BROADBAND X-CIRCULAR POLARIZED ANTENNA

SITI LAILATUL QADR BINTI ZULKIPLI

This Report Is Submitted In Partial Fulfillment of Requirement for the Bachelor of Electronic Engineering (Wireless Communication) With Honours

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

June 2012

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	BROADBAND X-CIRCULAR POLARIZED ANTENNA
Sesi Pengajian	:	1 1 / 1 2

Saya SITI LAILATUL QADR BINTI ZULKIPLI
mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	**TIDAK TERHAD**	

Disahkan oleh:

_____ (TANDATANGAN PENULIS)

_____ (COP DAN TANDATANGAN PENYELIA)

Tarikh: ……..

Tarikh: ……..

"I hereby declare that this report is result of my own effort except for quotes as cited in the references."

Signature : …….

Name : SITI LAILATUL QADR BINTI ZULKIPLI

Date : 25th JUNE 2012

"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 (Wireless Communication) with Honours."

Signature : …….

Supervisor's Name : EN. ABD SHUKUR BIN JA'AFAR

Date : 25th JUNE 2012

This project are dedicated
to my dearest parent,
Zulkipli Bin Ahmad and Rusimah Binti Ahmad,
my siblings, and not forget to my friends,
who have always sincerely pray for my
success and glory.
To my supervisors,
thank you for your care and taught so
that this task can be accomplished
successfully.

ACKNOWLEDGEMENT

In the name of Allah S.W.T, The Most Beneficial and The Most Merciful. It is with deepest serve gratitude of the Al-Mighty that gives me strength and ability to complete this final year project report. It has been a pleasant and knowledgeable journey in preparing this thesis.

First of all, I would like to take this opportunity to express my special thanks to my supervisor, Mr. Abd Shukur Bin. Ja'afar and my co-supervisor Mr. Mohamad Zoinol Abidin Bin Abd Aziz for the guidance, assistance, advise, kindness and also being helpful to guide me all the way through the development and progress of my final year project. Above all and the most needed, they provided me unflinching encouragement and support in various ways.

My appreciation also goes to my friends for their advice, supervision, and crucial contribution, which made them a backbone of this project to become successfully. Thank you for lending hands during progress of the project.

Finally, I also would like to express my exceptional thanks to my beloved parents for their support and unending prayers and helps me directly or indirectly in successful finishing of my final year project.

Thank you.

ABSTRACT

There is a tremendous growth in demand for wireless communication system such as data, voice and multimedia application. Today, worldwide wireless subscribers are growing rapidly within one second. This leads to have a large bandwidth since demanding of high speed internet access is increases. In order to receive signal capability and broad receiving pattern, circular polarization is generated and as a result, the effectiveness of the antenna is increased. A good antenna design promises a better system performance. Thus, large bandwidth with good polarization is necessary parallel in order to increase the performance of the antenna. This aim of this project is to design, simulate and fabricate broadband circular polarization antenna at center frequency of 2.4 GHz for wireless MIMO applications. Several design methods have been investigated to achieve a circular polarization antenna with large bandwidth such as truncated corner, slot and stacked method. The design process is analyzed and simulated by using CST software. To get a significant result, the proposed antenna is able to fulfill requirement simulation design at return loss below than -10dB with a frequency bandwidth of 228.25MHz.

ABSTRAK

Terdapat pertumbuhan yang amat besar dalam permintaan untuk sistem perhubungan tanpa wayar seperti data, suara dan aplikasi multimedia. Hari ini, pelanggan tanpa wayar di seluruh dunia berkembang pesat dalam masa satu saat. Ini membawa kepada jalur lebar yang luas semenjak kenaikan permintaan internet akses berkelajuan tinggi. Untuk menerima keupayaan dan corak isyarat yang luas, polarisasi bulat dihasilkan dan kesannya, keberkesanan antena meningkat. Rekabentuk antena yang baik menjanjikan prestasi sistem yang lebih baik. Oleh itu, jalur lebar yang luas dengan polarisasi baik adalah perlu selari untuk meningkatkan prestasi antena. Projek ini adalah bertujuan untuk merekabentuk, simulasi dan fabrikasi jalur lebar polarisasi antena bulat pada frekuensi 2.4 GHz bagi aplikasi Wayarles LAN. Beberapa kaedah rekabentuk telah dikaji untuk mencapai antena polarisasi bulat dengan jalur lebar yang luas seperti potongan sudut, slot, dan kaedah tindanan. Proses reka bentuk dianalisis dan simulasi dengan menggunakan software CST. Untuk mendapatkan hasil yang penting, antena yang dicadangkan dapat memenuhi keperluan rekabentuk simulasi dengan‘return loss’ rendah daripada -10dB dengan lebar jalur frekuensi 228.25MHz.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CST	-	Computer Simulation Technology
GPS	-	global positioning system
Z_L	-	Impedance load
Z_o	-	Characteristic Impedance 50Ω
GHz	-	GigaHertz
MHZ	-	MegaHertz
dB	-	Decibel
mm	-	Millimeter
Hz	-	Hertz
Km	-	kilometer
λ	-	Wavelength
ε_{eff}	-	Effective Dielectric Constant
$\boldsymbol{\varepsilon_r}$	-	Dielectric constant
CPW	-	Coplanar waveguide
EM	-	electromagnetic
LAN	-	Local Area Network
MIMO	-	Multiple Input Multiple Output
AR	-	Axial Ratio
RL	-	Return Loss
CP	-	Circular polarization
RHCP	-	Right Hand Circular Polarized
LHCP	-	Left Hand Circular Polarized

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

This chapter will briefly discuss on the overview of the project. The objective, scope and thesis outline will be presented in this chapter.

1.1 Project Background

Wireless networking has become common needs in the last few years. With prices reduced to a fraction of what they were, it is no wonder that wireless networking products have transitioned from the home, office and currently used in manufacturing. A wireless network provides freedom in convenience and lifestyle to exchange words, data and music or video with any computer across the internet, or around the world. One of the major problems of future mobile communications system is the rapid increase in the demand for different broadband services and applications [1].

The advantage of wireless technology is well known as to provide more speed and range within the network. The most significant new technology is called as Multiple-input multiple-output (MIMO). MIMO uses several antennas at both the transmitter and receiver to improve communication performance. Instead of sending and receiving a single stream of data, MIMO can simultaneously transmit three and receive two streams of data. This allows more data to be transmitted in the same

period of time. This technique can also increase range, or the distance over which data can be transmitted. MIMO approaches show promise of enabling better wireless communications because they mitigate problems inherent in ground-to-ground links, which are the most common links used by wireless devices, including cell phones and Wi-Fi. It is one of several forms of smart antenna technology [2].

Nowadays, there are a lot of methods that can be used to increased antenna bandwidth as well as to generate circular polarization. Circular polarized is defined as a light which consists of two perpendicular electromagnetic plane waves of equal amplitude and difference in phase by 90°. The advantage of circular polarized wave is well known in long distance communication such as satellites communication, radars and global positioning system (GPS). For GPS application, a circularly polarized microstrip antennas is widely been used due to its advantages in receiving signal capability and broad receiving pattern. Other advantage of circular polarized antennas is can reduce the multi-path effect around the receiver. It also has advantage in terms of its attractive physical properties and polarization. Several method of design has been investigated to achieve circular polarization [3, 5].

Furthermore, in order to satisfy the demanded precision and reliability, a high performance antenna must be capable to operate at widen bandwidth. In addition, to meet the required accuracy and reliability, high performance antenna must be able to operate on expanding broadband. Increase the antenna bandwidth will facilitate the high data rate, high mobility, the system roaming and seamless connection by the wireless network. A lot of method has been used to achieve broadband antenna such as slot and stacked method. In general, there are many methods to design a broadband antenna [4].

1.2 Problem statement

Nowadays, the forthcoming mobile communication systems are expected to provide a wide variety of services through high-data rate wireless channels which is from high-quality voice to high-definition videos [4]. Broad bandwidth and high efficiency are two keys important in wireless communication systems, radar and

sensors. Broad bandwidth offers the ability to carry voice, data and video at the same time, thus being attractive for broadband multimedia communications. Therefore, along with other developments, widening the bandwidth of polarized antennas has become a major branch of activities in the field of telecommunications.

The use of linear polarization gives a poor performance towards any signals which are not straight and only able to detect the signal in one direction, resulting lost signal strength. Circular polarization (CP) has alleviated this problem by always receive a component of the signal due to the resulting wave having an angular variation. CP antennas is able to send and receive signals in all angles, thus the signal strength is not transferred anywhere but to a different plane and are still utilized. Therefore, the aim of this project is to design a circularly polarized antenna at 2.4 GHz for MIMO applications. The main advantage of using circular polarization is that regardless of receiver orientation, it will always receive a component of the signal [5].

The challenge for RF engineers is to understand the complex systems starting with the transmitter and ending with the receiver. MIMO technique is used to improve channel capacity of the antenna. Not only that, MIMO technique is applied in order to improve the robustness and performance of wireless links. The term multiple-input multiple-output refers to the use of an array of antennas for both transmitting and receiving sides. These requirements such as broad bandwidth, polarization, high gain and smaller physical size of antenna are the criteria that will attract the attention of researchers and engineers to use widely in RF and microwave engineering.

1.3 Objectives

The objective of the project is to design, simulate, and fabricate a broadband X-circular polarized antenna at frequency 2.4 GHz. The proposed antenna should increase more than 200MHz of the frequency bandwidth at 90% efficiency. The antenna will generate an independent circular polarized signal in X form for wireless MIMO applications.

1.4 Scope Project

This project will focus on the design of broadband X-circular polarized antenna. The design is divided into three main parts which are design, simulate and fabricate circular polarized antenna, broadband circular polarized antenna and follow by broadband X-circular polarized antenna. The broadband X-circular polarized is designed by using probe feeding methods with several techniques which are calculation and parametric study. Then, the design is simulated by using Computer Simulation Technology (CST) 2010 software to analyze the antenna parameter through 3D techniques. The fabrication process is done by chemical etching technique using multiple layer FR4 board and 50Ω SMA port. Network analyzer and antenna measurement system are used to measure return loss, bandwidth, radiation pattern and gain of the design antenna.

1.5 Project Methodology

Literature review is done by gathering data and information from books, journal, article and also papers in order to get a deep knowledge about the design of antenna. The literature review is focus on the techniques to broaden the antenna bandwidth as well as to produce a circular polarization. There are several methods to broaden the bandwidth such as slot, stacked and also air gap distance. Circular polarization operation can be obtained by adjusting the dimensions of the basic patch with one or more feeds and trimming the corners of a square patch [5]. In this part, simulation process will be done by varying the antenna parameter by using CST 2010 software. The simulation process will be divided into three stages which are circular polarized, broadband circular polarized and broadband X-circular polarized antenna. The return loss, radiation pattern, gain, directivity and bandwidth have been obtained from simulation process. The circuit will be fabricate by using chemical etching technique on FR4 board with 1.6mm thickness, 0.019 tangent loss and 4.4 dielectric constant as the substrate. The measurement of antenna parameter such as bandwidth, gain and directivity will be measured by using laboratory equipment such as spectrum analyzer and signal generator. Lastly, the report has been prepared. Figure 1.1 shows the project flow chart of proposed antenna.

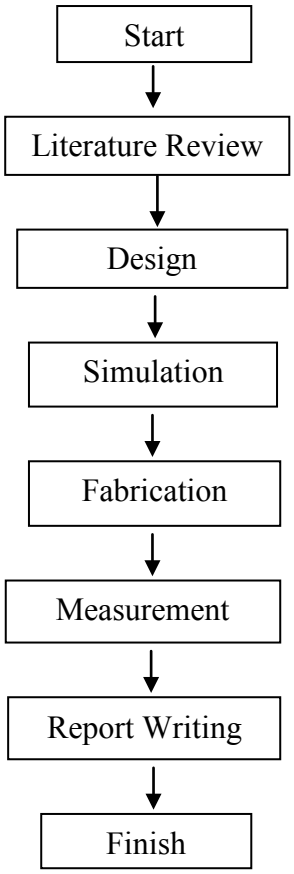

Figure 1.1: Project flow chart

1.6 Thesis Outlines

Chapter I will covers on the introduction of the project. A little explanation is discussing related to the project. Specification parameter of the project and the problem statement of the project are also discussed and mention in this chapter. Nevertheless, it also includes the objectives, scope of work and methodology of the project.

Chapter II consists of literature review of the project. The literature review was obtained from references book, journal paper, and technical paper. The literature review includes the review of basic antenna parameter and specification of the design. Basic antenna parameter is discussed and explained with the aid of figure.

In chapter III, project methodology is fully covered with explanation and discussion about the method of design antenna. The method of designing antenna will be include the design process, simulation, and fabrication and followed by antenna measurement. The first until last steps of the design are explained in detail in this chapter. All equation and parameter used are state in detail in this chapter.

The result from the simulation and measurement is analyzed, compared and explained in very detail statement in Chapter IV. The detail finding on analysis results for fabrication and measurement process is presented in this chapter.

Chapter V contains an overall conclusion of the project. The future works of the project is also described in this chapter.