ANALYSIS AND DESIGN OF HIGH GAIN AND LESS LOSS FOR MULTIBAND MICROSTRIP ANTENNA USING DEFECTED GROUND STRUCTURE (DGS)

NUR NABILA BINTI PILI

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Special dedication my lovely mother, Fauziah Binti Tetel, my father, Pili Bin Poying and my family.

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ABSTRACT

In this thesis, a few design of a high gain and less loss of multiband microstrip antenna using defected ground structure (DGS) are proposed. Total of three shape of DGS with number unit of 2, 4 and 6 DGS are proposed and only one best shape and number of unit DGS is selected to proceed with the next process which is the fabrication process. The measurement result show that the antennas have operating frequencies of 4.65 GHz, 6.871 GHz and 9.723GHz with return loss S11<-10dB. The gain of the proposed antenna also in range of 1dB – 6dB. Comparison of return loss and gain between simulation and fabricated antenna also be done in this project paper.

ABSTRAK

Dalam tesis ini, beberapa reka bentuk antena yang mmpunyai gandaan simulasi tinggi dan kehilangan balikan yang kurang dengan menggunakan teknik kerosakan struktur belakang telah dicadangkan. Sebanyak tiga bentuk kerosakan struktur belakang dengan jumlah unit 2, 4 dan 6 kerosakan struktur belakang dicadangkan dan hanya satu bentuk dan unit kerosakan struktur belakang terbaik dipilih untuk meneruskan proses berikutnya iaitu proses fabrikasi. Hasil pengukuran menunjukkan bahawa antena telah beroperasi di frekuensi 4.65 GHz, 6,871 GHz dan 9.723GHz dengan kehilangan balikan S11 <-10dB. Gandaan antena yang dicadangkan juga dalam lingkungan 1dB - 6dB. Perbandingan kehilangan balikan dan gandaan antara simulasi antena dan fabrikasi antena juga dilakukan dalam kertas projek ini.

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CHAPTER 1

INTRODUCTION

This chapter will discuss briefly about the background the problem statement, objectives and scope of the project that have been chosen.

Multiband antenna is an antenna designed to operate on several bands. A multiband antenna may have lower than average gain or may be physically larger in compensation.

DGS is realized by introducing a shape defected on a ground plane which disturbs the current distribution of the antenna [7]. The disturbance at the shielded current distribution will influence the input impedance and the current flow of the antenna. Shapes and number of DGS also affect the performance of the antenna.

The gain of an antenna is defined as the ratio of the power intensity radiated by the antenna in a given direction. Gain requirements may vary according to different applications of mobile communication. This report will present about the design of a high gain and less return loss antenna with multiband operation frequencies.

1.1 Project Background

This project proposed to analysis and design of high gain and less loss for multiband microstrip antenna using defected ground structures (DGS). Recently there has been much interest in microstrip patch antenna because of its simplicity and compatibility. Because of their advantages in simplicity and compatibility with printed circuit technology, microstrip antennas are widely used in the wireless telecommunication systems [2]. These types of antennas are attractive in antenna applications for many reasons such as they are easy and cheap to manufactured and also light in weight.

While using microstrip patch antenna the other problems which will occurs are high loss and surface wave in substrate layer, as the losses will always occurs in radiation as the antenna is transmitting the signals. Due to surface wave radiation excitation losses occur that will cause decrease in the antenna efficiency, gain and bandwidth because the surface wave occurs, it extract total available power for radiation to space wave [3].

1.2 Problem Statement

Microstrip patch antenna has been studied extensively over the past years because of its low profile, light weight, low cost and easy fabrication. Based on literature review studies, it is found that there is still a need for antenna to be improved in term of gain and return loss. One of the solutions proposed to improve these two parameters is to design an antenna by using Defected Ground Structure (DGS). With implement of DGS, it can increase the gain of the antenna and also reduce the return loss.

1.3 Objectives

The objectives of the project are:

1. To study the effect of different number and shapes of DGS toward improvement of gain and return loss in antenna
2. To design an antenna with implement of DGS at three operating frequency range from 3GHz to 10GHz
3. To fabricate the proposed antenna and conduct the experiment test on it.

1.4 Project Scopes

This project is about high gain and less loss antenna. The antenna design operates at three operating frequency between 3GHz to 10GHz. The proposed antenna should be simpler in design but the circuit must be able to receive high gain and has less return loss. The least cost also took into consideration since FR-4 substrate is used. The result of high gain antenna through simulation will be compared with the experiment result. Even though the experiment only focusing on the improvement of high gain and less loss, the other parameters such as bandwidth, radiation pattern, efficiency and directivity will be analyse using CST Microwave Studio.

1.5 Brief Explanation on Methodology

The suitable software is the first thing needed consideration in order to design the antenna. CST Studio Suite Software is the most common and user-friendly software to design antenna. The software enables users to design the desired antenna in 3D version that will give a clearer vision about the sooner fabricated antenna. By using this CST software, the users are able to do the simulation after designing the antenna. The simulation result will measure and display the various parameters such as gain, return loss, directivity bandwidth and so on. After getting the desired simulation result, the next step which is fabrication step will be proceed. In the fabrication step, the designed antenna will be fabricated on the FR4 substrate. After finish the fabrication step, then the test will be held upon the antenna by using the facilities and equipment provided in the lab at Universiti Teknikal Malaysia Melaka.

1.6 Methodology

This project will begin by determine the objectives of the project. Next is finding information on the antenna design by doing literature review. Next, the project will be continued by designing an antenna with DGS that operates in multiband by using CST Software. Then the simulation will be carried out to find out the desired value on gain and return loss. After achieve all desired parameter, process of fabrication the antenna will be done. Experiment test will be conduct and if the results differ from simulation, process of software will be repeated. Finally both experimental and simulation result will be compared and included in the final report.

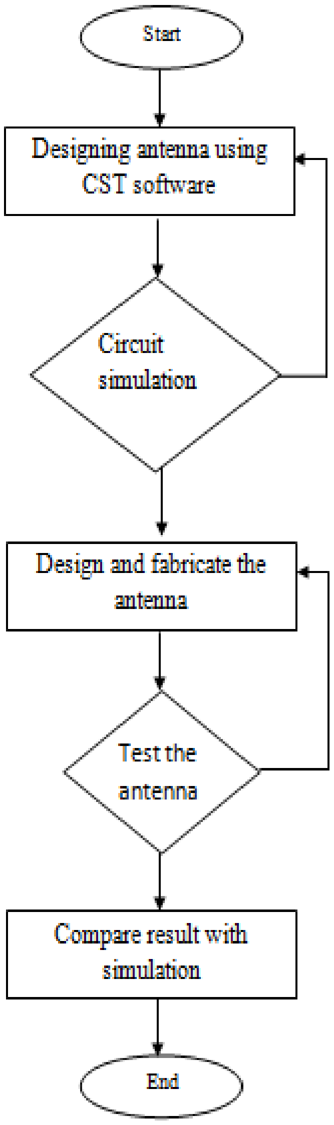

Figure 1.1: Flow chart of the project

1.7 Thesis Plan

This thesis will be divided into five chapters.

Chapter 1- This chapter will briefly explained about the introduction and the background of the project. Some information about the type of antenna used is also mentioned. This chapter also includes the problem statement, objectives and project scope and brief explanation on methodology.

Chapter 2- This chapter is about the literature review about this project will be reviewed. It includes the explanations of the past work research related to this project. The past research will be based on the high gain and less loss multiband antenna.

Chapter 3- This chapter is about methodology. It will explain in details the methods and procedures as the guideline to complete and run the project perfectly from the beginning till the end.

Chapter 4- This chapter will present all the tabulation data and results. The discussion about this project will be included in this chapter instead.

Chapter 5- This chapter will be presenting the overall conclusion of this project. Apart from that, the recommendation for the future work will be clarified.

CHAPTER 2

LITERATURE REVIEW

This chapter will explained on the fundamental concept and theory of multiband antenna with DGS base on past work research. The information gathered in this literature review chapter can be a guideline in designing and simulating the proposed antenna in the correct way so it may work perfectly according to plan. Most of the past study discussed about almost the same good features of multiband antenna that will achieve in a way desired.

2.1 Introduction

A microstrip patch antenna is a narrowband wide beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which form a ground plane [4]. The conducting patch can take any shape but rectangular and circular shapes are commonly used.

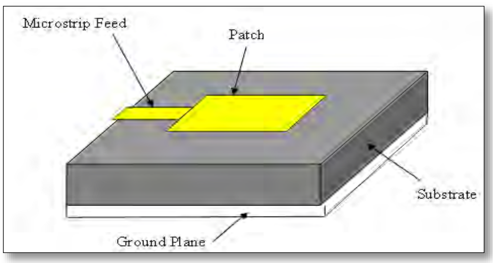

Figure 2.1: Basic structure of a microstrip patch antenna

2.2 Basic Operation of Microstrip Antenna

The figure below shows a patch antenna in its basic form which consist a flat over a ground plane. The center conductor of a coax serves as the feed probe to couple electromagnetic energy in and/or out of out of the patch. The electric field distribution of a rectangular patch excited in its fundamental mode is also indicated [5].

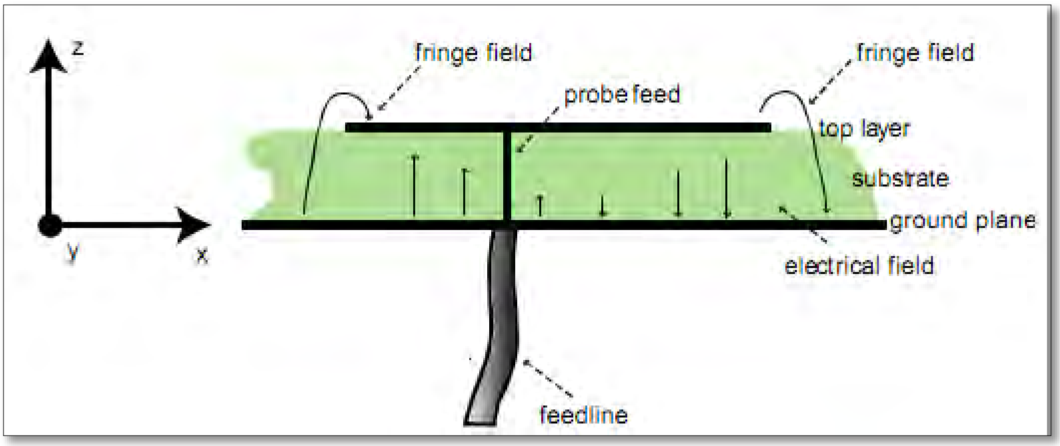

Figure 2.2: A side view of microstrip patch antenna

The electric field is zero at the center of the patch, maximum at one side, and minimum on the opposite side. It should be mentioned that the minimum and maximum continuously change side according to the instantaneous a cavity. Rather, the fields extend the outer periphery to some degree. These field extensions are known as fringing fields and cause the patch to radiate. Some popular analytic modeling techniques for patch antennas are based on this leaky-cavity concept. Therefore, the fundamental mode of rectangular patches often denoted using cavity theory as the TM10 mode.

TM stands for transversal magnetic field distribution. This means that only three field components are considered instead of six. The field components of interest include the electric field in the z direction and the magnetic field components in x and y direction using a Cartesian coordinate system, where the x and y axes is parallel with the ground plane and the z axis is perpendicular.