DESIGN OF SLOT PLANAR ANTENNA

NOR SAIDATINA BINTI ABDUL LATIF

This report submitted in the partial fulfillment of the requirement for the award of Bachelor of Electronic Telecommunication Engineering With Honours.

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2010

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : DESIGN OF SLOT PLANAR ANTENNA

Sesi Pengajian : 2009/2010

Saya NOR SAIDATINA BINTI ABDUL LATIF
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)

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

Signature : …………………………………………………….

Author : Nor Saidatina Binti Abdul Latif

Date : …………………………

"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)"

Signature : ………………………………………

Supervisor's name : En. Mohamad Zoinol Abidin Bin Abd Aziz

Date : …………………………

To my beloved family…..

ACKNOWLEDGEMENT

First and foremost, praise to Allah the Almighty for It countless blessings and guidance throughout the hard times I have endured. Thanks also to my beloved family and friends for giving me the support and encouragement.

I would like to express my utmost gratitude to Mr. Mohamad Zoinol Abidin Abd. Aziz for the guidance and thought me many things and enthusiastic to share knowledge. The cooperation in order to give me a knowledge and explanation is very thankful appreciate. I truly have learnt a lot and all this would not be without his guidance.

Last but not least, warm thank you to my fellow friends for giving me an encouragement and pray for a great success. Additionally, to those whom their names are not mentioned here that have help me directly or indirectly, there is no such meaningful word than thank you so much.

ABSTRACT

Microstrip antennas are useful in many applications such as application in WLAN. It is because of their numerous advantages such as low profile, low cost, lightweight and easy fabrication. However microstrip has disadvantage that is narrow bandwidth. In order to solve the problem of narrow bandwidth in WLAN systems, slot planar antenna is designed. The slot antenna provides a wider bandwidth with less dependence on substrate thickness. The current of a slot antenna is distributed on a metal sheet around the slot and so less energy is stored between the antenna and ground plane. They are also superior to dipole and patch antennas since they have low cross polarization and less surface wave losses. A slot planar antenna is designed in order to obtain the required parameter responses at 5.2 GHz to be used in WLAN. This slot planar antenna is simulated by using Computer Simulation Technology (CST). From the simulation, results of gain, directivity, radiation pattern, HPBW, FNBW and return loss are obtained. This antenna is etched on a FR4 with dielectric constant of 4.9 with the height of 1.6 mm. A prototype of the slot planar antenna is built and tested by Vector Network Analyzer (VNA). The main parameters concerned are return loss, bandwidth and gain. Then the measurement result obtained would be compared to the simulation result. With these designs, impedance bandwidth of approximately 20% has been obtained.

ABSTRAK

Antena mikrojalur mempunyai banyak kegunaan antaranya dalam WLAN. Hal ini kerana ia mempunyai banyak kelebihan seperti profil rendah, kos yang rendah, ringan dan mudah difabrikasi. Walau bagaimana pun, mikrojalur mempunyai keburukan iaitu lajurlebar yang kecil. Untuk mengatasi masalah jalurlebar yang kecil dalam sistem WLAN, antenna slot planar direka. Antena slot memberikan jalurlebar yang besar dengan kurang pergantungan pada tinggi substrat. Arus antena slot diedarkan pada logam di keliling slot, oleh itu sedikit tenaga disimpan di antara antena dengan satah bumi. Antena ini juga lebih unggul dari dwikutub dan antena patch kerana mempunyai polarisasi silang dan gelombang permukaan yang rendah. Dalam projek ini, antena planar slot direka pada 5.2 GHz untuk digunakan dalam WLAN. Antena planar slot ini disimulasikan dengan menggunakan Computer Simulation Technology (CST). Melalui simulasi, hasil HPBW, FNBW, polar radiasi dan direktiviti diperolehi. Antena slot planar difabrikasikan di atas FR4 dengan pemalar dielektrik 4.5 dan tinggi 1.6 mm. Prototaip antena planar slot diukur menggunakan Vector Network Analyzer (VNA). Kemudian hasil pengukuran yang diperolehi akan dibandingkan dengan hasil simulasi. Melalui rekaan ini, jalurlebar sebanyak 20% diperolehi.

CONTENT

LIST OF FIGURES

LIST OF TABLE

TABLES **TITLE**
PAGE

LIST OF ABBREVIATIONS

ε_r	-	Dielectric Constant
ADS	-	Advance Design system
BW	-	Bandwidth
CPA	-	Coplanar Patch Antenna
CPW	-	Coplanar Waveguide
CST	-	Computer Software Technology
dB	-	Decibel
DEA	-	Double-element Antenna
DIL	-	Distributed Inductive Loading
E1	-	Vertical Slot Length
F1	-	Feed Line Length
FDTD	-	Finite Difference Time Domain
FEM	-	Finite-Element Method
FNBW	-	First Null Beam Width
g2	-	Height of the Ground
GPS	-	Global Positional System
h	-	Thickness of Substrate
HPBW	-	Half Power Beam Width
HSA	-	Hybrid Slot Antenna
IEEE	-	Institute of Electrical and Electronics Engineers
L1	-	Length of the Patch
L_g	-	Lenght
MoM	-	Method of Moments
RF	-	Radio Frequency
S1, S2, S3	-	Slot Height
S4	-	Gap Width

SMA	-	SubMiniature version A
tan δ	-	Tangent Loss
VNA	-	Vector Network Analyzer
VSWR	-	Voltage Standing Wave Ratio
w1	-	Width of the Patch
W_g	-	Width
WLAN	-	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Overview

An antenna is an element used for radiating or receiving electromagnetic wave. Although antennas may seem to be available in numerous different shapes and sizes, they all operate according to the same basic principles of electromagnetics. As a general principle, a guided wave traveling along a transmission line which opens out will radiate as a free-space wave, also known as an electromagnetic wave. When an antenna is receiving, the antenna transforms free-space propagating waves by inducing a guided electromagnetic wave within the antenna. The guided electromagnetic wave is then fed into an integrated circuit. The integrated circuit then deciphers the signal being transmitted. When an antenna is transmitting, the antenna receives the guided electromagnetic wave for transmission from a feed line and induces an electric field surrounding the antenna to form a free-space propagating electromagnetic wave. The features of antenna can be known by the parameters of operation frequency, radiation patterns, reflected loss, and antenna gain, etc.

An antenna may be that component of a personal communication device, a radio, a television, or a radar system that directs incoming and outgoing radio waves between free space and a transmission line. Antennas are usually metal and have a wide variety of configurations, from the whip or mast like devices employed for radio and television broadcasting to the large parabolic reflectors used to receive satellite signals and the radio waves generated by distant astronomical objects. Many types of portable electronic devices, such as cellular phones, GPS receivers, palm electronic devices, pagers, laptop computers, and telematics units in vehicles, need an effective and efficient antenna for communicating wirelessly with other fixed or mobile communication units.

Advances in digital and radio electronics have resulted in the production of a new breed of personal communications equipment posing special problems for antenna designers. Personal wireless communication devices have created an increased demand for compact antennas. The increase in satellite communication has also increased the demand for antennas that are compact and provide reliable transmission. Wire antennas, such as whips and helical antennas are sensitive to only one polarization direction. As a result, they are not optimal for use in portable communication devices which require robust communications even if the device is oriented such that the antenna is not aligned with a dominant polarization mode [1].

1.2 Project Summary

The main purpose of this project is to design slot planar antenna with a certain frequency, bandwidth, gain and structure. The scopes of work are design the slot planar antenna, the simulation, fabrication and test the antenna which involve with some materials and tools. For example, the software called Computer Simulation Technology (CST) is used for the simulation and FR4 microstrip board for fabricate. The fabricated antenna will be measure and test in order to verify the performance.

1.3 Objectives

The objective of this project is to design a slot planar antenna that can operate at frequency of 5.2 GHz, broader bandwidth and suitable gain for WLAN application.

1.4 Problem Statement

Microstrip and printed antenna design have their own disadvantages such as narrow bandwidth (5% to 10% is typical without special technique), dielectric and conductor losses can be large for thin patches resulting in poor antenna efficiency and sensitivity to environmental factors such as temperature and humidity. Assessing the size of a small antenna is more difficult than it sounds because of the interaction between the antenna and its immediate environment (or the test equipment, during measurements) [1].

To overcome these problems, slot planar antenna is designed because slot antennas exhibit wider bandwidth, lower dispersion and lower radiation loss than microstrip antennas, and when feeding by a coplanar waveguide they also provide an easy means of the parallel and series connection of active and passive elements that are required for improving the impedance matching and gain. The planar antenna has the advantages of lightweight, compact size, easy manufacture, easy attachment and easy integration [7].

1.5 Scope of Project

The work scopes of this project are to design the slot planar antenna. This project is divided into four phase. The first phase involves, designing the slot planar antenna that operate at 5.2 GHz, broader bandwidth and suitable gain. Next, the simulation process will take place to simulate the antenna parameters such as radiation pattern, return loss and gain by using Computer Simulation Technology (CST) Software. Then, etching process is done to perform the fabrication on FR4 microstrip board. Finally the parameters of the antenna such as return loss, bandwidth and gain are tested by using network analyzer.

1.6 Outlines of Thesis

The outlines of the thesis are as follows:

Chapter 1: This chapter provides the introduction to the project, objective and scope of work.

Chapter 2: This chapter covers the literature review on the slot antenna, the antenna properties, and the feeding methods.

Chapter 3: This chapter covers the methodology of the project and the design guideline

Chapter 4: Chapter 4 consists of the slot planar antenna design, simulation and measurement.

Chapter 5: This chapter provides the conclusion and recommendation to the project.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss on the antenna parameters, types of antenna and various shapes of slot design.

2.1 Wireless Local Area Network (WLAN) System

Wireless LAN can be used either to replace wired LAN, or as an extension of the wired LAN infrastructure. There are in general two types of antennas for WLAN applications, fixed WLAN base stations or access points, and the other is for mobile communication terminals.

For base station applications, impedance matching for WLAN bandwidth should be better than 1.5:1 VSWR or about 14 dB return loss [3], similar to the cellular system base station. Antenna that capable to excite circular polarization is very attractive because it can overcome the multipath fading problem, thus enhance the system performance, especially indoor WLAN operation [3].

2.2 Types of Antenna

There are various types of antenna such as wire, aperture, microstrip, array and lens antenna.

2.2.1 Wire Antennas

Wire antennas are familiar to the layman because they are seen virtually everywhere-on automobiles, buildings, ships, aircraft, spacecraft, and so on. There are various shapes of wire antennas such as a straight wire (dipole), loop, and helix. Loop antennas need not only be circular. They may take the form of a rectangle, square, ellipse, or any other configuration. The circular loop is the most common because of its simplicity in construction [8].

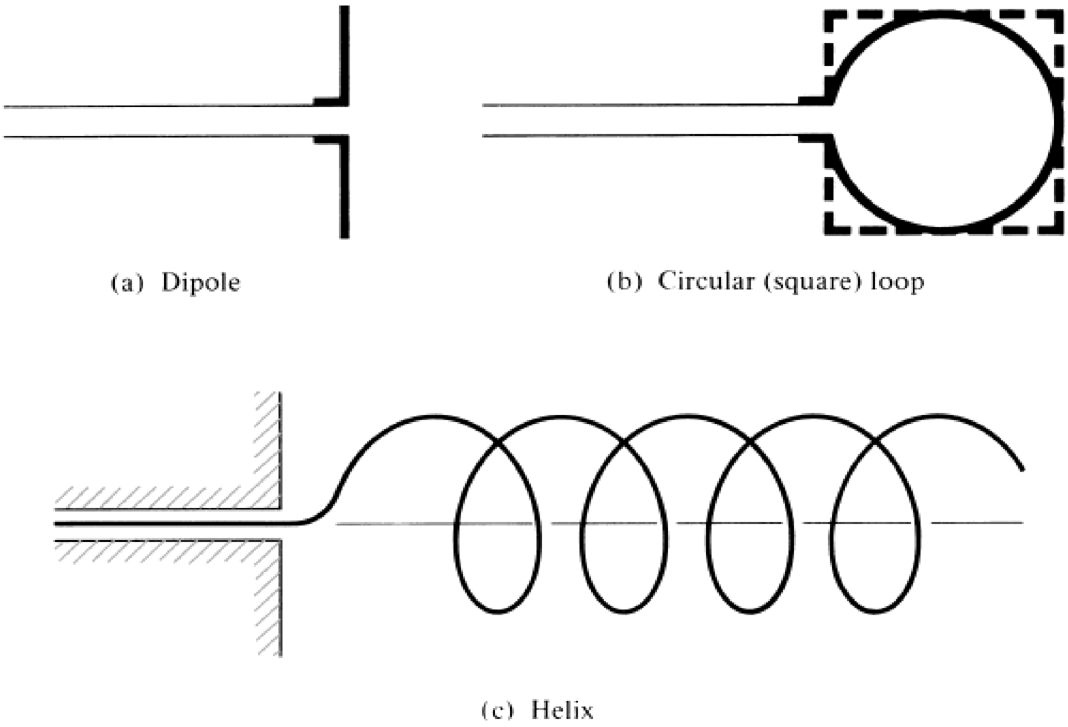

Figure 2.1: Wire Antenna Configurations [8]