MINIATURIZED WAVEGUIDE SLOT ANTENNA

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Dedicated to my beloved family and a very special person

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ABSTRACT

This project presents the design and analysis of a miniaturizedwaveguide slot antenna with a center frequency of 2.4GHz and a Bandwidth of 258MHz. The miniaturization of waveguide slot antenna takes into the considerations on the design specifications and performances available in the market. The research compares simulation results and lab test results. The initial antenna design was simulated using CST Microwave Studio software. The fabrication of the miniaturized waveguide slot antenna was realized using the FR4 dielectric substance with a feeder probe as antenna input.The miniaturized waveguide slot antenna provides a bandwidth of 228 MHz with a return loss of – 27.953 dB and gain of 3.528 dB operating at 2.4GHz.With this research, smaller waveguide slot antenna can be used in applications stated in IEEE 802.11 specifications for wireless application in the future.

ABSTRAK

Projek ini membentangkan tentang pengurangan saiz ruang antena dengan gelombang dorongan yang beroperasi pada frekuensi 2.4GHz dan membekalkan jalur lebar seluas 258MHz. Ruang antena dengan gelombang dorongan mengambil kira specifikasi serta prestasi daripada reka bentuk yang sama yang terdapat di pasaran. Thesis ini membincangkan dan membuat perbandingan diantara keputusan yang diperoleh dari perisian simulasi dan ujian makmal. Perisian CST Microwave Studio digunakan untuk mereka bentuk dan ujian simulasi. Kemudian, ruang antenna dengan gelombang dorongan ini difabrikasi dengan menggunakan bahan FR-4 dan teknik probe digunakan sebagai punca bekal kuasa. Antena ini dapat membekalkan jalur lebar seluas 258MHz, kembalian kerugian bernilai – 27.953 dB dangandaan bernilai 3.528 dB apabila ia beroperasi pada 2.40GHz. Dengan kajian projek inidiharapkan ruang antenna dengan golombang dorongan dapat digunakan sebagai aplikasi sepertimana pada specifikasi dari IEEE 802.11 untuk aplikasi wayarles di masa akan datang.

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LIST OF ABBREVIATIONS

BW	-	Bandwidth
W	-	Watt
FR-4	-	Flame Retardant Type 4
mm	-	millimeter
PCB	-	Printed Circuit Board
IEEE	-	Institution of Electrical and Electronic Engineer
MHz	-	Mega Hertz
GHz	-	Giga Hertz
FYP	-	Final Year Project
VSWR	-	Voltage Standing wave Ration
HF	-	High Frequency
R&D	-	Research and development
CST MWS	-	CST MICROWAVE STUDIO®
3D	-	3 Dimension
CAD	-	Computer-aided Design
FNBW	-	Full Null Bandwidth
HNBW	-	Half Null Beamwidth

SYMBOLS

L_2	-	Length 2
W_2	-	Width 2
L_1	-	Length 1
W_1	-	Width 1
f_L	-	Lower Frequency
f_H	-	Upper Frequency
%	-	Percentage
y_p	-	Probe Location
r_{inner}	-	Inner Radius
μ_0	-	Permeability of air space
ε_0	-	Permittivity of air space
ε_{reff}	-	Effective dielectric constant
ε_r	-	Dielectric Constant
dB	-	Decibel
h	-	Substrate Thickness
λ_0	-	Air space Wavelength
f_{min}	-	Minimum Frequency
f_{max}	-	Maximum Frequency
W	-	Width
e	-	Slot width
S_{11}	-	Return Loss
Ω	-	Ohm
λ	-	Wavelength
π	-	Pi

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

This chapter presents an introduction of waveguide slot antenna, background, problem statement, objectives and scope of the research.

1.0 Introduction:

Current advancement in communication technology, consumer demands, and growth in the wireless communication market demonstrate the need for smaller, power efficient and more reliable integrated wireless systems. Antennas which come in many kinds such as slot antenna are considered to be the largest components of integrated wireless system; hereby, antenna miniaturization is a challenge and an important task for engineers, designers in order to achieve an optimal design for integrated wireless system. Slot antenna which are used widely in spacecraft, missile, aircraft, satellites, cars and other mobile application are better than other type of antennas since it is cheap and easy for mounting and fabrication, suited for integration, light and mechanically robust, and provides low cross-polarization.

This project is carried out in order to present a miniaturized waveguide slot antenna operating at 2.4 GHz by using an air gap technique. It is hoped that this project will bring upon interest among people in the communication world in designing a good miniaturized waveguide slot antenna.

1.1 Project Objectives

The main objective of this project is to study and analyse the design of a miniaturized waveguide slot antenna using the technique of providing an air gap in order to provide the same properties and work operation of waveguide slot antenna but comes in smaller sizes.

1.2 Project Scope

The main areas being identified that need to be worked out are:

1. Conduct literature review about waveguide slot antenna and analyzed the list of parameters needed for the antenna design
2. Design and simulate the waveguide slot antenna and conduct several tests in order to get measurements for certain parameters and provide a simulation data record
3. Fabricate a waveguide slot antenna
4. Test and troubleshoot a waveguide slot antenna and providing experimental data record.

Other scopes of work include:

1. Study on theoretical engineering principles related to the proposed project
2. Design, simulate and fabricate the required antenna for the project
3. Maintain good log book records
4. Prepare the necessary documents
5. Present the completed project in the seminar

Final report and submission

1.3 Methodology

In order to complete this project, the following tasks must be executed and completed.

1. Initiate project plan and progress chart by using Gantt chart
2. Study about types of antenna, characteristics, designing, and parameter for testing as well as designing technique.
3. Search for suitable materials such as books, journals, conferences report, thesis writing and electronic media as references.
4. Do a simulation for several slot designing and test for gain, bandwidth, return loss and justify the radiation pattern.

5. Components and parts identification/specification/procurement.
6. Fabricate the chosen design and run a real time test for efficiency, bandwidth, path losses, and radiation pattern.
7. Presentation on outcome of the project.
8. Preparation and presentation of technical report.

1.4 Thesis Structure

This thesis comprises of five chapters. The following is the outline of Miniaturized Waveguide Slot Antenna – chapter by chapter.

Chapter 1: This chapter discusses on the brief overview about this project such as introduction, objective, and scope of study, problem statement and methodology.

Chapter 2: This chapter consists of literature review of this project which covers commercial development of microstrip patch antenna, its advantages, limitation, method to design, topology of rectangular, probe-fed, U-slot microstrip patch antenna on a single-layer, grounded substrate, substrate selection, review of antenna miniaturization technique, proposing tuning technique and finally, tuning technique for U-slot patch design.

Chapter 3: This chapter elaborates on the lists of procedure in designing a waveguide slot antenna starting with the work flowchart, antenna design specification, and simulation process by using CST Microwave Studio software, parametric studies of antenna process, miniaturization and optimization specification, and fabrication process.

Chapter 4: This chapter retrieves and discusses on the results obtained in simulation, parametric studies, and lab test result of miniaturized waveguide slot

antenna and finally compares the differences between results obtained from simulation and lab test.

Chapter 5: This chapter concludes this thesis and recommends future development of this research.

CHAPTER 2

LITERATURE REVIEW

This chapter discusses literature review of this project which consist of the commercial development of microstrip patch antenna, its advantages, limitation, method to design, topology of rectangular, probe-fed, U-slot microstrip patch antenna on a single-layer, grounded substrate, substrate selection, review of antenna miniaturization technique, proposing tuning technique, tuning technique for U-slot patch design, and finally about Glass Eproxy (FR-4).