MICROSTRIP LEAKY WAVE ANTENNA DESIGN FOR WLAN APPLICATION

NURLIYANA BT ABD MALIK

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

Faculty of Electronic Engineering and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2009

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**MICROSTRIP LEAKY WAVE ANTENNA DESIGN FOR WLAN APPLICATION**
Sesi Pengajian	:	**2008/2009**

Saya **NURLIYANA BT ABD MALIK**

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 317 JLN TKP 6,
TAMAN KANTAN PERMAI,
43000 KAJANG,
SELANGOR.

Tarikh: …………………………..

Tarikh: ………………………..

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

Signature	: ………………………………………………
Author	: NURLIYANA BT ABD MALIK
Date	: 6TH APRIL 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 (Telecommunication Electronics) With Honours."

Signature : ……………………………………….........................

Supervisor's Name : MOHAMAD ZOINOL ABIDIN BIN ABD AZIZ

Date : 6TH APRIL 2009

DEDICATION

To

My Beloved Parents,

En Abd Malik Hj Mahfudz & Pn Sabariah Ismail,

My Brother and Sister,

My kind hearted supervisor,

Mr Mohamad Zoinol Abidin Abd Aziz

And all my dearest friends.

ACKNOWLEDGEMENT

First of all, I would like to thank to Allah the Almighty who always beside me guiding and giving me blessing to finish my Project Sarjana Muda II successfully.

My sincere appreciation and gratitude are dedicated to my honorable supervisor, En Mohamad Zoinol Abidin Bin Abd Aziz for his encouragement, guidance and critics. Without his continued support and interest, this thesis would not have been the same as presentd here.

I would like to extend my sincere appreciation to all my dearest friends especially Shela, Hajar, Kak Iwan and Wani for their friendship, encouragement and always being beside me in every condition. Not to forget, all students under the same supervisor thank you for sharing the similar knowledge.

Last but not least, I would like to thank my beloved family especially my loving parents, En Abd Malik Mahfudz and Pn Sabariah Ismail. Their loves, supports and prayers have given me the strength to finish what I have started. Finally, to everybody that has been involved in my project directly or indirectly, thank you very much.

ABSTRACT

This project presents an overview of design of Microstrip Leaky-Wave Antenna for Wireless Local Area Network Application. WLAN and wireless information network requires low-cost, low profiles and efficiency smart antenna. Microstrip leaky-wave antenna (MLWA) can be a candidate for its simple construction, low profiles, easy to match and frequency-scanning ability. The circuit was designed by using CST Microwave Studio and the circuit was simulated to obtain the return loss, radiation pattern, gain, directivity, bandwidth, FNBW and HPBW. Design process of MLWA starts with designing the single patch and followed by designing the array antenna by varied the number of elements, N and value of phase different, β. Array Factor equation is used to plot the MLWA radiation pattern and the plot was compared with the simulation result. Minimum resonant frequency occurred when the number of elements is greater. When the number of β increase, the value for directivity and bandwidth will slightly increase. As the number of elements is increase, the multiple beam appear on the radiation pattern will also increase. FR4 photo-resist board is used for the fabrication of the selected design antenna by using chemical etching technique. Finally, the fabricated antenna was measured by using network analyzer and antenna trainer to measure the return loss, directivity, bandwidth, FNBW, HPBW and radiation pattern. The measurement result was compared with the simulation result.

ABSTRAK

Projek ini berkenaan dengan rekaan antena jalur-mikro kebocoran gelombang (MLWA) untuk aplikasi *WLAN*. Aplikasi *WLAN* ini memerlukan antena yang mempunyai ciri-ciri seperti kos pembinaan yang rendah serta mempunyai kecekapan yg tinggi. MLWA boleh dijadikan sebagai antenna yang terbaik untuk digunakan kerana ia mudah dari segi pembinaan serta mempunyai keupayaan pengesanan frekuensi yang tinggi. Penyediaan dan simulasi litar bagi antena ini akan menggunakan perisian CST Microwave Studio dan litar ini di simulasi untuk mendapatkan nilai kehilangan penghantaran, corak radiasi, nilai dapatan, nilai arah, lebar jalur, *HPBW*, dan *FNBW*. Proses merekabentuk antenna ini bermula dengan rekaan bagi satu elemen diikuti dengan membuat rekaan bagi rangkaian antenna dimana nilai elemen, N dan beza fasa β akan di variasikan . Rumus factor rangkaian, *AF* alkan digunakan untuk memplot corak radiasi dan plot tersebut akan dibandingkan dengan corak radiasi hasil daripada simulai. Nilai kehilangan penghantaran yang minimum terhasil apabila nilai elemen adalah banyak. Apabila nilai β dinaikkan, nilai arah dan jalur lebar akan meningkat. Apabila nilai elemen semakin besar, nilai alang yang terhasil pada corak radiasi akan menjadi semakin banyak. Fabrikasi bagi antenna ini telah menggunakan papan *FR4* dengan menggunakan teknik *chemical etching*. Kemudian, antenna yang telah difabrikasi akan di ukur dengan menggunakan penganalisa rangkaian dan set antenna untuk mendapatkan nilai kehilangan penghantaran, nilai arah, jalur lebar, FNBW, HPBW dan corak radiasi. Nilai-nilai tersebut akan dibandingkan dengan nilai yang terhasil daripada simulasi.

CONTENTS

II LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

LWA	-	Leaky-Wave Antenna
FPC	-	Fabry Perot Cavities
FSS	-	Frequency Selective Surface
FSW	-	Flat Slotted Waveguide
MLWA	-	Microstrip Leaky-Wave Antenna
MOS	-	Microwave Office Sotware
PRS	-	Partially Reflective Surface
RL	-	Return Loss
VSWR	-	Voltage Standing Wave Ration
WLAN	-	Wireless Local Area Network
P	-	Total Power Radiated
S	-	Power Density
U_i	-	Radiation intensity for isotropic antenna
HPBW	-	Half power beam-width
FNBW	-	First Null Beamwidth
D	-	Directivity of Antenna
Z_{in}	-	Antenna impedance at the terminals
R_{in}	-	Antenna resistance at the terminals
X_{in}	-	Antenna reactance at the terminals
RL	-	Return Loss
L	-	Length of Patch
W	-	Width of Patch
l	-	Length of Transmission Line

w	-	Width of Transmission Line
ΔL	-	Length extension
h	-	Height of Substrate
β	-	Phase different between two radiating elements
N	-	Number of elements
d	-	Distance between elements
θ	-	Polar Angle
AF	-	Array Factor
φ	-	Phase Shift
dB	-	Decibel
dBi	-	Isotropic Decibel
C	-	Speed of light in vacuum
λ_0	-	Free-space wavelength

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Project Introduction

In recent years, the microstrip leaky-wave antenna (MLWA) has got more and more attention for its simple feeding construction, easily coupling and frequency scanning. MLWA works in the first high mode TE_{10}. These antennas are intrinsically non-resonant and so are capable of wide band performance and, in addition, the main beam can be scanned by changing frequency. For these reasons, of late, they have attracted a lot of attention, especially for airborne applications. A microstrip leaky wave antenna with first higher-order mode excitation radiates power in the narrow frequency regime before cutoff. The radiation main-beam depends on the operating frequency. Therefore it can be used as a frequency-scanning antenna.

1.2 Objective of Project

The objective of this project is to design, simulate and fabricate Microstrip Leaky-Wave Antenna for WLAN application operating at frequency of 2.4 GHz. The designed antenna should have return loss of ≤ -10 dB and maximum value of directivity and gain.

1.3 Problem Statement

Wireless local area network and wireless information network requires low-cost, low profiles and efficiency smart antenna. Besides that, the demand of antenna which has the ability to frequency-scan leads to the development of new design of microstrip antenna. Since that conventional design of microstrip antenna doesn’t have the frequency-scanning ability, Microstrip Leaky-Wave Antenna (MLWA) can be the best candidate for its simple construction, low profiles, easy to match and frequency-scanning ability.

1.4 Scope of Project

This project will focus on 4 areas and the main focus is to design Microstrip Leaky-Wave Antenna operates at frequency of 2.4 GHz. Then, CST Microwave Studio was used to simulate the return loss, radiation pattern, directivity, gain, HPBW and FNBW of the design. Next, the design of leaky wave antenna was fabricated on FR4 board using the chemical etching technique. Finally, the return loss, directivity, gain, HPBW, FNBW and radiation pattern of the leaky wave antenna were measured.

1.5 Report Organization

The organization of this report is followed by Chapter 2 discusses the literature review of this project. This chapter contains research and information on several important concepts and types of antenna. It will follow by the design rules and calculations use in designing the antenna. Chapter 3 discusses and explains the methodology in completing this project. The calculation and simulation results will be include in Chapter 4. Finally, the conclusion from the study and extension progress in order to complete this project is stated in Chapter 5.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Antennas are metallic structures designed for radiating and receiving electromagnetic energy. An antenna acts as a transitional structure between the guiding device (e.g. waveguide, transmission line) and the free space. The official IEEE definition of an antenna as given by Stutzman and Thiele follows the concept: “That part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves”. The performance of an antenna can be gauged from a number of parameters [1].

2.2 Basic Antenna Parameter

There are several important antenna parameters that should be considered when choosing an antenna for certain application. Some important parameters of the antenna are return loss, radiation pattern, polarization, directivity and bandwidth.