A NEW CLASS OF MICROWAVE FILTER WITH DEFECTED MICROSTRIP STRUCTURE (DMS)

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This report submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunications Electronics) With Honours

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BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **A NEW CLASS OF MICROWAVE FILTER WITH DEFECTED MICROSTRIP STRUCTURE (DMS)**

Sesi Pengajian :

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"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honors"

Signature :

Supervisor's Name : DR. ZAHRILADHA BIN ZAKARIA

Date :

DEDICATION

"In the Name of Allah, the most Beneficent, the Most Merciful"

Special dedication to my beloved parents,

Megat Arif Fadillah Bin Megat Abdul Aziz & Roshidah Binti Mohamed

My supporting siblings:

Puteri Anis Arina Binti Megat Arif Fadillah

Megat Muhammad Heikal Bin Megat Arif Fadillah

Puteri Aleeya Binti Megat Arif Fadillah

Puteri Aleena Binti Megat Arif Fadillah

To my supervisor

Dr Zahriladha b. Zakaria,

My friends and my fellow lecturers

Thank you for all your care, support and believe in me

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ABSTRACT

A compact ultra-wideband (UWB) band-pass filter suitable for a short distance and high-rate such as UWB radar systems for military, medical and civilian is presented. However, undesired radio signal such as Wireless LAN and WiMAX in the range UWB band that can interfere UWB signal. Thus, this project is to design and developed five order band-pass filter by using optimum distributed high-pass integrated with Defected Micro-strip Structure (DMS) been used to produce a band reject characteristics simultaneously in UWB response. This design is simulated by ADS software and using Roger Duroid 4350 with a dielectric constant 3.48, thickness of substrate 0.508 mm and loss tangent 0.0019. The proposed UWB filters are verified by experiments and fabricated. Measurement for UWB filter implemented using the Agilent Vector Network Analyzer. The filter exhibits an ultra-wideband response from 2.238 to 9.842GHz with a return loss S_{11} better than 10 dB and insertion loss S_{21} less than 1 dB respectively, and the DMS exhibit a band rejects response better than 20dB at a frequency of 5.6 GHz. The proposed filter has better performance and is attractive for UWB application and able to reject undesired frequency in UWB communication.

ABSTRAK

Sebuah ultra luas jalur penapis laluan jalur yang padat sesuai dengan aplikasi jarak pendek dan ketinggian kedar data seperti UWB system radar untuk ketentaraan, perubatan dan awam dipersembahkan. Namun begitu, isyarat radio yang tidak diingin seperti LAN tanpa wayar dan WiMAX berada di dalam jarak ultra luas alur yang boleh menyebabkan gangguan pada isyarat ultra luas jalur. Dengan itu, reka bentuk dan penghasilan sebuah lima perintah penapis laluan jalur dengan menggunakan optimum diedarkan jalur tinggi bersepadu bersama dengan kecacatan struktur mikro-strip yang digunakan untuk menghasilkan jalur menolak yang bercirikan serentak didalam respon ultra luas jalur. Reka bentuk ini disimulasikan dengan perisian ADS dan menggunakan Roger Duriod 4350 dengan pemalar dielektrik 3.48, ketebalan substrat 0.508mm dan kehilangan tanjen 0.0019. Penapis UWB yang dicadangkan adalah disahkan oleh eksperimen dan dibina. Pengukuran untuk penapis UWB dilaksanakan menggunakan Agilent Vector Network Analyzer. Penapis mempamerkan ultra luas jalur respon dari 2.338 sehinnga 9.842 GHz dengan kehilangan pulangan S_{11} baik daripada 10dB dan kehilangan masukkan S_{21} kurang daripada 1 dB dan DMS mempamerkan respon jalur menolak baik daripada 20 dB pada kekerapan 5.6 GHz. Penapis yang dicadangkan mempunyai prestasi yang lebih baik dan menarik untuk aplikasi UWB dan mampu untuk menolak frekuensi yang tidak diingini dalam komunikasi UWB.

TABLE OF CONTENTS

2 LITERATURE REVIEW

3 METHODOLOGY

LIST OF FIGURE

LIST OF TABLES

LIST OF ABBREVIATIONS

UWB	**-**	**Ultra wide-band**
BPF	**-**	**Band-pass filter**
DMS	**-**	**Defected Microstrip Structure**
DGS	**-**	**Defected Ground Structure**
EBG	**-**	**Electromagnetic band gap**
WLAN	**-**	**Wireless Local Area Network**
WiMAX	**-**	**Worldwide Interoperability for Microwave Access**
ADS	**-**	**Advance Design System**
RF	**-**	**Radio Frequency**
FCC	**-**	**Federal Communication Commission**

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In 2002, the Federal Communications Commission (FCC) approved the use of ultra-wideband (UWB) (range of 3.1-10.6 GHz) for commercial purposes [2]. Ultra-wide band (UWB) systems have been receiving wide attention from both academia and industry for the prominent advantages, such as high speed data rate, extremely low spectral power density and high precision ranging[3].Recently, the development of new UWB filters has increased via different methods and structures[4]. Sharp selectivity and capabilities to avoid interference from existing radio signals are highly demanded to the UWB BPF within the range defined by the FCC [3]. Recently there is a much interest in developing of high-performance microwave components using slow-wave structure, such as electromagnetic band gap (EBG), structures defected ground structures (DGS) and detected microstrip structures. They have attracted the interest of many researchers, due to their interesting properties in terms of size miniaturization, suppression of surface wave and arbitrary stop bands [3].

DMS is made by etching certain slot patterns in the microstrip line, and it exhibits the properties of slow-wave, rejecting microwaves in certain frequencies that are similar to the defected ground structure (DGS) but without any manipulation of the ground plane. It is possible to design UWB filter integrated with defected microstrip structure (DMS) resonator to produce band pass and notch response simultaneously.

1.2 **Problem statement**

The UWB radios typically communicate with short pulses or cycles on the order of nanoseconds, spreading their energy over a wide swath of bandwidth, as opposed to modulated sinusoids whose energy is localized around a single frequency [6]. In 2002, the Federal Communications Commission (FCC) approved the use of ultra-wide band (UWB) for commercial communication applications. Ultra-Wide Band (UWB) is a promising technology with a large bandwidth, good ratio of transmission data low power cost with short distance application such as medical application [5]. However, radio signals such as the Wi-MAX (3.5-GHz band), wireless local-area network (WLAN) (5.2 and 5.8 GHz bands), and 6.8 GHz RF identification (RFID) communication in the range UWB band [5]. Thus, the signal interference in UWB communication will occur and cause the accuracy of the data reception will decrease.

1.3 **Objective of project**

The objectives of this project are to design a UWB band-pass filter integrated with the notch response using a circuit theoretic and parametric study. This theoretical method is used for calculating the transmission line and resonance line to achieve accuracy of UWB frequency response. A notch response where it involves the DMS to reconfigure at any desired resonant frequencies. To implement it, the capabilities of DMS to reconfigure at an arbitrary frequency have been investigated. This project has potential to be applied in the UWB application such to remove the undesired frequencies that interfere the UWB systems.

1.4 Scope of project

This project involves the synthesis technique for microwave filters to be applied in designing the band-pass filter. The research processes are based on the review studies of Ultra-Wideband filter and DMS technology. The simulation process includes the design of layout, simulation and optimizes the frequency response that already targeted. The simulation part is carried out using the Advance Design System (ADS) to simulate the synthesis technique of band-pass filter. The band-pass filter will be simulated in term of its return loss level, insertion loss level, bandwidth and it provides ultra wideband frequency from 3.1 GHz to 10.6 GHz with minimum stop-band insertion loss of -15dB. The DMS technology is carried out using a parametric study to provide the shape and better performance in term of selectivity and designed at a frequency of 5.6 GHz with a band reject response better than 20 dB with a 700 MHz bandwidth characteristic using the Advance Design System (ADS) software. Then fabrication and valuation process of band-pass filter integrated with notch response.

1.5 Chapter Review

Chapter 1 describes the general overview of this project. This chapter presents the objectives, problem statement and review of all chapters of this thesis. Chapter 2 describes the introductions to the filter and detected microstrip structure is presented. This chapter will explain the basic concept of the filter response. Then the introduction of the type of filter and design will be introduced. This chapter also gives the information about the parameter and synthesis technique involved in this filter design project.

The design process in this project presented in Chapter 3 knows as methodology. The methodology involves the procedure of designing UWB filter and DMS design. Tuning and optimization process that involved in this project. The results are presented in chapter 4 where it involves the calculation, parametric study of filter and DMS, the theoretical, simulated and experimental result are also shown in this chapter.

Chapter 5 will present the conclusion of this project. After all the theoretical, simulated and experimental result is achieved, the conclusion comes to conclude the overall project achievement and also the future work involved.

CHAPTER 2

LITERATURE REVIEW

In this chapter, it describes findings on a literature review of the project. Overall, it covers related research from UWB application. The chapter starts with the basic theory and fundamental of the filter. The basic understanding of the parameters and the basics of microwave filter must be clearly made before continuing on understanding the project. The most important part of this chapter is emphasizing literature on different technique designing band-pass filter. Hence, all the information related to this project has been put in this chapter.

2.1 **Ultra-Wideband (UWB)**

The ability to transmitting data over a huge spectrum of frequency bands for short distances with very low power and high data rates in wireless technology are using Ultra-wideband system. The operation of sending and receiving extremely short bursts of RF energy to be use it. For high data transmission rates of up to 1 G-bps can be realized by UWB technology. Furthermore, the UWB wave capable of operating in good condition although there are barriers in spaces. Advantages of UWB systems in terms of huge bandwidth, immunity to multipath and low cost equipment makes the system can overcome the narrowband systems as well as high data rates. The use of the low noise amplifier (LNA), microwave filters, antennas and components matching used in the RF front end with the required bandwidth for RF hardware. In RF hardware and digital included in one of the UWB transceiver system. In 2002, the Federal Communications Commission (FCC) approved the use of ultra-wide band (UWB) from 3.1 GHz to 10.6 GHz for commercial communication applications. According to the FCC indoor limit that is seen in Fig 2.1, the FCC Frequency Mask mainly requires the following rejection specs for an UWB filter design in -10 dB minimum rejection at 3.1 GHz and 10.6 GHz [32].

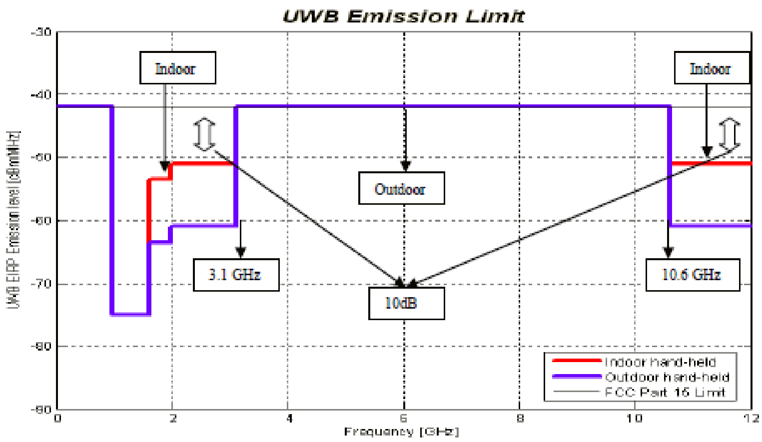

Figure 2.1: FCC Frequency Mask for UWB Applications [32]

2.1.1 UWB RF Systems and Application

The UWB radios typically communicate with short pulses or cycles on the order of nanoseconds, spreading their energy over a wide swath of bandwidth, as opposed to modulated sinusoids whose energy is localized around a single frequency [6]. For short-range data transmission in wireless connectivity between computing devices can be implemented effectively using UWB technology. Many applications in wireless technology have been focused on narrowband implementations. Technology requirements of UWB systems present differences from the narrow band ones.