MICROSTRIP BANDPASS FILTER AT 5.8 GHz

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DEDICATION

Special to my father and my family, thanks a lot for all your support.

For my friends, thank for helping and guide me for all this time.

Hope all of us will success and happy ever after.

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First and foremost, I would like to praise the Almighty Allah for blessing me with strength and capability to provide the final year report successfully for the 2008/2009 session. One more course to go, but I hope that this blessing will continually giving me the nurture that I need. I am so glad that I have given an opportunity to carry out this project, which exposes the actual system of evaluation process.

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ABSTRACT

The primary purpose of this report is more to brief to the reader with a detailed and comprehensive study of theory, design, fabrication, result and problem encountered in the designing bandpass filter. This filter design is operate at frequency center of 5.8 with bandwidth is 20% of frequency center. The approaches used to achieve this project are through literature review of microstrip filter including calculation, computer software simulation and fabrication process using FR4 board. Microstrip technology is the best technique because it is can give accurate value and economical. This technology is design to reduce the cost compared to conventional filter that had been used before. The bandpass filter has several types and design but this project is focused on the parallel-coupled bandpass filter to determine the suitable parameters. Microwave Office Software is used to analyze the characteristic parameter and determine the insertion loss and return loss of frequency response that has been used to analyze performance quality. The bandpass filter contributes to the application of Wireless Local Network Area application. This thesis exposes to the evaluation process of designing parallel-coupled microstrip bandpass filter.

ABSTRAK

Tujuan utama laporan ini adalah untuk memberikan maklumat secara terperinci kepada pembaca mengenai teori, rekabentuk, proses fabrikasi, keputusan dan permasalahan yang mungkin wujud dalam proses mereka bentuk. Reka bentuk turas ini beroperasi pada frekuensi tengah 5.8 GHz dengan jalur lebar pada 20% daripada frekuensi tengah. Pendekatan digunakan bagi mencapai projek ini adalah melalui kajian latar belakang termasuk pengiraan, simulasi perisian computer dan proses fabrikasi menggunakan papan FR4. Mikrostrip teknologi adalah teknik terbaik kerana ia adalah boleh memberikan nilai yang tepat dan jimat. Teknologi ini dapat mengurangkan kos berbanding dengan turas konvensional yang telah digunakan sebelum ini. Penapis lulus jalur mempunyai beberapa jenis dan reka bentuk tetapi menumpukan perhatian pada rekabentuk penapis lulus jalur ganding selari. Perisian Gelombang Mikro digunakan untuk menganalisa ciri-ciri parameter dan menentukan kehilangan sisipan dan kehilangan balikan bagi gerak balas frekuensi telah digunakan untuk menganalisa prestasi kualiti. Sementara itu, kaedah kehilangan penyisipan yang digunakan untuk menganalisis kualiti pelaksanaan. Penapis turas ini adalah digunakan dalam aplikasi Rangkaian Kawasan Setempat Tanpa Wayar. Laporan ini mendedahkan proses merekabentuk penapis lulus jalur ganding selari.

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LIST OF ABBREVIATIONS

BW	-	Bandwidth
BPF		Bandpass Filter
PCB	-	Printed Circuit Board
WLAN	-	Wireless Local Area Network
fc	-	Center frequency
f_L	-	Lower Cut-off Frequency
f_H	-	Higher Cut-off Frequency
Z_{in}	-	Input Impedance
Z_0	-	Characteristic Impedance
εr	-	Relative Dielectric Constants
εeff	-	Dielectric
h	-	Substrate Height
t	-	Thickness
l	-	Length
w	-	Width
s	-	Space

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

This project provides the reader with the detail and comprehensive study of theory, design, fabrication, result and problem encountered in the designing bandpass RF microwave filter. This project will develop bandpass filter by using microstrip technology. The approaches used to achieve this project are through literature review, dimensional calculation and computer software simulation. The characteristic and the required specification are analyzed before fabricating the microstrip bandpass filter. It is impossible to transmit an infinite signal through an infinite electromagnetic spectrum, electromagnetic spectrum is very limited, hence there is a need have a filter that will confined the desired Radio Frequency (RF) or microwave signal within the limited bandwidth.

Computer simulation is the best technique to get the solution because it can give the accurate value and it also economical. Microwave Office 2004 is the software that use to analyze the characteristics of the microstrip bandpass filter and to determine the suitable parameters.

This project methodology had been divided into three stages. The first stage is survey of literature review and the second stage is dimensional calculation followed by software simulation and lastly fabrication, testing and analysis of the results. The filter design is concentrated on the parallel-coupled bandpass filter operating at 5.8 GHz by using FR4 as a substrate.

1.2 PROJECT OBJECTIVE

Microstrip technology of filter in microwave is widely used and become one of the important technologies in the new era. This project will develop a bandpass filter by using microstrip technologies applications which is one of the ways to upgrade the communications system. The filter will be used in high speed and big capacity data transmission such as video in Wireless Local Area Network application. In developing this project, objective was the main concern to make sure that all process in this project will completely in the duration that given.

The objective for the microstrip bandpass filter is:

- To design a bandpass filter at 5.8 GHz by using microstrip technology. A simulate will be done by using Microwave Office Software 2004 and the circuit will be fabricate by using FR4 as a substrate.

1.3 PROBLEM STATEMENT

In this project, microstrip technology will be used. As we know, the cost for a bandpass filter is expensive. Originally, filters were designed using inductors, capacitors, and transformer and were terminated by resistors representing the load and the internal resistance of the source. This technology is design to reduce the cost compared to conventional filter that had been use before. There is no use the active devices such as capacitor and the whole circuit will fabricate using this technology, but the mathematical of filter approximation was being advanced independently of these devices. Bandpass filter is take time to build and this technology is try to make faster and simple way to design microstrip bandpass filter. The bandpass filter is working on 5.8 GHz based on IEEE802.11a standard for wireless LAN application. This frequency is becoming more widely recognized as an economical alternative for short distance voice and data communication.

1.4 SCOPE OF WORK

In this new era technology, all the application of communication system widely used the microwave radio frequency such as Japan, United State America, Great Britain and others. Malaysia is one of the countries that try to reach the technology.

This project is to develop a 5.8 GHz Chebyshev bandpass filter by using microstrip technologies. This project is focus on super high frequency (SHF) which the electromagnetic spectrum between 3 MHz to 300 MHz and the specification frequency at frequency 5.8 GHz. The scope of this project is divided to three stages which is study of literature review, simulation and fabrication of the circuit. A scope of work is:

- Analysis the type of filters and a significant set of parameters S_{11} and S_{21} known as 'scattering parameters' or more briefly S-parameters embody the effects of reflection or through transmission of power for any network. S_{11} is referring to return loss and S_{21} is the insertion loss of frequency response.
- By using software such as Microwave Office, the expected result for the filter can be determined which simulation process is one of the engineering methods to get the expected result.
- The last part of this project is fabricating filter circuit using FR4 board after do the simulation and the result will be compare with the expected result from simulation.

1.5 THESIS OUTLINE

Chapter 1 provides a first glimpse at the basic aspects of the research undertaken which is introduction, project objective, problem statement, and scope of work in the designing parallel-coupled microstrip bandpass filter.

Chapter 2 gives a literature review on parallel-coupled microstrip lines and overview of the fundamentals of parallel-coupled bandpass filter design. Coupling effect will be discussed. It also shows how a parallel coupled can be used for the filter design, based on the given specification how to obtain the Z_{oe} and Z_{oo} from lowpass filter prototype elements.

Chapter 3 shows the detail of designing a Chebyshev parallel-coupled bandpass filter. Flowcharts and sequence of the filter design will be presented. It is starting with dimensional calculation to analyze the order of filter and the physical dimension of the coupled-line. Careful and detail studies were carried out on chapter to obtain a right design equation. Finally an appropriate design equation was achieved and used for

further design of the parallel coupled bandpass filter. Filter design parameters are presented for bandpass filter center frequency 5.8 GHz with operation bandwidth of 20 %.

Chapter 4 is about the result and analysis microstrip bandpass filter. Based on the design equation from chapter 3, the design modification was introduced on the parallel coupled bandpass filter and simulated. The complete results are given for non modified and modified filters. From the results and analysis on this chapter, further modification has been done on the filter design parameter to achieve the actual design specification proposed in this research. Finally, the results are presented and analyzed.

Chapter 5 concludes the thesis followed by recommendations for future work.

CHAPTER II

MICROSTRIP BANDPASS FILTER

2.0 OVERVIEW

We are living in age of information of information technology. Most of this technology is based on the theory of filter design and its applications are supported by other disciplines such as computer science and engineering, and advances in technologies. Filter plays important rule in many radio frequency or microwave applications. It is used to separate or combine different frequencies.

In the early days of microwave engineering (1940), most components were manufactured as highly precise mechanical elements. There is no semiconductor processes were available such as any practical planar circuit board technologies at hand for industrial scale network. Active devices were mostly electron tubes which it is required the extreme capabilities of the mechanical workshop [3].