DUAL POLARIZED ANTENNA DESIGN FOR 5.8GHZ POINT TO POINT APPLICATION

NURUL SYAHIDAH BT RAZALI

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

Faculty of Electronic and Computer Engineering

Universiti Teknikal Malaysia Melaka

May 2009

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **DUAL POLARIZED ANTENNA DESIGN FOR 5.8GHZ POINT TO POINT APPLICATION**

Sesi Pengajian : **2008/2009**

Saya **NURUL SYAHIDAH BT RAZALI**

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)

Alamat Tetap:

NO 111 KG BARU TEBING TEMBAH
23100 PAKA, DUNGUN, T'GANU.

Tarikh: 8 MEI 2009

Tarikh: 8 MEI 2009

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

Signature :……………………………

Author : Nurul Syahidah Bt Razali

Date : 8 Mei 2009

“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 (Telecommunications Electronics) With Honours.”

Signature : …..

Supervisor’s Name :Mohd Zoinol Abidin B Abd Aziz.

Date : 8 Mei 2009

DEDICATION

For my beloved mom and dad

ACKNOWLEDGEMENT

Full of gratitude I have successfully completed my project. I would like to take this opportunity to express my gratitude to my supervisor, Mr Zoinol Abidin B. Abd Aziz from FKEKK, UTeM for his guidance and encouragement throughout the course of my studies. He has given me plentiful of ideas and advices in performing this project. Furthermore, I would like to thank to Master’s student, Mohd Syaiful for his great guidance and in-depth discussion towards my project. Lastly, I sincerely express my appreciation to my family and Muhammad Hanafi for their support in encouraging me to further study and taking up this course.

ABSTRACT

In this thesis, a project of dual polarized antenna with resonant frequency at 5.8GHz point to point application is presented. The dual polarized antennas are traditionally characterized in terms of port-to-port isolation and co- and cross-polar patterns. The dual polarized antenna that's investigated is design to produce +45° and -45° electromagnetic field which its vertical and horizontal systems are equivalent with respect to their propagation efficiency that can be used with good results for transmit and receive applications. Besides, the design of dual polarized antenna is considering the ideal requirement which is small, inexpensive and unique structure. First step is by calculating the width and length of the patch. Then, the design is simulate using CST Microwave Studio software to simulate the return loss, bandwidth, radiation pattern, gain, directivity and beam width. In order to verify the results, a prototype antenna is fabricated by using chemical etching techniques. After that, the return loss is measured by using network analyzer while gain and radiation pattern is measured by using spectrum analyzer. The result obtain showed the return loss of the antenna is lower than -10dB at 5.8 GHz and produce higher bandwidth. Furthermore, the polarization of antenna is at ±45° which also has acceptable gain.

ABSTRAK

Tesis ini adalah mengenai projek dwi-pengutuban antena dengan frekuensi resonan 5.8GHz. Antenna dwi-pengutuban dikategorikan berdasarkan '*isolation'* dari suatu pangkalan ke satu pangkalan serta berdasarkan paten '*co- and cross-polar'* . Antena ini akan menghasilkan ±45° medan elektromagnetik iaitu pengutuban menegak dan melintang antena ini sama berdasarkan tahap efisen penyebaran dimana sesuai digunakan untuk menghantar dan menerima isyarat dengan baik. Pertama sekali, *'patch'* antenna ini di kira panjang dan lebarnya. Kemudian, antena ini disimulasi menggunakan perisian CST Microwave Studio untuk mendapatkan kebocoran balik, jalur lebar, paten radiasi, '*gain*', '*directivity*', dan '*beamwidth*'. Prototaip antenna ini kemudiannya dihasilkan dengan kaedah teknik goresan untuk menguji kebolehannya. Kebocoran balik diukur menggunakan '*network analyzer'* manakala '*gain*' dan paten radiasi diukur menggunakan '*spectrum analyzer'*. Hasil kajian menunjukkan return loss adalah lebih kecil dari -10 dB pada frekuensi 5.8GHz dan menghasilkan jalurlebar yang besar. Selain itu, pengutuban antena ini adalah pada sudut ±45° dan mempunyai '*gain*' yang bersesuaian.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CST	–	Computer Simulation Technology
IEEE	–	Institute of Electrical and Electronics Engineers
E	–	Electric Field Vector
H	–	Magnetic Field Vector
P	–	Poynting Vector
P_{Ref}	–	Receiving power of a reference antenna
P_{Test}	–	Receiving power of a test antenna
S	–	Scattering
RL	–	Return Loss
BW	–	Bandwidth
FNBW	–	First Null Beamwidth
HPBW	–	Half Power Beamwidth
ε_r	–	Dieletric constant
f_r	–	Resonant Frequency
tan δ	–	Tangent Loss
h	–	Height of substrate
W	–	Width
L	–	Length
ε_{reff}	–	Effective dielectric constant
ΔL	–	Extended incremental length
Le	–	Effective length
Rin	–	Resonant input resistance
y_o	–	Inset feet-point distance

W_o	–	Width of feedline connected with the rectangular patch
$\ell_{\lambda/2}$	–	Length of feedline connected with the rectangular patch
Z_o	–	Input impedance
FR-4	–	Flame Resistant 4
ISM	–	Industrial Scientific and Medicine
L_f	–	Length of feedline
W_f	–	Width of feedline
AUT	–	Antenna Under Test
Tx	–	Transmitter
Rx	–	Receiver

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Nowadays, the growing capacity demand from the users in communication system leaded to the development of antenna arrays at the base stations. This is because antenna arrays give advantages like increased coverage, diversity gain and interference suppression. If the array is equipped with the dual polarized antenna, more degrees of freedom are available. Thus, the one that investigated in this thesis may play a significant role.

1.1 Project Background

Antenna is the transitional structure between free-space and a guiding device. It is crucial elements of any wireless communication system which have various types such as helix, yagi, dipole, parabolic, horn and patch. Among of them, the patch or microstrip antenna popularly employed in many wireless communication systems. This is due to their advantages which are lightweight, low profile, easy fabrication and conformability to the mounting structure.

Dual-polarization operation has been concerned in microstrip antenna designs since it have a better chance of receiving more total signal than a singly linear polarized antenna. A dual-polarized microstrip antenna can be realized by feeding the rectangular microstrip patch at two orthogonal edges, through edge feed or probe feed, which excites TM_{01}-and TM_{10}-mode with orthogonal polarizations [1]–[4].

1.2 Objective

The objective of this project is to design dual polarized microstrip antenna for 5.8GHz point to point application. Important technical objective of this project is to get the return loss below than -10 dB, have a maximum gain and polarization at ±45°. The antennas are simulated by using CST Microwave Studio software and fabricated by using chemical etching technique. Measurements are performed on the prototype in order to verify the results obtained during simulations.

1.3 Problem Statement

The growing capacity demand from the users on wireless communication system set up the development of dual polarized antenna [5]. Since dual polarized antenna is designed to divert things to have multipath, the antenna can increased the capacity on wireless communication system. Besides, many linearly polarized multipath signals with different orientation exist at the receive site. Dual polarized antenna has a better chance of receiving more total signal than a singly linearly polarized antenna.

1.4 Scope of Work

The dual polarized antenna is designed using microstrip technique for resonant frequency at 5.8GHz point to point application. Calculations are involved to determine width and length of rectangular patch, feed line and power divider for resonant frequency 5.8GHz. A software of *CST* Microwave Studio is used in order to simulate single patch element, slant 45° and -45° and also an array for 1x2, 1x4, 2x2, and 2x4. From simulation process, return loss, bandwidth, gain, radiation pattern, directivity and beamwidth are discovered at frequency resonant 5.8GHz. The design is then fabricated by using FR-4 board and applied chemical etching technique for antenna array of 1x2, 1x4, 2x2 and 2x4. Afterward, the return loss, radiation pattern and gain of antenna are measured. Finally, simulation and measurement results are compared and analyzed.