TUNABLE BAND PASS FILTER DESIGN BY USING RF SWITCH

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To my beloved family and friends.

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ABSRTACT

A microwave filter is a two-port network used to control the frequency response at a certain point in microwave system by providing transmission at frequencies within the passband of the filter and attenuation at the stopband of the filter. In this project, a tunable microwave band pass filter circuit for the WLAN bandwidth of 2.4GHz (IEEE 802.11b) is designed, purposely to tune within the 14 channels of WLAN range. The tuning is done by selecting four main reference channels that is not overlapping each other which are channel 1,5 9 and 13. By using Butterworth Response, the value of lumped elements of the band pass filter circuit is calculated. Shunt stub method is used for filter realization, Kuroda's Identity and Richard's Transformation is used for calculation. All the circuits are simulated by using Microwave Office software (AWR). From the simulation, the circuit layout is obtained and fabricated on FR4 board. For the tuning circuit, RF switch using PIN diode is chose as it has a faster speed and stable repeatable. The fabricated circuit is then measured by using Network Analyzer. This project produced the filter response of lumped elements filter presents better response compared to filter realization circuit.

ABSTRAK

Penapis gelombang mikro digunakan untuk memperolehi transmisi pada frekuensi yang dikehendaki. Dalam prokjek ini, sebuah *tunable band pass filter* dihasilkan untuk jalur lebar dari 2.4GHz WLAN (IEEE 802.11b) bagi 14 salurannya melalui saluran 1, 5, 9 dan 13. Dengan menggunakan *Butterworth Response*, nilai elemen induktor dan kapasitor pada rangkaian *band pass filter* dikira. Untuk *realization*, kaedah *stub shunt* digunakan dengan mengaplikasi Identiti Kuroda sebelum *Richard's Transformation* digunakan untuk menukar *lumped-element* kepada litar yang mempunyai *transmission line*. Simulasi dilakukan dengan menggunakan perisian Microwave Office (AWR). Dari hasil simulasi, susun atur litar dapat dipastikan dan difabrikasi pada papan mikrostrip FR4. Untuk pensuisan, suis RF menggunakan PIN diod telah dipilih kerana memiliki kelajuan lebih cepat dan lebih stabil. Pengukuran litar yang telah difabrikasi dilakukan dengan menggunakan *Network Analyzer*. Akhirnya, projek iini menghasilkan respon penapisan yang baik oleh litar dengan *lumped-element* berbanding litar penapis yang telah direalisasi.

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LIST OF ABBREVIATIONS/ SYMBOLS

GPS	Global Positioning System
MHz	Mega Hertz
GHz	Giga Hertz
TV	Television
WLAN	Wireless Local Area Network
MMIC	Monolithic Microwave Integrated Circuits
RF	Radio Frequency
dB	Decibel
RC	Resistor-capacitor
RIAA	Recording Industry Association of America
AC	Alternate Current
PA	Public Address
DUT	Device Under Test
PIN	Positive-Intrinsic-Negative
FET	Filed Effect Transistor
EM	Electromagnetic

PN	Positive-Negative
DC	Direct Current
Ω	Ohm
IL	Insertion Loss
RL	Return Loss
Γ	Reflection Coefficient
a	Incident Wave
b	Reflected Wave
VSWR	Voltage Standing Wave Ratio
S-Parameters	Scattering Parameters
MIC	Microwave Integrated Circuit
W	Width
t	Thickness
ε_r	Dielectric Constant
TEM	Transverse Electro Magnetic
ε	Permittivity
μ	Permeability
ε_e	Effective Dielectric Constant

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Nowadays, wireless communication is a technology that has been widely used anywhere and everywhere. Wireless gadget such as mobile phone, internet broadband, notebook, mobile radio, GPS, mobileTV and many more is not a new thing in electronic engineering fields. Such application helps human to have a pleasant life and improve the quality of technology gadgets.

However, the usage of wireless technology will also have the negative outcomes. Sometimes, the wireless signal might be interrupted for RF wireless communication system operating in the presence of a periodic noise environment and filter is used to overcome this problem in order to reject unwanted signal while permitting good transmission of wanted frequencies. Modern microwave technology is an exciting and dynamic field, due in large part to the advances in modern electronic device technology and the explosion in demand or voice, data and video communication capacity. Prior to this, microwave technique was the nearly exclusive domain of the defense industry. The recent and dramatic increase in demand for communication systems such as mobile phone, satellite communications and broadcast video has transformed this field to the commercial and consumer market. As a result, the diversity of applications and operational environments has led, through the accompanying high production volumes, to tremendous advances in cost-efficient manufacturing capabilities of microwave products. This, in turn, has lowered the implementation cost of a new wireless microwave service. Inexpensive handheld GPS navigational aids, automotive collision avoidance radar and widely available broadband digital service access are among these. Microwave technology is naturally suited for these emerging applications in communications and sensing, since the high operational frequencies permit both large numbers of independent channels for uses as well as significant available bandwidth per channel for high speed communication [1].

1.2 OBJECTIVE

The main objective of this project is to design a tunable band pass filter for WLAN. This filter can be tuned to the desired frequencies of 14 channels of WLAN by using RF switch.

1.3 PROBLEM STATEMENTS

A lot of filters produced and designed at a limited frequency[2]. Some of them are designed at a fix frequency [3] [4]. Related to this situation, this tunable band pass filter is designed in order to give choice and options for users and customers to attach themselves into a tuning technology.

1.4 SCOPE OF THE PROJECT

The scopes of this project is for designing tunable band pass filterby the insertion loss method on WLAN bandwidth of 2.4GHz (IEEE 802.11b) within its 14 channels and simulate using Microwave Office (AWR). Calculation on the elements of the circuit is done based on Butterworth response. Fabrication of the circuit is done on microstrip FR4 board according to shunt stub method andthe calculation of the element is referred to Kuroda's Identity.

1.5 METHODOLOGY

This project needs to be prepared from the basic information of filter theoretically and further on until the production of the band pass filter. All the related information via internet, web journal, books, articles and many more is used aguidance and possible references. All of the sources are then pointed out to supervisor and after a brief discussion; only the best materials will be selected for main references.

By referring to the related information, the tunable band pass filter willbe designed considering all the calculation and simulation. Several parameters such as S parameter, center frequency, return loss, insertion loss, upper cutoff frequency and lower cut-off frequency and bandwidth are determined by using manual calculationand also simulation using suitable mathematical software such as MATLAB or Microsoft Excel and the schematic circuit can be simulated using Microwave Office software (AWR).

After all simulation can be run and debug properly without any errors using the AWR, the project can be preceded to the next part which is fabrication. Fabrication of the tunable band pass filter circuit will be done on printed circuit board using microstrip parallel-coupled method. The tunable band pass filter is then used to measure and test the functionality. The methodology of the project is summarized in following Figure 1.1.

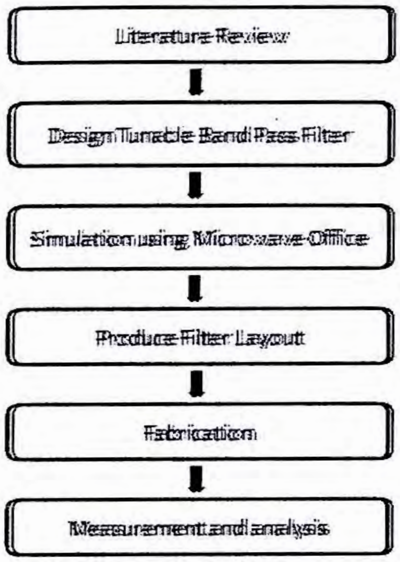

Figure 1.1: Methodology of Project

1.6 REPORT STRUCTURE

This report contains five chapters that explain detail of the project. The first chapter is the introduction of the project that included the objectives, scope, problem statement and the report structure.

The second chapter is the literature review contains the history of microwaves, microwave filter, types of microwave and types of filter response.For tuning circuit, PIN diode is reviewed and will be use, how it works through RF switch is also described in this chapter.

The third chapter is about project methodology. The working flow of this project is defined each terms of methodology from the review until the measurements process. All designs that have been analyzed throughout this project to produce a tunable band pass filter also includes in this chapter