DEVELOPMENT OF A 3G BANDPASS FILTER USING MICROSTRIP TECHNOLOGIES

AIZILIA BINTI MAT AFFIM

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DEDICATION

To my parents, family members and friends;
My all times beloved.

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Alhamdulillah, I finally able to complete the final year project and the thesis as well within the allocated time. First of all, I would like to take this opportunity to express my appreciation to some organizations and individuals who have kindly contributed to the successfully completion of my final year project in UTeM. With the cooperations and contributions from all parties, the objectives of the project; soft-skills, knowledge and experiences were gained accordingly. To begin with, I would like to convey my acknowledgement to UTeM PSM organization members especially my project supervisor, En. Chairulsyah Wasli for her cooperation and involvement from the begining untill the end of my project development. Her effort to ensure the successfull and comfortability of students under her responsibility was simply undoubtful. Thanks for the invaluable advices given before, while and after completion of the project. Furthermore, I would like to extend my sincere acknowledgement to my parents and family members who have been very supportive throughout the project. Their understanding and support in term of moral and financial were entirely significance towards the project completion. Last but not list, my appreciation goes to my fellow colleagues in UTeM, especially for those who came from FKEKK. Their willingness to help, opinions and suggetions on some matters, advices and technical knowledge are simply precious while doing upon completion of my final year project.

ABSTRACT

This thesis provides the reader with a detailed and comprehensive study of theory, design, fabrication, result and problem encountered in the designing band pass 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 band pass filter computer simulation is the best technique to get the solution because it is fast and economical. To achieve this purpose, computer software, microwave office 2004 is used to analyze the characteristics of the microstrip band pass filter and to determine its suitable parameters. The Insight Simulator is developed by using a technique called "Method of Moment (MoM)". This research generally is divided into three stages which includes literature review and dimensional calculation followed by software simulation and lastly fabrication, testing and analysis of the results. The filter design is concentrated on the parallel-coupled band pass microstrip filter operating at 2.4GHz by using NWFR4 and FR4 (epoxy glass) as a substrate.

ABSTRAK

Tesis ini memberi maklumat secara terperinci kepada pembaca mengenai teori, rekabentuk, proses fabrikasi, keputusan dan permasalahan yang mungkin wujud 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 cirri-ciri penapis lulus jalur bagi memenuhi spesifikasi yang diperlukan sebelum proses fabrikasi dilakukan. Simulasi perisian computer adalah cara penyelesaian yang terbaik kerana ianya cepat dan ekonomik. 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. Simulator Emsight bagi perisian ini menggunakan teknik *'Method of Moment (MoM)'*. Kajian ini secara amnya terbahagi kepada tiga peringkat iaitu kajian ilmiah dan pengiraan dimensi, membuat simulasi litar, fabrikasi litar penapis yang direkabentuk dan selanjutnya mengukur serta menganalisa keputusan ujikaji. Rekabentuk penapis ini ditumpukan kepada jenis penapis lulus jalur gandingan selari yang beroperasi pada frekuensi tengah 2.4GHz dengan menggunakan bahan dielektrik NWFR4 dan FR4 (kaca epoksi).

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LIST OF ABBREVIATIONS

A	-	Decay
BW	-	Bandwidth
F_0	-	Center Frequency
h	-	Thickness (‘height’) of substrate
t	-	Thickness of strip metallization.
εr	-	Dielectric constant of substrate
w	-	Width of strip
l	-	Length
λ	-	Length wave
ε_{eff}	-	effective dielectric constant
w_{eff}	-	effective width
Z_0	-	impedance of free space

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION FILTER

A filter is a device that passes electric signals at certain frequencies or frequency ranges while preventing the passage of others. Filter circuits are used in a wide variety of applications. In the field of telecommunication, band-pass filters are used in the audio frequency range (0 kHz to 20 kHz) for modems and speech processing. High-frequency band-pass filters (several hundred MHz) are used for channel selection in telephone central offices. Data acquisition systems usually require anti-aliasing low-pass filters as well as low-pass noise filters in their preceding signal conditioning stages. System power supplies often use band-rejection filters to suppress the 60-Hz line frequency and high frequency transients. In addition, there are filters that do not filter any frequencies of a complex input signal, but just add a linear phase shift to each frequency component, thus contributing to a constant time delay. These are called all-pass filters.

This section of the report describes about the design of the microwave Band pass filter by using micro strip technology. There are many possible techniques used to create micro strip filters, some of them are listed below;

- Comb line Filters

- Parallel Coupled and edge coupled Filters: small sized, light weight and low cost filters for narrow bandwidth applications.

Since this report is a project report, so it tends to be limited to the project. In this project design we used Parallel Coupled Filters, due to their easy and cheaper design (Like they does not require any via, as in the case of Comb line) and greater immunity to errors. It's a Band Pass Filter works at 2.4GHz; its response is quite good. The design was implemented on a FR4 substrate.

The extraction of a lower frequency signal, such as a 70MHz intermediate frequency signal from a microwave mixer circuit, requires a low-pass filter that needs to be more carefully designed than a bias network. Low-pass filters can be designed from the classical lumped-element low-pass prototype circuits and may either be fabricated in lumped element form or transformed into equivalent transmission line networks.

Band-pass filters require precise transmission characteristics that allow a desired band of signals to pass through the two-port network. Thus, between a transmitter and the transmitting antenna, a band-pass filter may be used to attenuate unwanted signals and harmonic components that may cause interference to other users of the electromagnetic spectrum. Conversely, between an antenna and a receiver, a band- pass filter will reject out-of-band signals that may cause interference within the receiver, especially if they are at a high signal level in comparison with the desired signals.

Band-stop filters reflect signals over a limited range of frequencies while allowing all others to pass through the network. They are used to minimize the transmission of possible high-level signals, e.g. the local oscillator of an up converter where only the upper-sideband is desired, and as tuned reflective elements in oscillator circuits.

It will be assumed here that the reader has a basic knowledge of classical lumped filter designs. Common filters include maximally-flat (Butterworth), equiripple (Chebyshev), Bessel and elliptic filters, where each name is descriptive of the filter characteristics. It will be assumed that the reader is able to use published filter tables intelligently for the design of filters.

There are two basic mechanisms for achieving filters action, that is, for obtaining variation of signal transmission through a circuit. If the filter is lossless, the only way in which a transmission of less than unity may be achieved is by reflection at the input. Most filters are of this type and, in their case; attenuation must imply a high reflection coefficient at the input. Thus it is impossible to maintain a good match across the attenuation band for lossless filters.

Reduction in transmission can also be achieved if lossy absorbing elements are inserted inside the filter. In this case, at least in principle, a good match across the attenuation band could be maintained, as the reduction in transmission is no longer predicated on the presence of reflections at the input. An example of a filter depending on a lossy element is the wave meter, where a resonator, coupled to a waveguide or a transmission line, couples energy into itself at resonance and dissipates it within the resonator losses. This is really a form of band-stop filter. Another example occurs when a diplexer is formed by connecting a low-pass filter in parallel with its complementary high-pass network. If the outputs of the two parallel networks are combined, say with a hybrid, an all-pass network is obtained. However, with completely separate loads a diplexer is obtained, with low frequencies going to one load and high frequencies to the other, while maintaining a matched input at all limes for the combined network. If, say, only the low-pass function is of interest then the low-pass filter section that is matched in both the pass and attenuation bands may be used, with the matched load terminating the high-pass network simply being an internal lossy element as far as the low-pass network is concerned.

The short length line approximations then may no longer hold and a correction to the classical filter design process may be required. Also, corrections due to losses in resonator elements may be needed, especially in very narrowband designs. However, this is not a problem unique to microstrip filters, as it is similar to that found in classical lumped filters.

Microstrip equivalents exist for both series-resonant and parallel-resonant circuits. However, it is often desirable to use resonators of one type only in which case immittance inverters may be employed to convert between the two types of resonant circuit. Immittance inversion in lumped circuit filters is achieved with active circuits to produce filters with only one type of reactive element, as in active filter arrangements with only capacitors. In microstrip circuits, immittance inversion is often conveniently achieved with quarter-wave directional coupler arrangements.

1.2 OBJECTIVES

This project will develop 2.4GHz Butterworth Band pass Filter by using Micro strip Technologies. This filter will be design and analyze by using microwave office software. Otherwise, the filter will be fabricate and tested using substrate FR4 and build a Butterworth Band pass filter using microstrip technologies.

1.3 SCOPE OF WORKS

- To study the theory of filter especially Band pass filter which going to develop using micro strip technologies and study how to operate microwave office software that will use for simulating the Band pass filter.
- Calculation result will be use in simulating in PSM II, the band pass filter will be fabricate using etching technologies and after that test those Band pass filter.
- To produce the band pass filter with frequency 2.4GHz. It is because frequency 2.4GHz – 2.45GHz make unlicensed frequency band and it is suitable for technology '*Bluetooth'*, '*WIF'I*, '*3rd Generation'* and so on.

- Make a simulating circuit using software 'M*icrowave Office 2004'*.
- Testing the result for filter design when all the process design is complete.
- Make a comparison result between band pass filter will be fabricate and with simulation result.

1.4 PROBLEM STATEMENT

Problem of the Bandpass Filter it self:-

- The price of 3G Bandpass Filter is expensive.
- For the fabrication Bandpass Filter, many processes are used like etching, soldering and testing and it is difficult to build the circuit.
- The circuit very small and need concentrate to build it.

1.5 BRIEF OF METHODOLOGY INFORMATION

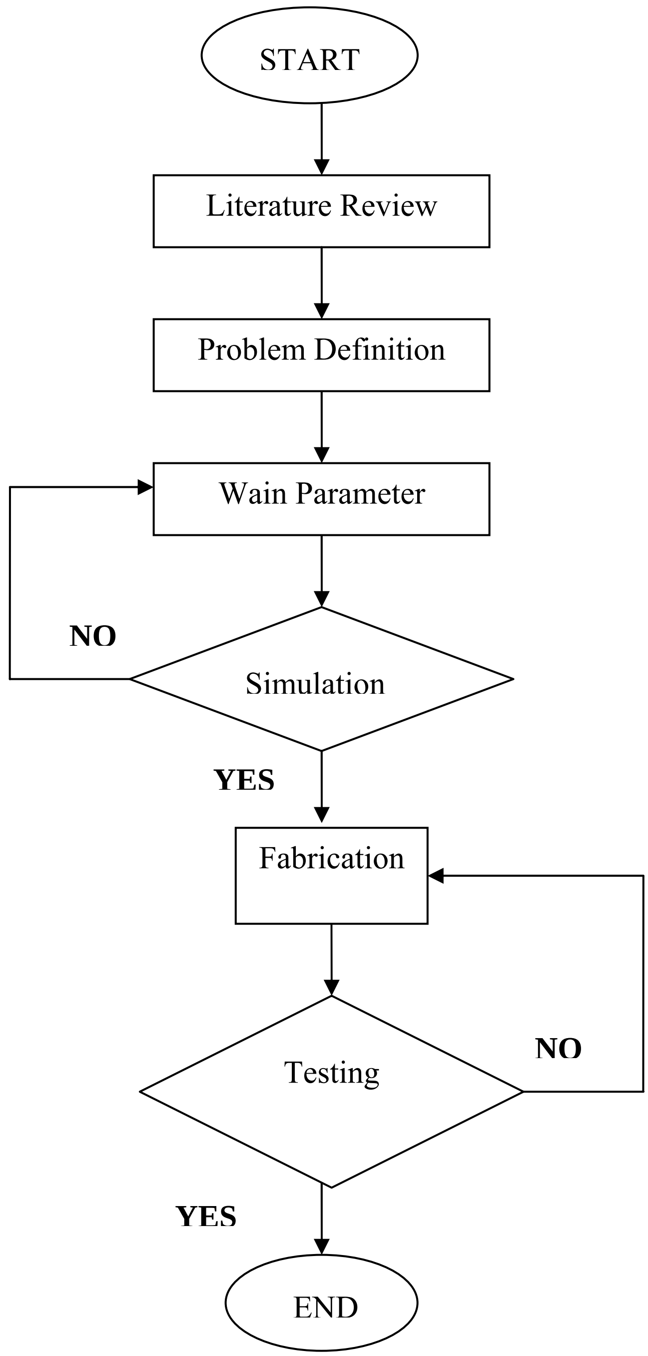

Figure 1.1: Flow chart for methodology

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION BANDPASS FILTER

There are two methods of design a band pass filter, image parameter method and insertion loss method. Image parameter method uses several two-port filter sections to provide the desired cutoff frequencies and attenuation characteristics, but do not allow the specification of a frequency response over the complete operating range. The insertion loss method uses a network synthesis technique to design filters with completely specified frequency response. The insertion loss method allows filter performance to be improved in a straightforward manner, at the expense of higher order filter.

2.2 THEORY OF BANDPASS FILTER

A resonating structure that forms the basis of many microstrip filters is a half-wavelength section of line that ideally is terminated at each end by an open circuit. The physical lines will he reduced in length from a half wavelength when allowances are made for the open-circuit fringing capacitances. There are two basic forms of coupled-resonator band-pass filters in microstrip line, named by the method for coupling energy into the resonators. The first form, an end-coupled filter, has capacitive coupling from each end of the resonator into the end of the adjacent line. On the other hand, edge- or parallel-coupled filters have resonators that are coupled through the even- and odd-mode fields along the edges of the lines. Parallel-coupled filters are generally preferred, because they lead to as much as a 50% reduction in length. Furthermore, larger gaps between lines are permitted for parallel-coupled filters, easing the tolerances and permitting a broader bandwidth for a given dimensional tolerance. However, perhaps of greatest significance is the fact that the first spurious response for a parallel-coupled filter occurs at three times the center frequency of the filter, whereas for the end-coupled filter it occurs at only twice the center frequency.

The task was to design band pass filters, a 2.4GHz band pass filter. The 2.4GHz band pass filter was to be designed at a center frequency of 2.4GHz with a bandwidth of 10MHz and 22dB attenuation. The bandpass filters the insertion loss method was used. A Chebyshev response was used to satisfy the requirement for the sharpest cutoff.

At first, a low pass filter prototype beginning with a series element having a 0.5 dB ripple response was designed. The elements values were determined by using the attenuation versus normalized frequency for an equal ripple filter at 0.5dB ripple. Then using the element values for the low pass prototype, L1, C2, and L3 were obtained. To make the prototype a band pass filter equations were used to get the value for L1, L2, L3, C1, C2, and C3.