DESIGN OF MULTIBAND MATCHED BAND-STOP FILTER USING T-SHAPE RESONATOR

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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Signature	:	
Supervisor Name	:	Prof. Dr. Badrul Hisham Bin Ahmad
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DEDICATION

First of all, I would like to express my gratitude to Allah S.W.T for His blessing and guidance. I would like to dedicate this thesis to my family especially my father and mother for their endless love, encouragement and supplication. In addition, I would like to dedicate this work to my beloved project supervisor, Prof. Dr. Badrul Hisham Bin Ahmad. He had given a lot of guidance and assistance to me in completing this project. Finally, I would like to dedicate this thesis to all lecturers and friends that help and give support to me in any situation.

ABSTRACT

Wireless communication system is a system that transfer information between two different places that are not connected by an electrical conductor while microwave filter is the basic component in every radio frequency (RF) front-end communication system. In designing a complicated wireless communication system or any other system that are working at microwave frequencies, noise is one of the big challenge. One of the techniques that can be used to avoid noise is by applying filtering techniques. Multiband matched band-stop filter using T-shape resonator were design at center frequencies of 1GHz and 1.5GHz. When designing multiband matched band-stop filter, the lossy nature of microstrip makes it difficult to achieve high Q factor. The objectives for this project is to design, simulate, fabricate and validate the design of multiband matched band-stop filter. The simulation process for this design is using Advanced Design System (ADS) software and fabricated using FR4 board. In real situation, this project will be able to isolate the signal of interest from interference signals. The result of the design can provide a better wireless communication system (noise free) and can reduce or eliminate noise/harmonics/spurious signal in wireless system.

ABSTRAK

Sistem komunikasi tanpa wayar adalah sistem yang memindahkan maklumat antara dua tempat yang berbeza yang tidak dihubungkan oleh konduktor elektrik manakala penapis gelombang mikro adalah komponen asas dalam setiap sistem komunikasi hadapan belakang frekuensi radio (RF). Dalam merancang sistem komunikasi tanpa wayar yang rumit atau sistem lain yang bekerja pada frekuensi gelombang mikro, bunyi bising adalah salah satu cabaran besar. Salah satu teknik yang boleh digunakan untuk mengelakkan bunyi bising adalah dengan menggunakan teknik penapisan. Penapis jalur berbilang pelbagai jalur yang sesuai dengan menggunakan resonator bentuk T telah direka pada frekuensi pusat 1GHz dan 1.5GHz. Apabila mereka bentuk jalur pelbagai yang sesuai dengan penala hentanan jalur, sifat kehilangan microstrip menjadikannya sukar untuk mencapai faktor Q yang tinggi. Objektif projek ini adalah untuk merekabentuk, mensimulasikan, mengarang dan mengesahkan reka bentuk penapis jalur berbilang pelbagai jalur yang sesuai. Proses simulasi untuk reka bentuk ini menggunakan perisian Advanced Design System (ADS) dan direka menggunakan papan FR4. Dalam keadaan sebenar, projek ini akan dapat mengasingkan isyarat kepentingan daripada isyarat gangguan. Hasil reka

bentuk dapat menyediakan sistem komunikasi tanpa wayar yang lebih baik (bunyi bebas) dan dapat mengurangkan atau menghilangkan bunyi bising/harmonik/isyarat palsu dalam sistem tanpa wayar.

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I would like to express my grateful to the Almighty with His grace and guidance that He had offered to me and for all peoples that is directly or indirectly involved in my thesis journey. Firstly, thank you to my beloved project supervisor, Prof. Dr. Badrul Hisham Bin Ahmad who gives a lot of guidance, encouragement, assistance and support to me in completing this project. All he had done to assist me will be remembered forever. Besides, to all lecturers and friends who give me support and guidance in any situation from the first day of project until this thesis had been done, a special thanks to all of them. Finally, my appreciations to my family especially both of my parents that always help and support me with their abilities.

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LIST OF SYMBOLS AND ABBREVIATIONS

BSF	:	Band stop filter
LPF	:	Low pass filter
HPF	:	High pass filter
BPF	:	Band pass filter
RF	:	Radio frequency
FR4	:	Flame retardant 4
ADS	:	Advanced design system
SMA	:	Sub miniature version A
ε_{eff}	:	Effective dielectric constant
l_s	:	Length of substrate
g	:	Coupling gap

CHAPTER 1

INTRODUCTION

1.1 Introduction to the project

Many research have been carried out in order to develop multiband matched band-stop filter. Multiband matched band-stop filter is design for applications such as advanced communication and electronic warfare systems by cascading two single-band matched band-stop filter [5]. In design a circuit, for example oscillator, band-stop filter is used to remove unwanted signal and higher order harmonics [2]. Band-stop filter (band-rejection filter) will isolate frequency band that is placed within a wide pass-band. For an ideal band-stop filter, an attenuation of frequencies will occur between the range of frequencies between the lower cut-off frequencies,f_1 and upper cut-of frequencies, f_2. The frequencies that is not in the range between f_1 and f_2 is

allowed to pass and it is known as pass-band region. Figure 1.1 shows the basic frequency response of a band-stop filter.

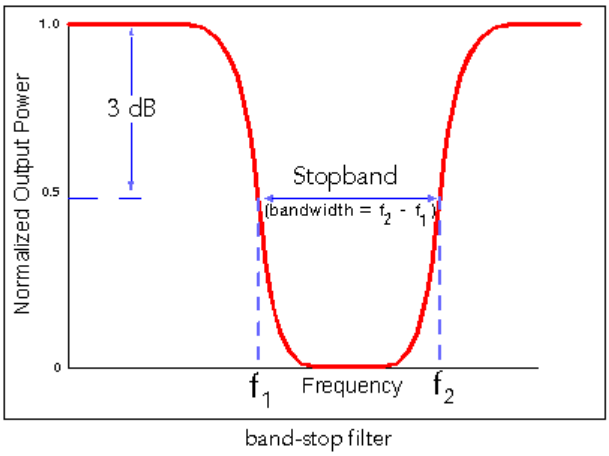

Figure 1.1 Band-Stop Frequency Response

Two lossy low Q resonator will be used to demonstrate the concept and design of perfect matched band-stop filter, so a high notched depth and selectivity of matched band-stop filters can be produced [2, 5]. To produce a maximum attenuation and to improve Q factor of band-stop limiter as shown in Figure 1.2, notch concept of filter is applied.

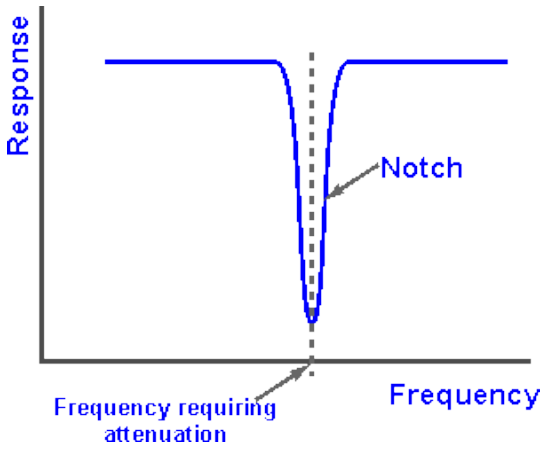

Figure 1.2 Notch Band-Stop Frequency Response

The simulation of multiband matched band-stop filter will be done using Advanced Design System (ADS) software. S-parameter performance; Return Loss (S_{11}), Insertion Loss (S_{21}) and unloaded Q factor is calculated using the design equations and the chosen frequencies and materials.

1.2 Project Objectives

The objectives of this project are:

1) To design and simulate multiband matched band-stop filter at center frequencies of 1GHz and 1.5GHz by implement two lossy low Q resonator using ADS software.
2) To fabricate and validate the design of multiband matched band-stop filter by fabricating using PCB machine on FR4 board.

1.3 Problems Statements

The design of multiband matched band-stop filter is one of the method that can be used to solve the increasing demands on how to isolate the unwanted signals in communication system. To design a filter, it is compulsory to give more priority to the effects of losses by using appropriate design techniques. The use of active approaches in design the filter is limited due to their inherent nonlinearity [1].

To design multiband matched band-stop filter, the implementation of lossy all-pass network in a band-stop limiter must be considered. To improve the Q-factor of band-stop limiter design, the perfect notch concept is applied. In perfect notch concept, two identical lossy resonators will be used. This two identical lossy resonator is coupled to a 3-dB 90° hybrid coupler with a correct coupling factors [1, 2, 5]. The use of two

low Q lossy resonators not only for high attenuation, but also to produce higher stop-band attenuation, to have matched at input and output port of the band-stop filter as well as compact in size [5].

The planar technologies particularly used microstrip suffer from low Q-factor compared with non-planar technologies. With low Q-factor of lossy resonator, a high notch depth and selectivity of matched band-stop filter is difficult to achieved, unless multiple lossy resonator is placed in the design for higher n-order of band-stop filter. However, the design tends to be physically large and complex [5].

1.4 Project Scope

Scope of work for this project focuses on three main areas. First, understand the filter, band-stop filter and perfectly matched band-stop filter by the data and information from research paper, journal, website and book. Second, this project focused on the design of multiband matched band-stop filter at center frequency of 1GHz and 1.5GHz. This design consists of two single band matched band-stop filter at center frequency of 1GHz and 1.5GHz that will be cascaded to perform a multiband. The multiband matched band-stop filter will using only two lossy low Q resonator to produce higher stop-band attenuation and achieve high Q factor. Lastly, the simulation of multiband matched band-stop filter is simulated using Advanced Design System (ADS) software and it is fabricated on FR4 board. The cost, mass production and marketing of this project will be not covered in this task.

1.5 Brief description of methodology

This project start with literature study and research about band-stop filter, microwave filter and others topic that related to this project. This literature study is done by find out all the journal, articles and books that related to this project. Next, all the process to simulate the design in ADS software, and the flow on how to run the simulation were learned. From the simulation, the band-stop response for multiband matched band-stop filter is observed. Lastly, the design filter was fabricated and tested.

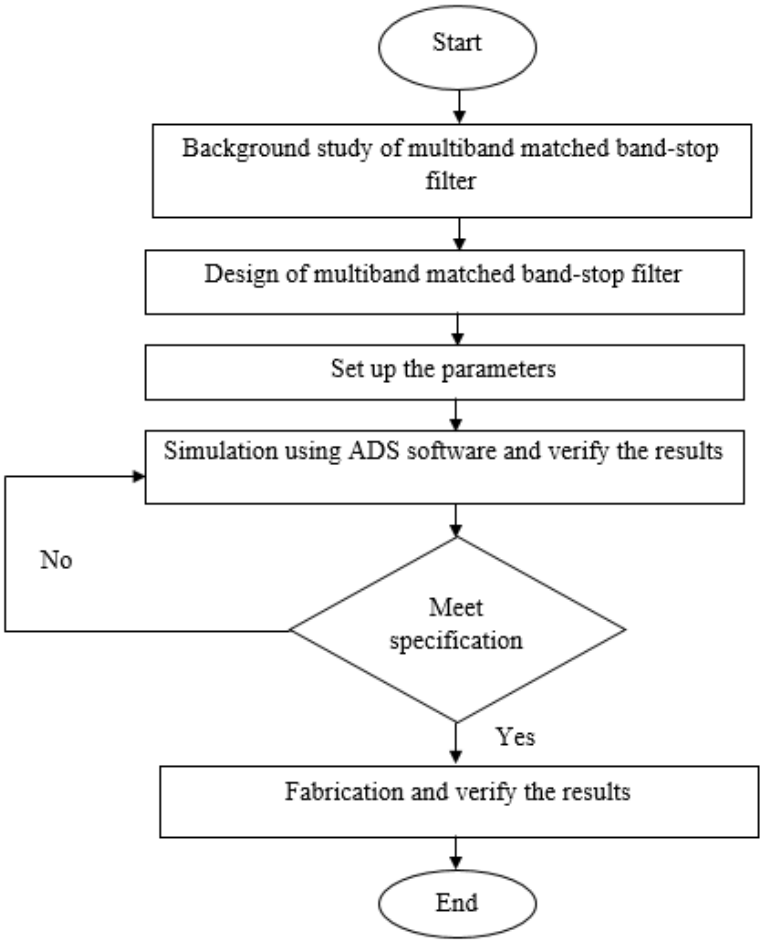

Figure 1.3 Flow Chart for the Whole Process of the Project