DEVELOPMENT OF SATELLITE COMMUNICATION FILTER USING MICROSTRIP TECHNOLOGIES.

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DEDICATION

"He who doesn't trust himself, will never prevails himself in the future"

By Harnani Binti Hanapi

For my mum Puan Siti Zainab Bt. Lin, my brother Mohd Hardi B. Hanapi and all my family, my friends, my classmates, my housemates

&

Mr. Chairulsyah Bin Wasli and others members.

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ABSTRACT

The 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. 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)".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 4,0GHz by using 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 dimension, dan simulcast Parisian computer. Ketiga-tiga pendekatan ini adalah perlu untuk menganalisa sama ada ciri-ciri penapis lulus jalur bagi memenuhi specifikasi yang diperlukan sebelum proses fabrikasi dilakukan. Simulasi perisian komputer 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 menetukan jenis parameter-parameter panapis lulus jalur yang sesuai untuk proses rekabentuk. Simulator Emsight bagi Parisian ini menggunakan teknik "Method of Moment (MoM)".Kajian ini secara amnya terbahagi kepada tiga peringkat iaitu kajan ilmiah dan pengiraan dimension, membuat simulcast litar, fabrikasi litar penapis yang direkabentuk dan selanjutnya megukur serta menganalisa keputusan ujikaji. Rekabentuk penapis ini ditumpukan kepada penapis jenis penapis lulus jalur gandingan selari yang beroperasi pada frekuensi 4.0GHz dengan menggunakan bahan dielektrik FR4 (kaca epoksi).

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A	-	Worsening
BW	-	Band width
f_0	-	Center Frequency
f_L	-	lower cut-off frequency
f_h	-	Higher cut-off frequency
Z_{in}	-	Input Impedance
Z_0	-	Characteristics Impedance
R_{in}	-	Input Resistance
R_o	-	Characteristic Resistance
ε_r	-	Relative Dielectric Constants
ε_{eff}	-	Dielectric
h	-	Substrate Height
t	-	Thickness
w	-	Width
L	-	Length
λ	-	Wavelength
Lumped	-	Lumped of Earth
Stub	-	a stump
Gaps	-	Interval Between
PCB	-	Printed Circuit Board

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CHAPTER I

INTRODUCTION

1. INTRODUCTION

This project will develop a 4.0GHz of a Satellite communication Bandpass filter by using Microstrip Technologies. This filter will be design, simulate, fabricate and tested. Several sets will be fabricate using substrate available in the market then choose the best one that meet specifications. Microstrip is normally used for the convenience and economy of printed construction. The electrical process is used for designing filter for any process for which the user has model knowledge. The Butterworth response has flat in the passband and stopband. The stopband attenuation rises sharply just beyond the cut of frequency.

In the operation of electronic systems and circuits, the basic function of a filter is to selectively pass, by frequency, desired signals and to suppress undesired signals. The amount of insertion loss and phase shift encountered by a signal passing through the filter is a function of the filter design. Similarly, the amount of rejection of an undesired signal is a function of the filter design. Filters play an important role in many Microwave systems, where they serve to suppress unwanted signals. As the characteristics of a single filter can have a significant impact on the overall system performance, it is desirable to achieve the most ideal response possible. One of the major performance limitations is the unload quality factor (Q) of the resonators. High performance filters generally require high-Q resonators, which are often physically large and may necessitate the use of an expensive technology such as dielectric resonators.

As you all probably know the function of a filter is to allow a certain range of frequencies to pass while to attenuate the others. Thus clearly there is a passband and a stopband. Ideally in the passband there should be no attenuation while in the stopband there should be maximum attenuation. However, with real components, such as inductors, capacitor, transmission lines and waveguides that is not the case. Contrary to the ideal case in the passband there are some attenuation, which can be controlled by improving the design and by proper choice of components. Similarly in the stopband the attenuation can be controlled. Filters can be low-pass, high-pass and band reject type.

Almost all Microwave receivers, transmitters, and test setups require filter action. The main filter functions are to reject undesirable signal frequencies outside the filter passband and to channelize or combine different frequency signals. Specifics applications include ESM receivers, satellite communication, mobile communications, direct broadcast satellite system PCM communications and Microwave FM multiplexers.

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 achieve these aims, the objectives of the project are formulated as follows:

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 analysis and bandpass filter design.

3. To develop a 4.0 GHz of a satellite communication bandpass filter by using Microstrip Technologies.

4. To research and study about bandpass filter using in a satellite communication by using Microwave Office to simulate the Microwave circuit.

5. To research how to design the Microwave filter by using Microstrip Transmission Line.

6. To fabricate the filter layout on to FR4 board and conduct analysis of the filter response

1.3 SCOPE OF WORK

In this new era of technology, all the application of telecommunication 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 4.0Ghz Bandpass Filter of a Satellite Communication by using Microstrip Technologies".

There are six parts scope of works:

1. Study about Microstrip filter, Microstrip transmission line and electromagnetic waveform. In this part, it need to calculate the dimensions values of filter, characteristics of dielectric, characteristics 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, characteristics of impedance, the relative permeability of dielectric material and one of the Microstrip filter layout.

3. By using the software such as Microwave Office, the expected result for the filter can be earned. Simulations process is one of the engineering methods to get the expected result without using any material that costly.

4. After that, when obtain an applicable circuit from simulation, fabricate can be started.

5. Test the fabricated filter circuit after the whole process is done.

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

1.4 PROBLEM STATEMENTS

The technology of filter in Microwave is widely used and become one of the important technologies in the new area. The bandpass filter of a Satellite Communication by using Microstrip Technologies for Microwave communication system. Communication satellite is a microwave repeater in the sky that consists of a diverse combination of one or more of the following; receiver, transmitter, amplifier, regenerator, filter on-board computer, multiplexer, demultiplexer, antenna, waveguide and about any other electronic communications circuit ever develop. A satellite system consists of one of or more satellite space vehicles, a ground-based station to control the operation of the system, and a user network of earth stations that provides the interface facilities for the transmission and reception of terrestrial communications traffic through the satellite system. The cost for a bandpass filter is very expensive, these projects try to make low cost bandpass filter. The accurate a high quality bandpass filter is take long time to build, this project try to make faster and simple way to build bandpass filter.

In the operation of electronic systems and circuits, the basic function of a filter is to selectively pass by frequency, desired signals and to suppress undesired signals. The amount of insertion loss and phase shift encountered by a signal passing through the filter is a function of the filter design. Similarly, the amount of rejection of an undesired signal is a function of the filter design. Constant impedance band-pass filters have been designed to allow signals to pass within the passband and to be rejected outside of this band. However, these filters provide matched 50-ohm impedance both within and outside the passband.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

The most common filter responses are the Butterworth, Chebyshev, and Bessel types. Many other types are available, but 90% of all applications can be solved with one of these three. Butterworth ensures a flat response in the passband and an adequate rate of rolloff. A good "all rounder," the Butterworth filter is simple to understand and suitable for applications such as audio processing. The Chebyshev gives a much steeper rolloff, but passband ripple makes it unsuitable for audio systems. It is superior for applications in which the passband includes only one frequency of interest (e.g., the derivation of a sine wave from a square wave, by filtering out the harmonics). There are many types of filter. The more popular ones are:

a) Butterworth or maximally flat filter.
b) Tchebyshev (also known as Chebyshev) filter.
c) Cauer (for elliptical) filter for steeper attenuation slopes.
d) Bessel or maximally flat group delay filter.

All of these filters have advantages and disadvantages and the usually chosen is the filter type that suits the designers needs best. From the frequency range, the types of filter are: low pass, high pass, bandpass and stopband configurations.
The filter design process is a two part effort. First, the response of the filter is determined. By this it is meant that the attenuation and/or phase response of the filter is defined. In step two the topology of the filter, how it is built, is defined. This application note is intended to help in step one. Several different standard responses are discussed, and the attenuation, group delay, step response and impulse response are presented.

The filter tool is then employed to design the filter. There are many transfer functions that may satisfy and attenuation and/or phase requirements of a particular system. The importance of the frequency domain response must be determined. Also, both of these might be traded off against filter complexity, and thereby cost.

2.2 BUTTERWORTH FILTER

The Butterworth filter is the best compromise between attenuation and phase response. It has no ripple in the passband or the stopband and because of this is sometimes called a maximally flat filter. The Butterworth filter achieves its flatness at the expense of a relatively wide transition region from passband to stopband, with average transient characteristics. The values of the elements of the Butterworth filter are more practical and less critical than many other filter types. The response of the maximally flat, power law or Butterworth type which is used when a fairly flat attenuation in the passband required. The Butterworth filter achieves the ideal situation only at the ends of the frequencies the attenuation increases very gradually, the curve being virtually flat. With increasing frequency the attenuation rises until it reaches the prescribed limit. At the 3dB frequency there is a point of inflexion, and thereafter the cut-off rate increases to an asymptotic value of 6n dB/octave, where n is the number of arms. As the number of arms is increased the approximation to the ideal improves.