INTEGRATED ANTENNA WITH NOTCH FILTER FOR MULTIFUNCTION OPERATION IN WIRELESS COMMUNICATION SYSTEM

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To my lovely father and mother

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ABSTRACT

Ultra-wideband (UWB) frequency spectrum (3.1 to 10.6 GHz) was released in 2002 by FCC of the United State for unlicensed indoor and hand-held commercial applications. Because of the attractive merits such as high mobility, flexibility, and extremely high data rate, the UWB radio systems have been raising more and more attention from scientists and engineers. In recent years many techniques such as embedded open-circuited stubs, Multilayer LCP, and so forth have been proposed for design the UWB band pass filter. For some practical applications, there is a need to introduce notch band within the UWB pass band to avoid the interference from existing wireless communication systems such as between 5.12 to 5.825 GHz band wireless local area network (WLAN). The design of microstrip circular ring antenna parameters must be recognized. The microstrip circular ring patch antenna is designed for reject the WLAN applications operating at frequencies of 5.15 to 5.825 GHz. CST Studio Suite software is used for simulation and design for a decision. The return loss for the antenna is ≤ -10 dB, gain, the form of radiation, the percentage achieved, and so the antenna.

ABSTRAK

Spektrum frekuensi bagi ultra-jalur lebar (UWB) pada kadar 3.1-10.6 GHz telah dikeluarkan pada tahun 2002 oleh FCC Amerika untuk aplikasi komersial dalaman dan tangan yang tidak berlesen. Oleh kerana merit menarik seperti mobiliti yang tinggi, fleksibiliti, dan kadar data yang sangat tinggi, sistem radio UWB telah menaikkan perhatian yang lebih daripada ahli-ahli sains dan jurutera. Dalam tahun-tahun kebelakangan ini, banyak teknik seperti stubs tertanam terbuka pintaskan, multilayer LCP, dan sebagainya telah dicadangkan untuk reka bentuk UWB penapis lulus jalur. Bagi sesetengah aplikasi praktikal, terdapat keperluan untuk memperkenalkan jalur takuk dalam lepasan jalur UWB untuk mengelakkan gangguan dari sistem komunikasi tanpa wayar seperti antara jalur 5.15-5.825 GHz rangkaian kawasan tempatan tanpa wayar (WLAN) yang sedia ada. Reka bentuk parameter bagi mikrostrip berbentuk cincin antena harus diakui. The mikrostrip mikrostrip berbentuk cincin antena direka untuk menolak permohonan WLAN beroperasi pada frekuensi 5.15-5.825 GHz. perisian CST Studio Suite digunakan untuk simulasi dan reka bentuk untuk keputusan. Kehilangan balikan untuk antena sedang ≤ -10 dB, gandaan, bentuk radiasi, peratusan yang dicapai, dan antena.

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LIST OF ABBREVIATIONS

UWB	-	Ultra-wideband
FCC	-	Federal Communications Commission
WLAN	-	Wireless Local Area Network
CST	-	Computer Simulation Technology
VSWR	-	Voltage Standing Wave Ratio
VNA	-	Vector Network Analyzer

CHAPTER I

INTRODUCTION

1.1 Project Background

The antenna is an important part of the microwave communication which is both transmitting and receiving the information. It is a device that is made to efficiently radiate and receive the radiated electromagnetic waves. Antenna is a transducer which converts the voltage and current on a transmission line into an electromagnetic field in a space, consisting of an electric and magnetic field travelling right angles at each other. The bandwidth is the antenna operating frequency band which are needed for the antenna performances, such as input impedance, radiation pattern, gain, efficiency so on and so forth.

In 2002, the Federal Communications Commission(FCC) allocated frequency spectrum of 3.1~10.6 GHz for unlicensed indoor and hand-held commercial applications [1]. There are two factors influence Ultra-wideband (UWB) antennas of gaining prominence and becoming very attractive in modern and future wireless communication systems. Firstly, the increase of high demand from user for the wireless transmission rate and UWB properties such as high data rate, low power consumption and low cost, which give a large boost to the UWB antennas' research and development in industry and academia since the FCC officially released the regulation for UWB technology in 2002. Secondly, now the wireless portable device need antenna operated in different frequencies for various wireless transmission functions, and operation bands and functions are increasing more and more, which

may result in challenges in antenna design, such as antenna space limitation, multi antennas interference, and other. One UWB antenna can be used to replace multi narrow-band antennas, which may effectively reduce the antenna number [2].

The special characteristics of merits such as high mobility, flexibility, and extremely high data rate, the UWB radio systems have gained more attention from scientists and engineers. For some practical applications, there is a need to introduce notch band (s) within the UWB pass band to avoid the interference from existing wireless communication systems such as band 3.5 GHz WiMax and 5.6GHz band wireless local area network (WLAN). Todays, many techniques such as embedded open-circuited stubs, Multilayer LCP, and so forth have been proposed for designing the UWB band pass filter [3].

1.2 Problem Statement

Nowadays, there are increasing demand for wireless communication systems spurs on the need for antennas capable of operating at a wide frequency band. Due to their attractive merits such as simple structure, pure polarization and radiation pattern, the conventional monopole and its variants have been widely used in wireless communications. Wireless multimedia systems are receiving increasing research and application interests [4]. Somehow, the improvements are still required to provide higher data rate for simple structure and compact size.

1.3 Project Objective

The objectives of this project are:

a. To synthesize and design a simple structure of UWB antenna for frequency range of 3.1 to 10.6 GHz with the notch filter at WLAN between range 5.15 to 5.825 GHz.
b. To investigate and analyze a compact size of UWB antenna with the notch filter at WLAN range frequencies.

1.4 Project Scope

This project concentrates on a development of integrated antenna and notch filter for multifunction operation in wireless communication system by using CST software. To develop the whole project, it consists of three methods that are the concept of wireless communication system, ultra-wideband antenna, and notch filter, the designing process by using CST software, the fabrication, and the testing and measurement.

The implementation of this project is to design ultra-wideband antenna for frequency range of 3.1~10.6 GHz and design notch filter for WLAN 5.6 GHz. This project requires understanding the concept of microstrip antenna and the techniques that using. As a first step of design process collect the related journal and papers on the internet, and design the ultra-wideband antenna with notch filter for WLAN. The patch element will be design based on circular patch. The design would be simulated using CST software. After the complete design process, the next procedure is to fabricate circuits and do testing and measurement procedures. The result obtained from the fabricated would be analyzed and compared with simulation results. Other antenna parameters such as return loss level, gain, and radiation pattern also will be analyzed from antenna design.

1.5 Project Methodology

There are several steps to be applied in the form of integrated antenna and notch filter for multifunction operation in wireless communication system by using CST software. The first step is to study and learn about the antenna fundamentals, ultra-wideband antenna and the notch with WLAN frequency which lies in the desired UWB at 5.6 GHz to avoid the interference. Step two is to calculate the parameter involves in this antenna design. Step three is to construct the physical layout of the design antenna. Next is carry out simulation by using the CST software. Then, consider all antenna basic characteristics such as a resonance frequency, return loss, bandwidth, gain, and directivity before fabricate the antenna. After that, measure return loss, bandwidth, gain and directivity of the antenna and then observe the result of calculation and

simulation. Next is carry out the fabrication process of the antenna when all the specification meets the requirement. This process should only be done up to this safety system successfully test and measure the fabricate antenna hence to compare again with all the calculation and simulation results where the result is almost the same. The project methodology will be explained in detail in Chapter III Methodology.

1.6 Contribution of Project

A compact UWB antenna with notch filter presented. The notched band can be controlled by properly selection of the location of the stub, width of the stub, and length of the stub. The proposed UWB antenna with notch filter is promising for the application in new UWB antenna wireless technologies due to its simple structure, notch filter which can reject other unwanted signal, compact size, and easy integration with antennas and other devices.

1.7 Report Outline

In **chapter 1** explains the background of ultra-wideband antenna, the project objective, the problem statement, and the project scope of integrated antenna and notch filter for multifunction operation in wireless communication system. The concepts of ultra-wideband are the major element as a guide for the development of the integrated antenna and notch filter for multifunction operation in wireless communication system.

The wireless communication system involved for the development integrated antenna and notch filter for multifunction operation by using CST software is explained in **chapter 2**. The understanding of three systems, which are the ultra-wideband antenna, notch filter, and wireless communication system stated in this chapter needed for the development of the whole project.

Chapter 3 focuses on the methodologies for the development and integration of ultra-wideband antenna for frequency range of 3.1–10.6 GHz with notch filter for

WLAN 5.6 GHz. It gives a brief review on the concept of ultra-wideband antenna, notch filter, CST software, and multifunction operation in wireless communication system.

The results obtained in **chapter 4** are discussed about the whole project. All discussions are concentrating on the result and performance of the integrated antenna and notch filter for multifunction operation in wireless communication system by using CST software. The discussion is valuable for future development of integrated antenna and notch filter for multifunction operation in wireless communication system by using CST software.

Chapter 5 discusses about the conclusion on development of integrated antenna and notch filter for multifunction operation in wireless communication system by using CST software. The recommendations and modification required on this project is stated in this chapter for further development.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter discusses some issues that are most important in designing ultra-wideband antenna for frequency range of 3.1~10.6 GHz and design notch filter for WLAN 5.6 GHz. This chapter also discussed about basic antenna parameter that will affect the performance of the antenna.

2.2 Critical Literature Review

Research was carried out by reviewing the literature in several journals which related to the topic of ultra-wideband antenna and notch filter in wireless communication system. The related data and facts about the characteristics of low profile, light weight, small size with symmetric radiation patterns, satisfactory gain and good time domain behavior make the proposed antenna suitable for different UWB applications that can be used to apply in the design process of this project had been collected. Table 2.1 shown the comparison of the previous research.

Table 2.1: The comparison of the previous research

Journal	Year	Title	Band notch UWB antennas	Dimension	Notched band	Performance	Limitation
[5]	2010	Study of an ultra-wideband monopole antenna with a band-notched open-looped resonator	Monopole antenna with open-looped resonator	35mm × 30mm	Centered at 5GHz	A resonator is placed at the center of the fork-shaped antenna to create notched frequency band centered at 5 GHz.	Although the antenna possess a fairly compact dimension, it requires a complex filter structure to create and control notched band for WLAN.

[6]	2011	Compact ultra-wideband antennas with single band-notched characteristics using simple ground stubs	Ultra-wideband antennas using simple ground stubs	30mm×39.3mm	5.15–5.825 GHz	A pair of ground stubs locating along the edge of the ground plane is used to generate the band notch characteristics.	Though the antenna successfully created notched band for WLAN, the antenna do not possess a physically compact profile having a dimension of 30 mm × 39.3 mm.
[7]	2012	Compact band-notched	Compact printed antenna using inverted L-slit	30mm × 36mm	4.85–6.04 GHz	To achieve the notched frequency band for WLAN, an inverted L-	Though the antenna possesses a fairly compact dimension,