THE MINIMIZATION OF 5.75 GHZ CHEBYSHEV BAND PASS FILTER

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This report is submitted in partial fulfillment of the requirement for the award of Bachelor of Electronic Engineering (Telecommunication Electronic) With Honours

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Tajuk Projek : The Minimization of 5.75 GHz Chebyshev Band Pass Filter

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Signature	**: …………………………….**
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Dedicated to my beloved family

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ABSTRACT

This project presents the minimization of Chebyshev 9th order band pass filter with a center frequency of 5.75GHz and a bandwidth of 100MHz. The minimization of the band pass filter has taken considerations on the same design specifications and performances. This thesis will compare the simulation results of two substrates, TLY-5A and FR4. The designed circuits were simulated using An-soft SV software. The fabrication of the miniaturized band pass filter was realized using the FR4 dielectric substance by using parallel coupled method. The minimized filters were named as Ω-Type and W-Type. The insertion loss of the Ω-Type filter was – 20.01 dB with a bandwidth of 460 MHz operating at 5.75 GHz. The W-Type had an insertion loss of -23.03 dB with a bandwidth of 260 MHz operating at 5.75 GHz. With this research, smaller band pass filter can be used in applications such as RF front end receiver and other communication systems in the future.

ABSTRAK

Projek ini membentangkan tentang pengecilan saiz penapis lulus jalur pertengahan jenis Chebyshev pada tahap 9 dengan frekuensi pertengahan pada 5.75GHz dan jalur lebar seluas 100 MHz. Pengecilan pada penapis lulus jalur pertengahan ini mengambil kira spesifikasi dan prestasi dari reka bentuk asal. Tesis ini membincangkan perbezaan dari segi keputusan simulasi dari dua jenis bahan yang berbeza iaitu TYL-5A dan FR-4. Perisian An-soft SV digunakan bagi ujian simulasi bagi reka bentuk ini. Kemudian, bahan FR-4 dengan teknik pasangan selari digunakan untuk memfabrikasi reka bentuk ini. Penapis ini dilabel sebagai Jenis-Ω dan Jenis-W. Nilai kehilangan sisipan bagi Jenis-Ω ialah -20.01 dB dengan nilai jalur lebar sebanyak 460 MHz beroperasi pada 5.75 GHz. Manakala, Jenis-W pula mempunyai nilai kehilangan sisipan sebanyak -23.03 dB dan nilai jalur lebar sebanyak 260 MHz beroperasi pada 5.75 GHz. Melalui kajian ini, penapis lulus jalur pertengahan yang telah mengalami proses pengecilan ini dapat digunakan untuk sesetengah aplikasi seperti penerima akhir frekuensi radio dan lain-lain sistem komunikasi di masa akan datang.

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LIST OF ABBREVIATIONS

RF	-	Radio Frequency
MIC	-	Microwave Integrated Circuit
LAN	-	Local Area Network
WLAN	-	Wireless Local Area Network
Op-amp	-	Operational Amplifier
FFT	-	Fast Fourier Transform
IIR	-	Infinite Impulse Transform
FIR	-	Finite Impulse Response
DC	-	Direct Current
BW	-	Bandwidth
P_{LR}	-	Power Loss Ratio
IL	-	Insertion Loss
L_A	-	Attenuation Characteristics
TEM	-	Transverse Electromagnetic Wave
FR4	-	Flame Retardant Type 4
TLY-5A	-	Taconic TLY model 5
PCB	-	Printed Circuit Board
UV	-	Ultra Violet
UWB	-	Ultra Wide Band
IEEE	-	Institution of Electrical and Electronic Engineer
MHz	-	Mega Hertz
GHz	-	Giga Hertz
FYP	-	Final Year Project

SYMBOLS

%	-	Percentage
ε_e	-	Effective Dielectric Constant
ε_r	-	Dielectric Constant
Δ	-	Fractional Bandwidth
C	-	Capacitence
dB	-	Decibel
g	-	Element Values
d	-	Substrate Thickness
E	-	Electrical Phase
J	-	Inverter Constant
K_0	-	Wave Number
M	-	M-Derived Constant
N	-	Number of order
n	-	Number of Order
L	-	Inductance
P	-	Physical Length
W	-	Width
S	-	Spacing
P_{inc}	-	Incident Power
P_{load}	-	Load Power
R	-	Input Termination Resistance
R_0	-	Source Impdance
S_{11}	-	Return Loss
S_{21}	-	Insertion Loss
Vp	-	Phase Velocity
Z0e	-	Even Impedance

Z0o	-	Odd Impdance
Zo	-	Characteristic Impedance
βl	-	Electrical Length
Ω	-	Ohm
β	-	Propagation Constant
λ	-	Wavelength
π	-	Pi

LIST OF APPENDIX

CHAPTER I

INTRODUCTION

1.1 Introduction:

Microwave filter is a two-port network used to control the frequency response at a certain point in a microwave system by offering transmission at frequency range for pass band of the filter and attenuation in the stop band of the filter. Normal frequency responses include low-pass, high-pass, band-pass, band reject characteristics and all pass characteristics [1].

Nowadays, filters play important roles in several RF and microwave communication systems. The present developments in RF and microwave filter are mainly based towards better performance, integration and smaller, lighter weight, and affordable cost. Unfortunately, smaller size can be crippling towards a microwave engineer, since it is often suitable to utilize the properties of structures which have dimensions comparable to the signal wavelength. When the design area becomes comparable to or smaller than the signal wavelength, such structures can be difficult or impossible to incorporate [2].

1.2 Project Objectives

The main objective of this project is to design a minimized size of the conventional Chebyshev band pass filter at 5.75 GHz while maintaining the specifications desired.

1.3 Project Background

Filter networks are vital building elements in many ranges of microwave engineering. Such systems are used to select, reject, separate or even combine signals at different frequencies in a number of microwave systems and equipment. Though the physical realization of filters at microwave frequencies may vary, the circuit network topology is mutual to all [3].

Filter is the most vital passive element used in microwave subsystem which is also the narrowest bandwidth components in the system. Filter limits such system parameters as gain and group delay flatness over frequency [4]. The development of microwave filter had begun since 1937, during the age of World War II, where the microwave filter had been extensively developed. A lot of researches demonstrated on variety of filter arrangements to realize both filter compactness and selectivity improvement. The most common band pass and band stop filter configurations are parallel coupled line, comb line, inter digital and hairpin line [5].

Andrew Elvis Simon and Lim Kuang Yaw specified that although traditional filter structures, like hair pin filters, inter digital filters and coupled lines do have good response over the microwave frequency range, however, a more robust and efficient filter structure search is still preferred [2]. This implies filter size reduction, selectivity improvement and spurious response control are the most innovative research purposes. Over the years, the rapid development of Microwave Integrated Circuit (MIC) in radar, satellite, and mobile communications tends to progress in terms of bandwidth, cost and size. Wideband applications requires coupled line microstrip and stripline filters because the demand on selectivity is not severe. On the other hand, wireless applications need miniature filters due to space and cost constraints [4].

According to Othman A. R., the advance and demand of WLAN technology have emphasized enhancement of low cost, less power and small size transceiver by using microstrip technology. A filter design of 5.75GHz 9th order Chebyshev band pass filter can be used for the purpose of WLAN application which is an alternate economical method for small distance voice and data communication. The design parameters are 100MHz bandwidth, insertion loss less than 10dB and equal ripple of 0.5dB [6]. Thus, the filter design of Dr.Abdul Rani is used as a reference for this research work.

1.4 Project Scope

The prime scope of the project is to decrease the size of the conventional Chebyshev 9th order band pass filter while retaining the specifications. The design specifications remained the same where the center frequency of filter is 5.75GHz. The bandwidth of the filter is 100MHz and the insertion loss, S_{21} is less than 10dB. The equal ripple of the filter is 0.5dB. This project is simulated using the An-soft Designer SV2 simulation tool. Simulation and analysis are done on the minimized filters based on the objective of the project. In additional, the prototype is fabricated and measured to obtain the frequency response of the band pass filter. Simulation and measurement results are compared in order to verify the objective in this research work.

1.5 Methodology

The designing process is divided into three stages:

In the first stage, a literature review will be done regarding the Chebyshev filter designing and the architecture of microstrip bandpass is selected. The dimensions, characteristic impedance and relative permeability of the material for bandpass filter will be calculated according to the design specifications.

In the second stage, the bandpass filter will be modeled by using Ansoft Designer according to the design specifications. The bandpass is then simulated for the system characteristic such as insertion loss, center frequency etc.

In the third stage, the fabrication of the simulated filter will commence. Tests will be done where by the individual parameters of band pass filter will be measured for verification with the parameter value that are specified in the filter.

Figure 1.1 below shows the flow of the designing process discussed above.

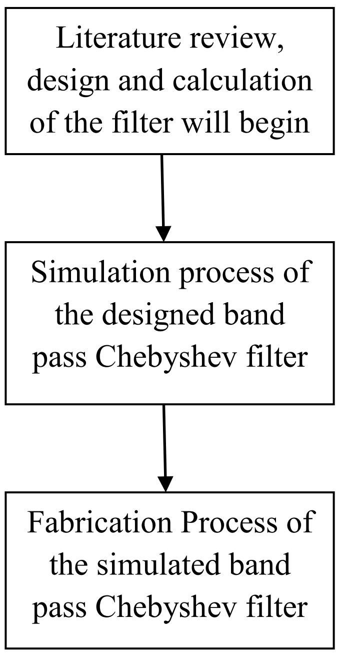

Figure 1.1: Designing Processes

1.6 Thesis Structure

This thesis consists of five chapters which are categorized as below to discuss on the project of Chebyshev band pass filter design. Chapter 2 is the literature survey of the RF filter designs, which covers the background study on the miniaturized band pass filter design and literature review on filter design theory. These will influence the selection of the filter design method and the techniques in the project. Chapter 3 discusses the methodology of the project. The methods and procedures to design and minimized the Chebyshev band pass filter are covered in this chapter. Chapter 4 illustrates the simulations and measurement results of the band pass filter. Result analysis will be covered in this chapter. Chapter 5 describes the conclusion of this thesis and it also includes the discussion and recommendations of this project.