DESIGN OF MICROSTRIP ANTENNA WITH PARASITIC ELEMENT

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To my beloved family…..

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ABSTRACT

Antenna is a device which radiates or receives electromagnetic wave. The antenna is the transition between a guiding device and free space. There are many types of antenna and nowaday, microstrip antenna has higher demand between users. The advantages of microstrip antennas have made them a perfect candidate for use in the wireless local area network (WLAN) applications. Though bound by certain disadvantages, microstrip patch antennas can be tailored so they can be used in the new high-speed broadband WLAN systems. This project concentrates on manufacture of broadband microstrip patch antenna with parasitic elements for the 2.4 GHz frequency band and possible implementation using additional of parasitic elements in research scenarios. This thesis represents the design process that cover calculation and analysis part, simulation by using Computer Simulation Technology software and development of microstrip antenna with parasitic elements. All the result and data are state clearly in this thesis.

ABSTRAK

Antena ialah suatu alat yang meradiasikan gelombang elektromagnetik. Antena berfungsi sebagai pengantaraan diantara alat pemancar dan penerima serta ruang udara bebas. Terdapat pelbagai jenis antena di pasaran tetapi antena jenis jalur mikro mendapat permintaan menggalakkan daripada pihak pengguna. Kelebihan yang terdapat pada antena jalur mikro menjadikannya sebagai calon yang sesuai untuk digunakan dalam aplikasi sistem jalur bebas tempatan (WLAN). Walaupun terdapat kelemahan tersendiri, namun antena mikro jalur mampu digunakan untuk sistem jalur lebar berkelajuan tinggi. Projek ini memfokuskan kepada pembangunan antena jalur mikro yang mempunyai elemen parasit untuk kegunaan jalur bebas dalam julat operasi frekuensi sebanyak 2.4GHz dan diadaptasikan dalam arena pengakajian antena. Tesis ini turut memaparkan proses pembinaan yang meliputi cara kerja dan bahagian analisis, simulasi menggunakan CST serta pembangunan untuk membuat antena jalur mikro yang mempunya elemen parasit. Semua keputusan dan data yang diperoleh dipaparkan secara jelas di dalam tesis ini.

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ε_r	-	Dielectric Constant
ADS	-	Advance Design system
BW	-	Bandwidth
CST	-	Computer Software Technology
dB	-	Decibel
FNBW	-	First Null Beam Width
g2	-	Height of the Ground
GPS	-	Global Positional System
h	-	Thickness of Substrate
HPBW	-	Half Power Beam Width
IEEE	-	Institute of Electrical and Electronics Engineers
RF	-	Radio Frequency
tan δ	-	Tangent Loss
VNA	-	Vector Network Analyzer
VSWR	-	Voltage Standing Wave Ratio
WLAN	-	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

This chapters covers the introduction of the project, background study regarding the project topic, project objective, the problem statement involves, the scope of work and the methodology of this project

1.1 Project Background

An antenna or aerial is a transducer designed to transmit or receive electromagnetic waves. In other words, antenna converts electromagnetic waves into electrical currents or vice versa [1]. Besides, antenna is the transitional structure between free-space and a guiding device. Antenna which can work in more than one frequency region either for transmitting or receiving electromagnetic (EM) waves are termed as Multiband Antenna. The purpose of this project is to design antenna with a multiple frequency range, impedance bandwidth, gain, structure and layout. The scopes of work in this project are literature review, calculation, simulation, fabrication and measurement. All simulation is done using Computer Simulation Technology (CST) software. FR4 board is used for fabricate, measure and test the antenna.

1.2 Project Objective

The objective of this project is to design a microstrip antenna with parasitic elements which can operate at frequency of 2.4 GHz and suitable gain.

1.3 Problem Statement

Microstrip antenna has a narrow bandwidth. Using only single antenna in the multi signal band is better than using the each antenna element in the separate way. Microstrip patch antennas are widely used because of there are many merits such as the low profile, light weight, low cast and planar also.

Microstrip antenna also has spurious feed radiation, poor polarization purity, limited power capacity, and tolerance problems.

However patch antenna have a disadvantage of narrow bandwidth typically 1-5 % impedance bandwidth, 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.

1.3 Scope of Work

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 single patch and parasitic elements that operate at 2.4 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.

1.4 Outlines of Thesis

The outlines of the thesis begin with Chapter 1 where this chapter provides the introduction to the project, objective and scope of work. Chapter 2 covers the literature review on the slot antenna, the antenna properties, and the feeding methods. Chapter 3 covers the methodology of the project and the design guideline. Chapter 4 consists of the slot planar antenna design, simulation and measurement. Finally, Chapter 5 provides the conclusion and recommendation to the project.

CHAPTER 2

LITERATURE REVIEW

This chapter is discusses precisely about the information and theory relates to this project also the overview of major component involved. Factors that should be consider while developing this project also will be covered.

2.1 Project Flow

Following the project flow from the chapter 1, this project is start with studying the literature review about parameters of antenna such as matched impedance, VSWR, gain, frequency, bandwidth, return loss, amplitude of radiation pattern and polarization. These parameters determine the performance of the antenna designed.

Then the structure and dimension of the design is calculated to get the actual value in design part. For this project, there is a method that call parametric study or parametric sweep to get the value of the dimension.

After understand all the basic and the objective of this project, the layout can be design using the Computer Simulation Technology (CST) Software. The understanding how to use the software is important before doing the implementation.

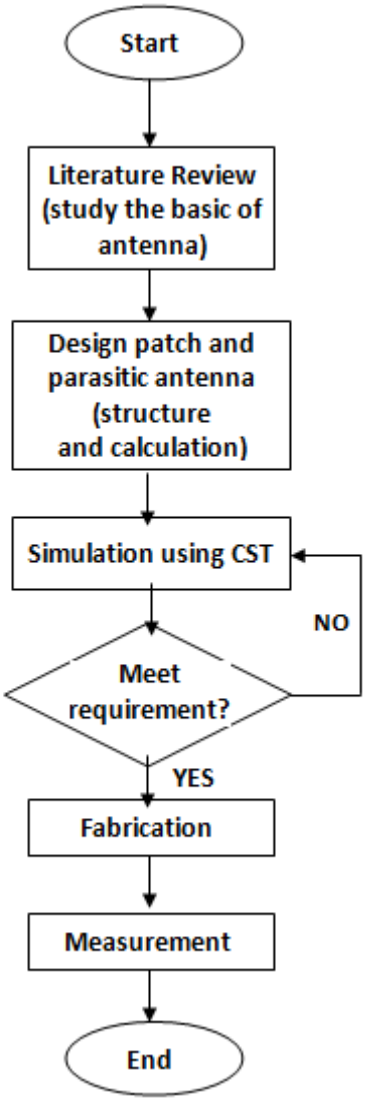

Figure 2.1 : flow chart of methodology

It is followed by simulation running by Computer Simulation Technology (CST) Software to simulate the results of radiation pattern, return loss, directivity, gain, HPBW and FNBW.

After design and simulate all antenna‘s designed, the best topologies must be choose according the simulation result to become a prototype. When the best topology has been choose, the design can be fabricate using all the equipments that involve in fabrication process.

The process of fabrication will take place where the actual dimension of the antenna is fabricated on the FR4 microstrip board. Etching process is done to perform the fabrication on the FR4 microstrip board.

The process of antenna measurement is where the experiment determines all the parameters above. Comparison and analysis of the fabricated and simulated design is made in order to verify the performance. The parameters of the antenna such as S-parameter, bandwidth and frequency can be tested by using network analyzer.

2.2 Introduction of Antenna

An antenna or aerial is a transducer designed to transmit or receive electromagnetic waves. In other words, antennas convert electromagnetic radiation into electrical current, or vice versa. Antennas generally deal in the transmission and reception of radio waves, and are a necessary part of all radio equipment. Antennas are used in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, cell phones, radar, and spacecraft communication. Antennas are most commonly employed in air or outer space, but can also be operated under water or even through soil and rock at certain frequencies for short distances [1].

2.3 Antenna Parameters

2.3.1 Radiation Patterns

An antenna radiation pattern or antenna pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. In most cases, the radiation pattern is determined in the far-field region and is represented as a function of the directional coordinates. Radiation properties include power flux density, radiation intensity, field strength, directivity phase or polarization.

In most cases, radiation pattern can be said as representation of the radiation properties of the antenna as a function of angular position. In term of angular position, there is power pattern which is the trace of angular variation of the received or radiated power at the constant radius from antenna. Amplitude field pattern is the trace of a spatial variation of the magnitude of magnetic field at a constant radius from the antenna. Often the field and power pattern are normalized with respect to their maximum value, yielding normalized field and power patterns.

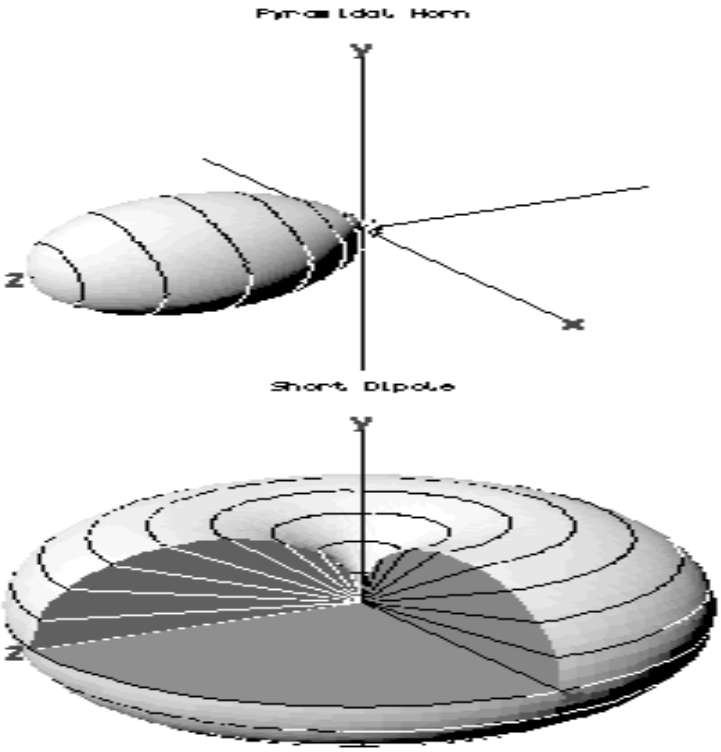

Figure 2.2: Radiation Pattern

Generally the radiation patterns can be plotted in terms of field strength, power density, or decibels. They can be absolute or relative to some reference level, with the peak of the beam often chosen as the reference. Radiation patterns can be displayed in rectangular or polar format as functions of the spherical coordinates θ and $\emptyset$.