FABRICATION OF UWB BANDPASS FILTER

KAMARUL ARIFFIN BIN OMAR

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DEDICATION

Special to my father and my family, thanks a lot for all your support.
For my friends, thank for helping and guide me for all this time.
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ABSTRACT

This project presented an ultra-wideband (UWB) bandpass filter using parallel coupled microstrip line. The proposed design of filter will be simulated, fabricated, measured and analyzed for UWB system application. UWB provides high data rates, resulting low interference, low cost, resistance to jamming and high performance in multipath channel compare to narrowband system which have interference signal in radio system, low channel capacity and costly. The expected of filtering range is about 3.1 GHz to 10.6 GHz. This filter also will be expected to produce low insertion loss. A planar bandpass filter, based on microstrip structure can provide the advantage of easy design, lower fabrication cost and compact size and has been widely used. It will provide low insertion loss over the band as a conventional filter, to have good performance at low frequency end and outside the operating band to meet the Federal Communication Commission (FCC) limit. AWR 2006 will be used for simulation of the filter while the fabrication will be done on Flame Retardant 4 (FR-4) board.

ABSTRAK

Projek ini menyediakan Ulta-wideband (UWB) Bandpass Filter dengan menggunakan teknik barisan pasangan selari mikrostrip. Reka bentuk penapis ini akan melalui proses simulasi, fabrikasi, pengukuran, dan analisis untuk aplikasi sistem UWB. UWB memberikan kadar pemindahan data yang tinggi, menghasilkan campur tangan yang rendah, kos rendah, tahan kepada kesesakan dan juga prestasi yang tinggi dalam saluran yang banyak jika dibandingkan dengan sistem Narrowband yang menghadapi masalah dalam isyarat campur tangan, kapasiti siaran yang rendah dan kosnya lebih tinggi. Nilai julat tapisan yang dijangkakan adalah dalam lingkungan 3.1 GHz hingga 10.6 GHz. Penapis ini juga akan dijangkakan untuk menghasilkan jumlah sisipan kehilangan yang rendah. Penuras Planar berdasarkan bentuk mikrostrip menghasilkan kelebihan dari segi reka bentuk yang mudah, kos fabrikasi yang rendah dan saiz yang mampat dan digunakan secara meluas. Ia akan menghasilkan sisipan kehilangan yang rendah di sepanjang jalur frekuensi untuk mempunyai prestasi yang baik pada penghujung frekuensi dan di luar daripada jalur operasi untuk mengikut sempadan Federal Communication Commission (FCC). AWR 2006 akan digunakan dalam proses simulasi manakala fabrikasi akan dijalakan dengan meggunakan papan Flame Retardant 4 (FR-4).

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LIST OF ABBREVIATIONS

BW	-	Bandwidth
BPF		Bandpass Filter
PCB	-	Printed Circuit Board
WLAN	-	Wireless Local Area Network
fc	-	Center frequency
f_L	-	Lower Cut-off Frequency
f_H	-	Higher Cut-off Frequency
Z_{in}	-	Input Impedance
Z_0	-	Characteristic Impedance
εr	-	Relative Dielectric Constants
εeff	-	Dielectric
h	-	Substrate Height
t	-	Thickness
l	-	Length
w	-	Width
s	-	Space

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CHAPTER I

INTRODUCTION

1.1 Project Background

Twentieth century has seen remarkable developments in the field of telecommunications. Wireless communication is indeed a very promising area in the field of telecommunication that came into picture in the last century. Wireless replaces the wired communication, making the communication more easy and efficient. There is been many advancements in the field of wireless communication in the last two decades. One of the most important and promising advancements in the field of wireless communication is Ultra-Wide Band (UWB). Federal Communication Commission (FCC) authorized the unlicensed use of 7.5 GHz bandwidth of spectrum from 3.1 GHz to 10.6 GHz in the year 2002 for UWB communication. This led to opening of a new chapter in the wireless communication research. UWB communication has attracted the attention of many researchers worldwide since its inception. UWB is mainly used for indoor communication since it allows transmission of low power signals.

Communication inside metal confined environments like intra-ship, intra-vehicle, intra-engine, manufacturing plants, assembly lines, nuclear plants, etc., is very critical but achieving effective communication in these kinds of environments has always been a problem. Due to resonance caused by the metal walls, narrow band wireless technologies have proved ineffective in these environments [1]. But UWB wireless technology can resolve the resonance into many time-resolvable pulses which correspond to extremely rich multipath. Due to large bandwidth of UWB, higher data rate can be achieved in these kinds of short range communications. Sensing of objects and person inside metal confined environment especially in intra-ship environment which is required for Naval forces was also considered big problem in these environments. But UWB can be effectively used in these environments for sensing and detection of objects and persons. Planar bandpass filters with a bandwidth of 3.1 GHz, are higly suitable for integration of UWB front-ends. A planar bandpass filter, based on microstrip structure can provide the advantage of easy design, lower fabrication cost and compact size, and has been widely used. It will provide low insertion loss over the band as conventional filter, to have good performance at low frequency end and outside the operating band to meet FCC's limit.

1.2 Problem Statement

In narrowband system, some problems such as interference signal in radio system, low channel capacity and costly. Smaller bandwidth can cause some problem such as easy to jam and the signal is easy to interfere with the other signals.

The proposed of this design is to overcome the previous problem in narrowband system bandpass filter. Compare to UWB, it provides high data rates, resulting low interference, low cost, resistance to jamming and high performance in multipath channel. The important thing to design bandpass filter in UWB is to provide low insertion loss and also to reduce inteference signal by rejecting other signals outside UWB band.

1.3 Project Objectives

The aim of this project is to design microstrip bandpass filter for UWB application in the range of 3.1 GHz to 10.6 GHz and also to produce low insertion loss.

1.4 Scope

The scope of this project is to design microstrip parallel coupled bandpass filter using microwave office, matching to 50 Ω microstrip line parallel coupled and analysis of insertion loss and return loss using Chebyshev prototye. This project will involve simulation and fabrication of microstrip bandpass filter

1.5 Thesis Outline

In this part, the summary or overview for each chapter contained in this thesis is discussed. The introduction of this project is outlined in Chapter I where it contains problem statement, objectives of the project and project scope methodology.

Literature research and review is discussed in Chapter II. In this chapter, we will study the basic theory of UWB system, application of UWB, advantage of UWB and how important we need to design bandpass filter in UWB range.

For chapter III, we will study the basic theory of microstrip filter, lumped element filter, comparison between lumped element and microstrip filter and parrallel coupled filter as the proposed design for this project.

In chapter IV, the methodology and development of the project is to be explained. The flowchart showing the flow of this project is outlined here to show step by step plan to achieve the goal of this project.

Result and discussion of the project is covered in chapter V. All the findings and analysis is discussed in this chapter to determine whether it has covers the overall objectives of the project.

Finally, in chapter V the conclusion for the project is made and few enhancements is suggested for further implementation and consequently to upgrade the system itself.

CHAPTER II

UWB APPLICATION

Ultra wideband (UWB) communication system has emerged as one of the most promising technology in the field of wireless communication recently. The term Ultra wideband was first coined by the U.S. Department of Defense in 1989. This is due to the fact that UWB communication system instantaneous bandwidth is many times greater than minimum required bandwidth to deliver particular information. This large bandwidth is the defining characteristic of UWB communication system.

2.1 History of UWB

Ultra wideband is not a new innovation, its roots lies in the very first wireless transmission via the Marconi Spark Gap Emitter. The transmitted signal is created by the random conductance of a spark [4]. The signal transmitted was a UWB signal because its instantaneous bandwidth is much greater than its information rate. The research on UWB started in the early 1960s. This research was led by Harmuth at Catholic University of America, Ross and Robins at Sperry Rand Corporation, and van Etten at the United States Air Force (USAF) Rome Air Development Center. With the development of sampling oscilloscope in 1960s, the research on UWB took a step further. The sampling oscilloscope provided a method to display and integrate.

UWB signals. It also provided simple circuits necessary for subnanosecond, baseband pulse generation. In early 1970, research was carried out on using UWB for radar communications. In 1974, the first ground-penetrating radar based on UWB was launched. UWB was used for only radar applications until the early 1990s. But a paper written by Robert Scholtz in 1993 presented a multiple access technique for UWB communication systems. This proved to be a turning point in UWB communications because with a multiple access technique UWB can be used for wireless communication also. This was followed by extensive research on UWB propagation in the late 1990s and early 2000s. The Federal Communications Commission (FCC) did an extensive investigation on the effects of UWB emissions on existing narrowband systems. Finally in 2002, FCC granted an unlicensed spectrum from 3.1 GHz to 10.6 GHz, at a limited transmit power of -41.3 dBm/MHz for use in high-speed UWB data services. In 2003, the first FCC certified commercial system was installed, and in April 2003 the first FCC-compliant commercial UWB chipsets were announced by Time Domain Corporation.

2.2 Wireless technology overview

Wireless technologies can be broadly categorized into three categories: Wide Area Networks (WAN): Wireless WANs consists of technologies that can operate in ranges of several miles to thousands of kilometers, with typical data rates of a several Mbps, and up to 70 Mbps for WiMAX [5]. To operate at these distances, these systems operate at high transmit power. Examples of these technologies include Satellite TV, GPS, WiMAX, and cellular phone technologies.

Local Area Networks (LAN): The most commonly deployed Wireless LAN technology is commonly called WiFi, also known as the IEEE standard 802.11a/b/g [4]. WLANs have an operating range of approximately 150 feet (50m), and data rates of

54Mbps for 802.11a and g. Currently, a draft of the 802.11n standard is being finalized, which increases the data rate to 540Mbps. WLANs can consume high amounts of DC power, because of their potential operation over a relatively long distance.

Personal Area Networks (PAN): Wireless PAN technologies operate within 30feet (10m), and include infrared devices (TV remote controls), Bluetooth (handsfree headsets), Zigbee [7] (sensor networks), and UWB (wireless USB). Data rates vary from a few kbps for Zigbee, to 3Mbps for Bluetooth 2.0, and up to 400Mbps for UWB. Due to the short distances in which WPAN systems operate, the power consumption is typically very low, especially relative to WLAN systems.

For some of the wireless technologies described, Figure 2.1 summarizes their data rates and operational ranges. As seen in Figure 2.1, UWB systems operate at high data rates over short distances. Next, the bandwidth used by each of these technologies can be summarized in Figure 2.2, where the frequency usage is shown. Within the large UWB band of frequencies, there are many “narrowband” systems. It is in these overlapping bands where interference can become an issue. If these systems are operating concurrently, they can interfere with each other.