A STUDY AND DESIGNING GPS ANTENNA USING MICROSTRIP TECHNOLOGIES

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This report is submitted in partial fulfilment of requirement for the award of Bachelor of Electronic Engineering (Industrial Electronics) with honours.

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Dedicated to my beloved mother, father, families, supervisor, lecturers, technicians and fellow friends.

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ABSTRACT

This project proposed to study the antenna in GPS (Global Positioning System), designing the antenna and fabricate it. The GPS is a system that is able to determine the location of object and human on the earth. GPS has become a vital global utility, indispensable for modern navigation on land, sea, and air around the world, as well as an important tool for map-making, and land surveying. GPS also provides an extremely precise time reference, required for telecommunications and some scientific research, including the study of earthquakes. The frequency that use for GPS is 1575.42 Mhz. The main objective of this project is to design and fabricate a cheap GPS antenna. The best way to fabricate a cheap antenna is by using the microstrip antenna technology. The microstrip antennas are manufactured using printed-circuit technology, so that mass production can be achieved at a low cost. Microstrip antennas have several advantages, including that they are lightweight and small-volume and they can be conformal to the host-surface. Microstrip technology which are used for defense and commercial application, are replacing many conversional antennas. However, the types of applications of microstrip antennas are restricted by antennas inherently narrow bandwidth.

ABSTRAK

Tujuan projek ini adalah untuk mendapat maklumat dan mengkaji antena yang digunakan di dalam sistem GPS '*Global Positioning System*', serta mereka bentuk dan membina antena tersebut. GPS adalah sistem yang mampu menentukan kedudukan sesuatu objek ataupun manusia di atas bumi ini. GPS menjadi perkhidmatan global yang penting untuk navigasi moden yang di gunakan di darat, laut dan udara di seluruh dunia, serta penting di dalam sistem pemetaan dan peninjauan tanah. Sistem ini juga menyediakan rujukan waktu yang tepat, yang diperlukan oleh sesetengah kajian termasuk kajian gempa bumi. Frekuensi yang digunakan untuk sistem ini adalah 1575.42 Mhz. Objektif utama projek ini adalah untuk mereka bentuk dan membina antena GPS yang murah. Penyelesaian terbaik untuk membina antena yang murah adalah dengan mereka bentuk antena yang menggunakan antena microstrip. Antena microstrip dihasilkan menggunakan teknologi 'printed-circuit', maka pengeluarannya dapat dilakukan dengan kos yang rendah. Antenna microstrip mempunyai banyak kelebihan termasuk ringan dan kecil dimana boleh diletakkan dan disesuaikan dengan perumah. Antena microstrip yang digunakan untuk pertahanan dan kegunaan komersial sedang menggantikan kebanyakkan antenna biasa. Bagaimanapun, jenis-jenis aplikasi antena microstrip adalah terbatas kerana sifatnya yang mempunyai jalur lebar yang sempit.

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GPS	-	GLOBAL POSITIONING SYSTEM
GSM	-	GLOBAL FOR MOBILE COMMUNICATION
MSA	-	MICROSTRIP ANTENNA
MIC	-	MICROWAVE INTEGREATED CIRCUIT
RMSA	-	RECTANGULAR MICROSTRIP ANTENNA
BW	-	BANDWIDTH
VSWR	-	VOLTAGE STANDING RATIO
HPBW	-	HALF WAVE BEAM WIDTH
FNBW	-	FIRST NULL BANDWIDTH

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CHAPTER I

INTRODUCTION

1.1 Project Introduction

This project covers on the designing and fabricates a GPS rectangular patch antenna with the frequency of 1.575 GHz using Microstrip Antennas Technology. The reason for using Microstrip Antenna Technology is because there are a lot of advantages, such as low cost antenna and others. The importance from this study is to increase the bandwidth of the microstrip antenna.

1.2 Objectives

The objective of this project is the antenna that will be built is able to pick and discriminate very weak signals. The frequency that used in this project is classified in weak signals that are about 1 GHz to 3 GHz.

The antenna also must operate at just L1 frequency, or both the L1 and L2 frequencies. For this project, the design of the antenna used L1 frequency 1.575 GHz. As the signals are circularly polarized, the GPS antenna must also be circularly polarized.

Besides that, the objective of this antenna is to design and fabricate a low cost GPS antenna using the Microstrip Antenna Technologies.

1.3 Problem Statements

The problems in GPS and Microstrip Antenna Technology are:

i) **The frequency used in this system**

In the GPS, there are about 5 bands of frequency that must be studied and for the fabricated of the antenna, these frequencies must be considered. The suitable frequency for public used is been selected.

ii) **The narrow bandwidth of the microstrip antenna**

The characteristics of microstrip antenna that got narrow bandwidth are the major limiting factors for the widespread application of these antennas. The bandwidth can be increased by using a thick substrate with low dielectric constant, planar gap-coupled and directly coupled multiresonator.

ii) **Shapes of microstrip antenna**

There are several shapes of the antenna in microstrip antenna. Among the shaped are square, circular, triangular, semicircular, sectoral and annular ring. The selection of the shaped is decided by considering the frequency and parameters.

1.4 Scope of Works

The scopes for this project are to understand the system of GPS and the antenna in the system. Before designing and fabricated the GPS antenna the specification in the system must be known first.

Then the characteristic of microstrip antenna must be understood. The characteristic of the microstrip antenna can be learning through research and also experiment.

The engineering tools use for this project, Microwave Office is learned. The designing of the antenna will be using this software. After designing the antenna, the fabricated antenna will used the exact dimension from design process.

1.5 Thesis Outline

This report is divided into five chapters. The following is the outline of this project, A Study and Designing of GPS Antenna chapter by chapter. Each part will cover on a topic required.

As for chapter 1, it will cover on introduction of the project. A little bit of explanation will be done due to the project. It also includes the objective and the problem statement of the project.

Chapter 2 is a chapter which covers on the literature review of the project. Each of the literature review is divided into a certain sub topic or explanation. The literature review begins with the introduction, followed by GPS antenna, microstrip antenna, rectangular patch, microstrip technologies and software use in antenna development.

Introduction is an explanation on the overview of the literature review. As for the antenna topic, it is about the general description of an antenna. It is also covered on the GPS and the basic principal of the antenna. Microstrip antenna is an

explanation regarding the microstrip antenna where it is slightly different from the general explanation of the general antenna.

The next explanation is on microstrip antenna, followed by the rectangular patch antenna itself. This topic is more specific where it is only explain on the microstrip antenna. It is also shows on designing an antenna. The design is focus on rectangular patch antenna. Besides, it also covers on the characteristics of antenna, the specifications and more.

Next, chapter 3 will be cover on project methodology where it is focusing on the method that used to completing the project accordingly. The methodology are presented in the flowchart. In addition, it is representing in details in the form of sentences.

As for the chapter 4, the preliminary result of the project will be discussed. The progress of the project is assigned into two parts which is the complete tasks and project in progress. The complete progress will be including the calculation regarding the patch antenna and the transmission line and the actual result. The project in progress is informing on the simulation for the design. This part also will discuss the comparison of the simulation result with the actual result.

The last chapter is chapter 5, where it is the conclusion part for the project. In this chapter, the analysis of the project accomplished and recommendation for next study after this project was made. The recommendation to improve the project and the contribution of the project to the university, faculty and the students itself also in this part.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The literature review will start with the introduction of the GPS. The GPS (Global Positioning System) is a system that is able to determine the location of object and human itself on the earth. In this system, a constellation of more than two dozen GPS satellites broadcasts precise timing signals by radio to GPS receivers, allowing them to accurately determine their location (longitude, latitude, and altitude) in any weather, day or night, anywhere on earth [1].

GPS has become a vital global utility, indispensable for modern navigation on land, sea, and air around the world, as well as an important tool for map-making, and land surveying. GPS also provides an extremely precise time reference, required for telecommunications and some scientific research, including the study of earthquakes. The frequency that use for GPS is divided into 5 bands as shown in table 2.1 below [2].

Table 2.1: The frequencies make up the GPS electromagnetic spectrum

Frequency	Description
L1(1575.42 MHz)	Carries a publicly usable coarse-acquisition (C/A) code as well as an encrypted precision P(Y) code.
L2 (1227.60 MHz)	Usually carries only the P(Y) code, but will also carry a second C/A code on the Block III-R satellites
L3 (1381.05 MHz):	Carries the signal for the GPS constellation's alternative role of detecting missile/rocket launches (supplementing Defense Support Program satellites), nuclear detonations, and other high-energy infrared events.
L4 (1841.40 MHz)	Being studied for additional ionospheres correction.
L5 (1176.45 MHz)	Proposed for use as a civilian safety-of-life (SoL) signal.

For this project, the frequency used for designing the GPS antenna is from the L1 band 1575.42 MHz. This frequency is used because the designing for this antenna is for the public user. Next, the introduction of the antenna will be explained.

2.2 Antenna

Antenna is a device, which is used for sending and receiving the electric wave for the communication. It is usually called an aerial. The antenna is a device which builds in the air of effectively radiating electric wave for the purpose of wireless communication. It is also effectively maintaining the electromotive force by the electric wave [3].

The transmission line in the wireless communication is not a wiring transmission line, but free space. It is the antenna that transmits and receives the signal in such free space as the terminal. The electric signal is transmitted as the flow of charges through a conductor. It wills causes the charges cannot pass through a nonconductor such as free space. However, the electromagnetic wave cannot pass through a conductor and proceeds by forming the magnetic fields on a nonconductor [3].

Antenna is a device that will convert the electric signals, which can be expressed in terms of voltage and current. While for the electromagnetic wave, it can be expressed as electric field and magnetic fields. It is represented by the figure 2.1. By interconnecting the electric signal on a conducting line of the antenna and the electromagnetic field change outside the electric or electronic device can detect the electromagnetic signal in the air and vise versa [3].

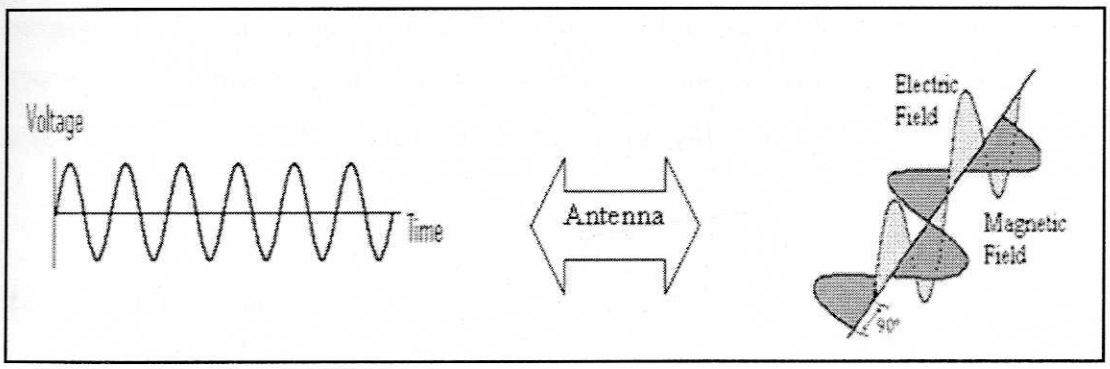

Figure 2.1: The wave radiated from antenna

2.2.1 Basic Antenna Operation

As for the basic operation of an antenna, it is apparent that the size of an antenna is inversely proportional to frequency. A relatively small antenna can efficiently radiate high frequency electromagnetic waves. As for the low frequency waves, it require relatively large antennas. Each of an antenna has directional characteristics and radiates more energy in certain directions relative to other