# DEVELOP A 5.8GHz CHEBYSHEV BANDPASS FILTER USING MICROSTRIP TECHNOLOGIES

**CHE KAMARIAH BINTI BABJAN**

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

**Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer**
**Universiti Teknikal Malaysia Melaka**

**MEI 2007**

# MEMBANGUNKAN PENAPIS LULUS JALUR JENIS CHEBYSHEV PADA 5.8 GHz MENGGUNAKAN TEKNOLOGI JALUR MIKRO

**CHE KAMARIAH BINTI BABJAN**

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

**Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer**

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**UNIVERSTI TEKNIKAL MALAYSIA MELAKA**
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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| **Sesi Pengajian** | : | 2006/2007 |

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

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## ABSTRACT

This thesis provides the reader with a detailed 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. 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 5.8GHz 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. With this method, it can find out whether the parallel-coupled microstrip bandpass filter can be design in good condition or not.

## 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 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 5.8GHz 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. Dengan cara ini dapat menetukan sama ada penapis lulus jalur gandingan dapat direkabentuk dengan baik atau sebaliknya.

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| | | |
|---|---|---|
| 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 |
| $\varepsilon_r$ | - | Relative Dielectric Constants |
| $\varepsilon_{eff}$ | - | Dielectric |
| $\varepsilon_o$ | - | 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 |

# 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.

Computer simulation is the best technique to get the solution because it is fast and economical. Microwave Office 2004 is the software that used to get the solution of 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)".

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 bandpass microstrip filter operating at 5.8GHz by using FR4 as a substrate.

## 1.2 PROJECT OBJECTIVE

The technology of filter in microwave is widely used and become one of the important technologies in the new era. To develop a 5.8GHz Chebyshev Bandpass Filter by using microstrip technologies applications is one of the ways to upgrade the communications system.

The objective for the research is:-

1. To conduct research and understand the existing literature on microstrip analysis and synthesis equations.

2. To conduct research and understand the existing literature on microstrip low pass and high pass filter design.

3. To develop a 5.8GHz Chebyshev bandpass filter by using microstrip technologies by using 'Microwave Office 2004' to simulate the microwave circuit.

4. To research how to design the microwave filter by using microstrip transmission line.

5. How to test the fabrication circuit of microstrip filter.

## 1.3 PROBLEM STATEMENT

The cost for a bandpass filter is very expensive. These projects try to make how cost for bandpass filter. The accurate high quality, bandpass filter is to take long time to build. This project try to make faster and simple way to build bandpass filter.

## 1.4 SCOPE OF WORK

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

This project to develop a 5.8GHz chebyshev bandpass filter by using microstrip technologies means that, this research is focus in super high frequency (SHF) and the specification frequency for bandpass filter at frequency 5.8GHz.

There are six parts scope of work:-

1. 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.
2. 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.
3. By using the software such as 'Microwave Office 2004' 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.
4. When obtain an applicable circuit from the simulation, fabricate can be started.
5. Test the fabricate filter circuit after the whole process is done.
6. 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. Refer Gantt chart in Appendix A.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 BEYOND 3G: FORTH GENERATION WIRELESS NETWORK

At the end of the 1940's, the first radio telephone service was introduced, and was designed to users in cars to the public land-line based telephone network. Then, in the sixties, a system launched by Bell Systems, called IMTS, or, "Improved Mobile Telephone Service", brought quite a few improvements such as direct dialing and more bandwidth. The very first analog systems were based upon IMTS and were created in the late 60s and early 70s. The systems were called "cellular" because large coverage areas were split into smaller areas or "cells", each cell is served by a low power transmitter and receiver.

For 1G and 2G standards, bandwidth maximum is 9.6 kbit/sec, This is approximately 6 times slower than an ISDN (Integrated services digital network). Rates did increase by a factor of 3 with newer handsets to 28.8kbps. This is rarely the speed though, as in crowded areas, when the network is busy, rates do drop dramatically. Third generation mobile, data rates are 384 kbps (download) maximum, typically around 200kbps, and 64kbps upload. These are comparable to home broadband connections.

Fourth generation mobile communications will have higher data transmission rates than 3G. 4G mobile data transmission rates are planned to be up to 100