CIRCULAR MICROSTRIP ANTENNA

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Tajuk Projek : Circular Microstrip Antenna

Sesi Pengajian : | | | | | |

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To my beloved mom and dad

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ABSTRACT

The real aim for this project is to design circular microstrip antenna for WLAN application using analysis method of cavity model. The design of this antenna is made by using CST Design Microwave 2010. The feeding method used for this project is coaxial probe feed. The antenna consists of three layers which are the ground, substrates and patch. The Ground and the patch are made using copper while the substrate is using FR4.The problem about typical microstrip antenna is that it has linear polarization and low bandwidth especially for antenna that use coaxial probe feeding method. In order to get a great performance from antenna, the antenna is designed to produce circular polarization using the slot method. A slot is made at the patch to make two orthogonal modes excited with 90º phase differences between them. To improve the bandwidth of antenna, the slot is also embedded at the ground of the antenna. Here a small circular microstrip antenna is successfully design with circular polarization and good bandwidth. As for the future, this project hopes to bring advantage in telecommunication technology as it comes with a small size, good polarization and bandwidth.

ABSTRAK

Tujuan utama projek ini adalah untuk membuat rekaan mikrostrip antena berbentuk bulat bagi pengunaan WLAN. Rekaan antena dihasilkan menggunakan perisian CST Design Microwave 2010. Rekaan in menggunakan kaedah coaxial probe feed untuk menyambung antena ke sumber tenaga. Antena ini mempunyai tiga lapisan iaitu lapisan bawah, lapisan substrat dan lapisan patch. Lapisan bawah dan patch dibuat mengguna kuprum manakala bahagian substrat diperbuat daripada FR4. Masalah biasa yang terdapat pada mikrostrip antenna ialah ianya mempunyai polarisasi mendatar dan nilai bandwidth yang rendah bagi antena yang menggunakan coaxial feed. Untuk menghasilkan antena yang berprestasi lebih baik, antena ini direka khas untuk menghasilkan polarisasi membulat menggunakan kaedah slot. Satu slot dibuat di patch untuk menmbuatkan dua ortogonal mod mempunyai 90° perbezaan fasa di antara satu sama lain. Untuk meningkatkan bandwidth antena pula, satu lagi slot dibuat pada lapisan paling bawah antena. Melalui projek ini sebuah mikrostrip berbentuk bulat yang mempunyai polarisasi membulat dan bandwidth yang baik telah berjaya dihasilkan. Adalah diharapkan project ini akan menyumbang kebaikan di dalam bidang telekomunikasi kerana antena ini mempunyai saiz yang kecil serta mempunyai polarisasi dan bandwidth yang baik.

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CHAPTER I

INTRODUCTION

1.1 Project Background

Microstrip antenna is an ideal antenna that is suitable for use in an application of WLAN and telecommunication due to the simple characteristic of the antenna which is easy to fabricate, easy to feed, smaller size, light weight, low cost and designer flexibility.

The aim of this project is to design a circular microstrip antenna for WLAN. Circular patch antenna is one of the popular patch antennas that receive a lot of attention not only as a single element but also in array. In circular microstrip antenna, there is only one degree of freedom to control which is the radius of patch. Coaxial probe feed is chosen due to its ease of fabrication and easily matching by putting the feed at proper location.

However, the disadvantages of the microstrip antenna are the narrow bandwidth especially the antenna that is fed by coaxial connector and linear polarization for basic microstrip antenna. To overcome this problem, the antenna is designed to obtain wider bandwidth and good polarization.

In this project, embedded a slot at the patch and at the ground of antenna method is chosen due to its better performance in bandwidth improvement and the same time able to obtain the circular polarization.

1.2 Project Objective

The objectives of this project are to:

1. Design, simulate, and fabricate a circular microstrip antenna
2. Investigate and analyze the performance of the circular microstrip antenna.
3. Improve the performance of circular microstrip antenna.

1.3 Problem Statement

These days, there is a very large demand for wireless applications, high-performance aircraft, spacecraft, satellite, and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints [1]. Antennas which are used in these applications should be low profile, light weight, low volume, and conformable to planar and non-planar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology [1]. To meet all the demand for all this aspect, this problem can be solve by using microstrip antenna. But microstrip antenna also has a few disadvantages which are low bandwidth and linear polarization for basic antenna. This project is made to overcame the problem by design a circular microstrip antenna with circular polarization and improved bandwidth by apply a slight modification to the antenna which is using the slot method.

1.4 Scope of Work

1. Make a research about circular microstrip antenna and how to design it.
2. Simulate antenna using the CST software.
3. Improve the microstrip antenna performance by the circular polarization and bandwidth improvement.
4. Fabricate the microstrip antenna using FR4, with dielectric constant (ε_r) 4.4 and height of 1.6 mm.
5. Measure the microstrip antenna using the network analyzer and the measured values are compared with the simulated values.

1.5 Methodology

The methodology of this project is consists of four steps which are:

1. Calculation and design
   - Calculation and design are made based on literature review.
2. Simulation
   - CST software is used to design and simulate the antenna.
3. Fabrication
   - Using FR4 printed circuit board (PCB).
4. Measurement
   - Fabricated antenna is measured and the result is compared with simulation value.

1.6 Thesis Organization

Chapter I:

This chapter introduces and explains the project background, project objective, problem statement, scope of work and methodology.

Chapter II:

This chapter explains on the literature review which covers previous research that can be related to this project. From this literature review, the solution and best method can be chose to test and overcome the problem in this project. Here, hypothesis can be made regarding the best solution method to be used.

Chapter III:

In this chapter, methodology of the project is discussed. The flow chart of the methodology is shown to explain the step of methodology used. Several methods are discussed. The advantage and disadvantage of each method will be taken into consideration for choosing the best method to design and improve the performance of design. Here the project design is separated into two parts which are simulation and measurement.

Chapter IV:

This chapter discusses the performance result of the design. The result will be explained and compared with the past research. The simulation, theoretical and measured values will also be compared and discussed.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Microstrip antenna idea can be tracing at 1953 by Deschamps, and a patent at 1955 by Gutton and Baissinot. Microstrip antenna start receive attention during 1970s where the development of the microstrip-antenna concept started by many research publications. At that time, the most popular two books are published by Bahl and Bhartia and by James, Hall and Wood which remain as referent in current use today. Today, microstrip antenna is an established type of antenna that confidently used by designers worldwide, particularly when low-profile radiators are demanded [2].

At the time of its inception, microstrip antennas were associated with many disadvantages, such as low efficiency, lower power, high Q, poor polarization purity, poor scan capability, and very narrow bandwidth. With the evolution of design technology, planar microstrip antennas have achieved higher bandwidth, mechanical robustness and versatility with respect to resonant frequency, improved polarization Pattern and wider impedance bandwidth [1].

In wireless application, microstrip antenna have been widely used and researched due to their attractive characteristic such as low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to manufacture, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs and very versatile in terms of resonant frequency, polarization, pattern, and impedance. The quest now is for more and more innovative designs coupled with reliable manufacturing methods. The driving force in antenna engineering is request for the lower-cost, less-weight, lower profile antennas for modern system requirements [2].

2.2 Microstrip Antennas

Microstrip antennas are similar to parallel plate capacitors. Both have parallel plates of metal layer and a sandwiched dielectric substrate among them. In microstrip antenna, one of these metal plates are infinitely extended than the other, to form the ground plane; whereas the smaller metal plate is described as radiating patch. Size of the patch is proportional to frequency of the propagating signal. The smaller the antenna, the higher frequency it propagates. This contributes to the basic shortcoming of the microstrip antennas related with its narrow bandwidth. Several shapes of microstrip patches, is shown in figure 2.1, which may be rectangular, circular, triangular, semicircular, sectoral and annular etc, are successfully used as radiating antenna elements employed in various communication and control devices. [1]

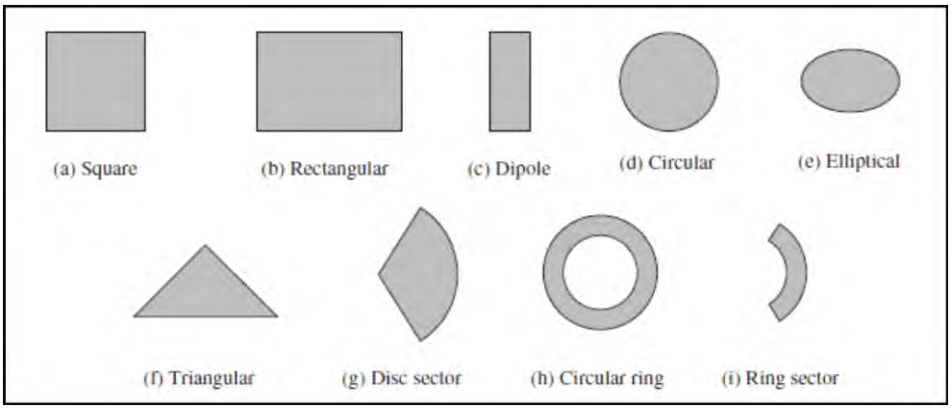

Figure 2.1 Basic Shapes of Microstrip Antennas [1]

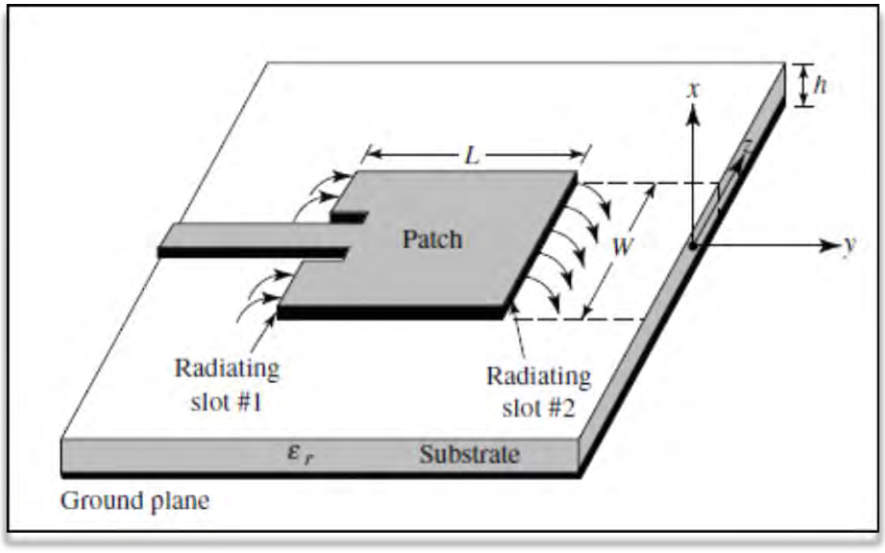

Figure 2.2 Microstrips Rectangular Patch Antenna [1]

Figure 2.2 shows the most basic type of rectangular microstrip patch antenna. After the patch is excited by a feed line, the charge is distributed on underside of patch and the ground plane. During at the particular instant time, attractive forces between underside of the patch and the ground plane hold a large amount of charge. Repulsive forces push the charges to the edge of the patch and creating a large density of charge at the edges and here the fringing field happens. Radiation can occur from fringing fields between the periphery of the patch and the ground plane [1].

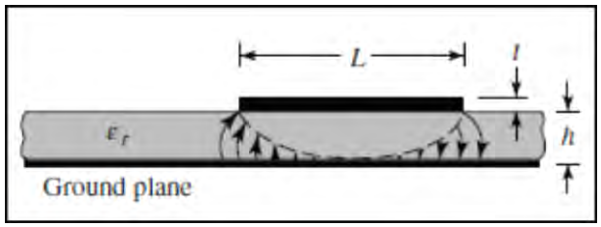

Figure 2.3 Electric Field Distribution (side view) [1]

Figure 2.3 shows the electric field excited by the patch when assuming no variations of the electric field along the width (W) and the thickness (t) of the microstrip structure.

2.3 Advantages of Microstrip Antennas

Microstrip antenna has a few advantages compare to other type of antenna which is [4]:

i. They are light in weight and low profile.
ii. Their ease of mass production using printed circuit technology leads to a low fabrication cost.
iii. They are easier to integrate with other microstrip circuit.
iv. They support both linear polarization and circular polarization.
v. Dual frequency and dual polarization operation antenna can easily be made.
vi. Cavity backing is not required.
vii. The matching network and feeding can be fabricated with the antenna structure.