SLOT ULTRA WIDEBAND (UWB) ANTENNA

MUSFIRAH BT HILMI

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PROJEK SARJANA MUDA II

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Date :…………………………………….

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For my beloved mom and dad.

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ABSTRACT

Since the release by the Federal Communications Commission (FCC) of a bandwidth of 7.5 GHz (from 3.1 GHz to 10.6 GHz) for ultra wideband (UWB) wireless communications, UWB is rapidly advancing as a high data rate wireless communication technology. Due to the requirements of large capacity of data and high speed data transmission rate, UWB technology has become the promising communication system. There are many types of UWB antenna such as dipole, bow-tie, TEM horn, slot UWB antenna, planar antenna and array antenna. This project presents the design of a planar slot UWB antenna. The design is based on the slot UWB antenna by using a planar structure and designed for a frequency of 3.1 GHz to 10.6 GHz. The UWB antenna is achieved by applying parameter analysis in the design process. The slot UWB antenna design is simulated on Computer Simulation Technology (CST) Microwave Studio Software and fabricated on Flame Resistant 4 (FR4) substrate by using chemical etching techniques. The antenna achieved an absolute bandwidth of 7.2GHz with return loss -25dB. An average gain obtained from simulation is within the range from 2dB to 5.3dB.

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ABSTRAK

Sejak Suruhanjaya Komunikasi Persekutuan (FCC) melancarkan jalur lebar berfrekuensi 7.5 GHz (dari 3.1 GHz hingga 10.6 GHz), untuk komunikasi wayarles "*Ultra Wideband (UWB)*" , *UWB* berkembang dengan pantas sebagai kadar data tinggi dalam komunikasi wayarles teknologi. *UWB* teknologi menjadi keperluan dalam sistem komunikasi disebabkan oleh permintaan yang tinggi untuk kapasiti data yang besar serta kadar penghantaran yang mempunyai kelajuan yang tinggi. Terdapat beberapa jenis antena *UWB* seperti antena dwikutub, *bow-tie*, *TEM horn*, slot antena UWB, antenna *planar* dan *array*. Projek ini bertujuan membina slot antena *UWB*. *UWB* antenna diperolehi melalui analisis parameter semasa proses rekaan. Antena tersebut disimulasi menggunakan program *Computer Simulation Technology (CST)*. Setelah proses simulasi selesai, antena difabrikasi pada papan substratum *Flame Resistant 4* (FR4) dengan menggunakan proses goresan. Antena tersebut mencapai jalur lebar 7.2GHz dengan kehilangan balikan -25dB. Purata kenaikan yang diperolehi melalui simulasi adalah antara 2dB hingga 5.3dB.

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LIST OF ABBREVIATIONS

1G	-	First-generation
2G	-	Second-generation
3G	-	Third-generation
4G	-	Fourth-generation
A	-	Width of Stub
ABW	-	Absolute Bandwidth
AWGN	-	Additive White Gaussian Noise
B	-	Distance between slot and U-shaped
C	-	Width of Stub
CPW	-	Coplanar Waveguide
CPWG	-	Coplanar Waveguide with Ground
CST	-	Computer Simulation Technology
dB	-	Decibel
dBi	-	Decibel above isotropic
FBW	-	Fractional Bandwidth
FCC	-	Federal Communications Commission
FDTD	-	Finite-difference Time-domain
FR4	-	Flame Resistant 4
GHz	-	Giga Hertz

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GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communication
IEEE	-	Institute of Electrical and Electronics Engineers
ISM	-	Industrial Scientific and Medicine
L	-	Length
MHz	-	Mega Hertz
MIC	-	Microwave Integrated Circuit
mm	-	millimeter
MMIC	-	Monolithic Microwave Integrated Circuit
MSRSA	-	Microstrip Square-Ring Slot Antenna
PCB	-	Printed Circuit Board
SNR	-	Signal-to-Noise Ratio
SRSA	-	Square-Ring Slot Antenna
SSRSA	-	Split Square Ring Slot Antenna
UMTS	-	Universal Mobile Telecommunications System
UWB	-	Ultra Wideband
VSWR	-	Voltage Standing Wave Ratio
W	-	Width
W_f	-	Center Conductor Width
W_S	-	Slot Width
Wi-Fi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WPAN	-	Wireless Personal Area Network

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CHAPTER I

INTRODUCTION

1.1 Introduction

Ultra wideband (UWB) is currently receiving special attention in industry and academia. The technical improvements have also enabled a large number of new services to emerge. The first-generation (1*G*) mobile communication technology only allowed analogue voice communication while the second-generation (2*G*) technology realized digital voice communication. Currently, the third-generation (3*G*) technology can provide video telephony, internet access, video/music download services as well as digital voice services. In the near future, the fourth-generation (4*G*) technology will be able to provide on-demand high quality audio and video services, and other advanced services.

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In recent years, more interest has been put into wireless personal area network (WPAN) technology worldwide. The future WPAN aims to provide reliable wireless connections between computers, portable devices and consumer electronics within a short range. Furthermore, fast data storage and exchange between these devices will also be accomplished. This requires a data rate which is much higher than what can be achieved through currently existing wireless technologies [1].

The maximum achievable data rate or capacity for the ideal band-limited additive white Gaussian noise (AWGN) channel is related to the bandwidth and signal-to-noise ratio (SNR) by Shannon-Nyquist criterion [2], as shown in Equation 1.1.

$$C = Blog_2(1 + SNR) \tag{1.1}$$

where *C* denotes the maximum transmit data rate, *B* stands for the channel bandwidth.

Equation 1.1 indicates that the transmit data rate can be increased by increasing the bandwidth occupation or transmission power. However, the transmission power cannot be readily increased because many portable devices are battery powered and the potential interference should also be avoided. Thus, a large frequency bandwidth will be the solution to achieve high data rate.

On February 14, 2002, the Federal Communications Commission (FCC) of the United States adopted the First Report and Order that permitted the commercial operation of UWB technology. Since then, UWB technology has been regarded as one of the most promising wireless technologies that promises to revolutionize high data rate transmission and enables the personal area networking industry leading to new innovations and greater quality of services to the end users [3].

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1.2 Objectives

The main objective of this project is to design and implement slot Ultra Wideband (UWB) antenna for UWB application. The UWB antenna should be capable of operating over an ultra wide bandwidth as allocated by the FCC with bandwidth requirement from 3.1GHz to 10.6GHz and return loss below than -10dB.

1.3 Problem Statement

In recent years, there has been an increase in the demand of large capacity of data and high speed data transmission rate. The limited bandwidth for wireless communication system is a drawback for the requirement of large capacity of data rate [1]. Besides the demand for small size and compact profile antennas, broadband ones are often required in order to cover simultaneously several bands. UWB is rapidly advancing as a high data rate wireless communication technology [4]. A slot UWB antenna is designed to have a larger bandwidth with large capacity of data and high speed data transmission rate.

1.4 Scope Of Work

The slot UWB antenna is designed by using planar slot structure and simulated by using CST software in order to obtain the return loss, frequency bandwidth, gain, directivity, and radiation pattern. Then the antenna is fabricated on FR4 board by using chemical etching technique. Finally, analysis has been done to compare between the simulation and the measurement result.

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1.5 Methodology

This project involves five major phase as shown in Figure 1.1. Firstly, a literature review was carried out from various sources such as journals, articles, books, and technical reports on UWB antenna. All the basic parameters such as its shape, dimensions, and all the mathematical parameters like its return loss, wavelength, directivity, VSWR and etc is analyzed and comprehended.

Then, the slot UWB antenna is designed by using planar slot structure. The UWB antenna should be capable of operating over an ultra wide bandwidth from 3.1GHz to 10.6GHz.

The CST software implementation is studied to design the antenna. The design that has been made with all parameters attained is then simulated using CST to analyze the antenna performance in order to obtain the return loss, frequency bandwidth, gain, directivity, and radiation pattern. If the design is not achieved a good performance, the design is being altered or redesign.

The UWB antenna is then fabricated on FR4 board by using chemical etching technique to validate the simulated prediction. Lastly, the return loss, gain, radiation pattern and frequency bandwidth are measured. The simulation results are compared to measurement results.

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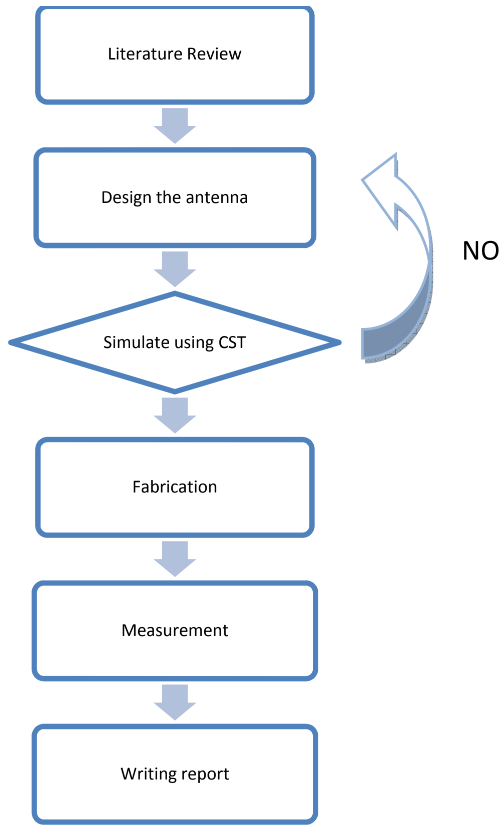

Figure 1.1 Flow Chart of Methodology

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