the EBG structure, which is placed around the patch antenna. The proposed design is evaluated using the Microwave Office and the effectiveness of the design is compared with the conventional microstrip antenna.

1.2 Objectives

The objectives of this project are to design, simulate and fabricate the new EBG structure operating at 2.4GHz frequency and study the performance of the rectangular microstrip antenna with and without EBG structure.

1.3 Scope of work

The scopes of work of this project are to study the basic electromagnetic band gap (EBG) properties from several published papers and books, design a conventional rectangular microstrip antenna and the new EBG structure operating at 2.4GHz frequency.

These designs are simulated using Microwave Office software. The designs were then etched on FR4 substrate with dielectric constant of 4.5 and height of 1.6 mm. Network Analyzer was used to measure the designs. Both simulated and measured data are compared and contrasted.

1.4 Outline of the Thesis

The thesis consists of six chapters and the overview of all the chapters are as follows:

Chapter 1: This chapter provides a brief introduction on the background, the objectives of the project and scope of work involved in accomplishing the project.

Chapter 2: A technical description of microstrip antenna focusing on basis characteristics and typical excitation (feeding) methods, and

concludes with an analytical model of the patch were discussed in this chapter.

Chapter 3: Literature review of electromagnetic bang gap (EBG) is describes in this chapter. This chapter focuses on the underlying principles of electromagnetic band gap (EBG) and their associate properties.

Chapter 4: This chapter gives an overview of the antenna design methodology with the fundamental process in the design, simulate, fabricate and testing (measurement) procedures.

Chapter 5: Chapter 5 describes the simulation and measurement results obtained from the described methodology.

Chapter 6: A final conclusions is made in chapter 6 based on the outcome of the project, followed by the recommendations for the future work.

1.5 Summary

This chapter provides the introduction for the project. Its cover the objectives, scope of work and the flow of this thesis. This chapter is the major part of the thesis because its summaries the whole process.