INVESTIGATION OF MICROSTRIP PARALLEL COUPLED BANDPASS FILTER FOR GPS APPLICATIONS

DZUL FITRY BIN ISMAIL

This report is submitted in partial fulfillment of requirements for the award of Bachelor Degree of Electronic Engineering (Telecommunication Electronic Engineering) with honours

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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MENGKAJI PENAPIS LULUS JALUR GANDINGAN SELARI UNTUK APLIKASI GPS

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Laporan ini dikemukakan untuk memenuhi sebahagian daripada syarat penganugerahan Ijazah Sarjana Muda Kejuruteraan Elektronik (Elektronik Telekomunikasi) dengan kepujian

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To my love, my lovely mum, dad and to all my family and friends

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ABSTRACT

This thesis provides the reader with a detailed and comprehensive study of theory, design, fabrication, and result in designing bandpass RF microwave filter. The approaches used to achieve this project are through literature survey, dimensional calculation and computer software simulation. These approaches are used to analyze the characteristics and the required specification before fabricating the microstrip bandpass filter, computer simulation is the best technique to get the solution because it is fast and economical. The bandpass filter has several types and design. There are parallel-coupled microstrip bandpass filters, edges microstrip bandpass filter and hairpin microstrip bandpass filter. The filter design is concentrated on the parallel-coupled bandpass microstrip filter operating at 1.575GHz by using FR4 as a substrate. To achieve this purpose, computer software, Microwave Office 2004 is used to analyze the characteristics of the microstrip bandpass filter and to determine its suitable parameters. The Emsight Simulator is developed by using a technique called "Method of Moment (MoM)". Meanwhile, insertion loss measurement is one of the critical measurements that have been used to analyze performance quality.

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ABSTRAK

Tesis ini memberi maklumat secara terperinci kepada pembaca mengenai teori, rekabentuk, proses fabrikasi, dan keputusan dalam proses merekabentuk penapis lulus jalur gelombang mikro. Pendekatan yang telah dilaksanakan untuk menjayakan projek ini ialah menggunakan kaedah kajian secara ilmiah, pengiraan dimensi, dan simulasi perisian komputer. Ketiga-tiga pendekatan ini adalah perlu untuk menganalisa sama ada ciri-ciri penapis lulus jalur memenuhi spesifikasi yang diperlukan sebelum proses fabrikasi dilakukan. Simulasi perisian komputer adalah cara penyelesaian yang terbaik kerana ianya cepat dan ekonomik. Rekabentuk penapis lulus jalur mempunyai pelbagai jenis dan bentuk. Antaranya penapis lulus jalur ganding selari, penapis lulus jalur sisi, dan penapis lulus jalur penyepit rambut atau "*hairpin*". Rekabentuk penapis ini ditumpukan kepada penapis jenis penapis lulus jalur gandingan selari yang beroperasi pada frekuensi tengah 1.575GHz dengan menggunakan bahan dielektrik FR4. Untuk tujuan ini, perisian komputer '*Microwave Office 2004*' telah digunakan untuk menganalisa ciri-ciri dan seterusnya menentukan jenis parameter-parameter penapis lulus jalur yang sesuai untuk proses rekabentuk. *Emsight Simulator* bagi perisian ini menggunakan teknik "*Method of Moment* (MoM)". Sementara itu, kaedah kehilangan penyisipan digunakan sebagai salah satu cara untuk menganalisa kualiti perlaksanaan.

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LIST OF TERM

A	-	Worsening
BW	-	Bandwidth
fo	-	Center Frequency
f_L	-	Lower Cut-off Frequency
f_H	-	Higher Cut-off Frequency
Z_{in}	-	Input Impedance
Z_o	-	Characteristics Impedance
R_{in}	-	Input Resistance
R_o	-	Characteristic Resistance
ε_r	-	Relative Dielectric Constants
ε_{eff}	-	Dielectric
ε_o	-	Wavelength
h	-	Substrate Height
t	-	Thickness
L	-	Length
w	-	Width
s	-	Space
Gaps	-	Internal Between
Lumped	-	Lumped of Earth
Stub	-	A Stump
PCB	-	Printer Board Circuit

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Chapter I

INTRODUCTION

1.1 Introduction

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. The approaches used to achieve this project are through literature survey, dimensional calculation and computer software simulation. It also approaches used to analyze the characteristic and the required specification before fabricating the microstrip bandpass filter.

This research is all about parallel-coupled microstrip bandpass filter that operates at 1.575GHz. Their parameters that have been used such as height, h are 1.6mm while their tan δ is 0.019. The best technique to get the better solution by is using computer simulation because it is fast and economical. According to the parameters, several equations is used to find the other parameter such as order of filter, value of elements, odd and even characteristic impedance and physical dimension of coupled line.

All the equation is convert into Matlab 6.5.1 command to make sure all the calculation is accurate. In this project, Microwave Office 2004 have been choose as

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the software that can be used to get the solution of the characteristics of the microstrip bandpass filter and to determine its suitable parameters.

This project will be fabricate after all the parameters and the simulation result shows that their return loss, S_{11} and insertion loss, S_{21} is reach at the target value. The return loss must reach at 0dB, while insertion loss at -10dB or below than that. Lastly, the parallel-coupled microstrip bandpass filter will be measure by using Network Analyzer to measure their return loss and their insertion loss. If the measured result shows the values that occur are equal to the simulation or greater than simulation, it shows this project is reaching their goal.

1.2 Problem Statement

Meanwhile, this research is made to avoid the problem about the GPS system before this. The problem is including:-

i. It is well known that like any other radio signal, GPS is most easily disrupted at the receiver RF front-end whereas the signal modulation itself may be resistant to any impact.
ii. Such sources can cause outages to GPS receivers due to poor filtering.

To avoid this problem, the microstrip of bandpass filters, when compared against the other available techniques offer a great deal of promise in mitigating these sources effects on GPS reception.

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1.3 Project Objective

The technology of filter in microwave is widely used and become one of the important technologies in the new era. The research of microstrip bandpass filter for GPS applications is one of the ways to upgrade the GPS system.

The objective for this research is:-

i. To design the microwave parallel-coupled bandpass filter by using microstrip transmission line.

ii. To optimize the bandpass filter response by changing important parameters such as length, space and width of each resonator.

1.4 Scope of Work

Investigation of Microstrip bandpass filter for GPS applications means that, this research is focus for GPS that operate at frequency 1.575GHz. There are six parts scope of work:-

i. Study about microstrip filter, microstrip transmission line and electromagnetic waveform. In this part, it need to calculate the dimensions value of filter, characteristic of dielectric, characteristic of impedance and frequency reception to make sure the filter design is perfect and success.

ii. Develop the equations that related with the research to calculate the dimensions of microstrip filter, characteristic of impedance, the relative permeability of dielectric material and one of the microstrip filter layout.

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iii. By using the software such as 'Microwave Office 2004' and MATLAB, the expected result for the filter can be earned. Simulation process is one of the engineering methods to get the expected result without using any material that costly.

iv. When obtain an applicable circuit from the simulation, fabricate can be started.

v. Test the fabricate filter circuit after the whole process is done.

vi. Compare the result with the expected result in simulation.

1.5 Project Methodology

At the first, start planning the project with the literature review for the related journal, books and all information from internet, magazine and each other. With the all information, develop an equation to get the expected result by simulation. Try to run the simulation to look their expected result before fabricate the filter circuit. If not, back to simulation once again.

If the expected result shows the accurate value that we want, fabricate the filter and then test it. Then measure and calculate the result to compare with the simulation result. If the fabricate result shows the perfect result it seem the project is successfully done. If not, back to fabricate and then test it again until we get the accurate result. Lastly, at the end of the research the whole process of the project will be written into thesis. Flow chart below is shown the overall process.

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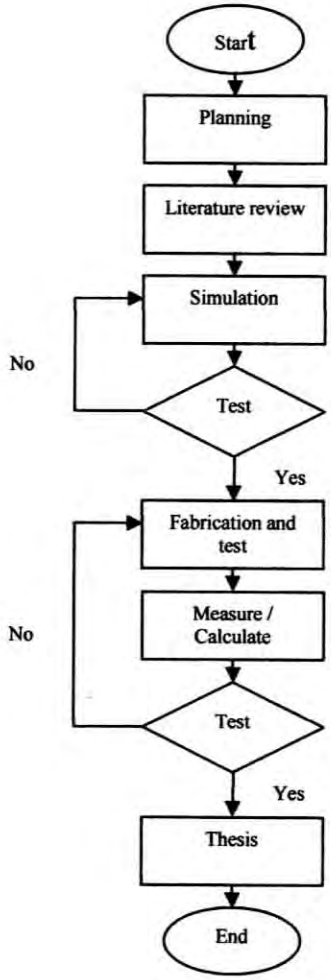

Fig. 1.1: Flow chart for overall process

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Chapter II

BACKGROUND STUDY

2.1 Global Positioning System (GPS)

The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations [5]. GPS uses these as reference points to calculate positions accurate to a matter of meters.

In fact, with advanced forms of GPS it can make measurements to better than a centimeter. In a sense it's like giving every square meter on the planet a unique address. GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. And that makes the technology accessible to virtually everyone.

These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, even laptop computers. Soon GPS will become almost as basic as the telephone.

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