

**DESIGN ULTRA WIDEBAND ANTENNA WITH
DEFECTED GROUND STRUCTURE**

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**DESIGN ULTRA WIDEBAND ANTENNA WITH DEFECTED
GROUND STRUCTURE**

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**This report is submitted in partial fulfillment of the requirements
for the degree of Bachelor of Electronic Engineering with Honours**

**Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka**

2019

**BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II**

Tajuk Projek : Design ultra-wide band antenna with defected ground structure
Sesi Pengajian : 2018/2019

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DEDICATION

This project is dedicated to my parents, family and friends.

ABSTRACT

Ultra-Wide Band (UWB) technology is rapidly developing area in the field of Wireless Communication. There are many challenges in this field, one of the challenges is to design an antenna which covers the entire UWB frequency range. The objective of this thesis is to design UWB antennas that operates in the frequency range from 4.0 GHz to 12.0 GHz. The proposed antenna is simulated using CST Microwave Studio Software. The antenna has been fabricated by using etching process and FR-4 as substrate. For measurement results, the Vector Network Analyzer (Agilent) is used to determine the S-Parameter, meanwhile for radiation pattern was measured in anechoic chamber. This thesis covers study of basics and fundamentals of microstrip patch antenna, in this paper rectangular microstrip patch antenna with defected ground structure (DGS) which is Y-shaped for ultra-wide band (UWB) application is presented. A comparative parametric analysis has been made based on return loss, gain, radiation pattern characteristics and impedance bandwidth. Simulation results and measurement results are analyzed and confirm the validity of the proposed antenna.

ABSTRAK

Teknologi dalam bidang komunikasi tanpa wayar telah berkembang dengan pesat termasuklah teknologi jalur lebar ultra (UWB). Terdapat pelbagai cabaran didalam bidang ini, salah satu cabarannya adalah untuk mereka sebuah bentuk antenna yang meliputi keseluruhan julat frekuensi UWB itu sendiri. Objektif tesis ini ialah untuk mereka sebuah bentuk antenna UWB yang beroperasi dalam julat frekuensi 4.0 GHz sehingga 12.0 GHz. Antenna telah menjalani simulasi dengan menggunakan perisian computer iaitu CST Microwave. Antena juga telah difabrikasi dengan menggunakan kaedah etsa dan menggunakan FR-4 sebagai substrat. Untuk mendapatkan keputusan ukuran S-Parameter, Vector Network Analyzer telah diperkenalkan. Manakala untuk mendapatkan bentuk radiasi ukuran telah dijalankan di dalam kebuk antigema. Tesis ini merangkumi kajian asas dan asas-asas antenna microstrip tampalan. Didalam tesis ini juga, garis antenna mikrostrip suapan dengan kaedah kerosakkan struktur tanah (DGS) diperkenalkan iaitu bentuk Y. Satu analisis perbandingan parametrik telah dibuat berdasarkan kerugian pulangan, keuntungan, ciri-ciri corak radiasi dan galangan jalur lebar. Keputusan simulasi dan kiraan dianalisis dan dipastikan kesahihan keupayaan antenna.

ACKNOWLEDGEMENTS

In the name of Allah SWT, the Most Gracious, the Ever Merciful. Praise is to Allah, Lord of the Universe. Peace and Prayers be upon His final Prophet and Messenger Muhammad SAW.

Foremost, I would like to express my sincere gratitude to my advisor Mr. Harris for the continuous support of my study and research, for his patience, motivation, enthusiasm, and immense knowledge. He consistently allowed this paper to be my own work but steered me in the right the direction whenever he thought I needed it. His guidance helped me in all the time of research and writing of this thesis.

Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents; whose love and guidance are with me in whatever I pursue. They are the ultimate role models. This accomplishment would not have been possible without them.

I also place on record, my sense of gratitude to one and all, who directly or indirectly, have lent their hand in this venture. Thank you.

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LIST OF SYMBOLS AND ABBREVIATIONS

CST	:	Computer Simulation Technology
λ	:	Wavelength
RMPA	:	Rectangular Microstrip Patch Antenna
MPA	:	Microstrip Patch Antenna
RL	:	Return Loss
L	:	Length
W	:	Width
GP	:	Ground Plane
FR-4	:	Flame Retardant 4
ϵ_r	:	Dielectric Constant
VSWR	:	Voltage Standing Wave Ratio
BW	:	Bandwidth
H	:	Substrate Thickness
DGS	:	Defected Ground Structure
<i>Fl</i>	:	Lower Frequency
<i>Fh</i>	:	Higher Frequency

<i>F_c</i>	:	Cut off Frequency
<i>F_o</i>	:	Operating Frequency
<i>F_r</i>	:	Resonating Frequency
ABW	:	Absolute Bandwidth
BW	:	Bandwidth
FCC	:	Federal Communication Commission
FBW	:	Fractional Bandwidth
PCB	:	Printed Circuit Board
VNA	:	Vector Network Analyzer

CHAPTER 1

INTRODUCTION

1.1 Project Background

Wireless technology for communication purposes offers cheaper equipment and adaptable way. In communication systems, antenna has its significance; It delivers electromagnetic energy radiation in all directions evenly. Antenna is a transducer that transforms one energy form to another. Its role electromagnetic waves are transmitted or received from one source to the destination. Microstrip antennas have a few benefits compared to other standard microwave antennas and are thus widely used in many commercial applications. Almost all microstrip patches were produced for use in wireless applications [1].

Special attention is given to Ultra-wideband (UWB) nowadays in industry also academia. This technology is being used over the previous 20 years in the fields of

sensing, radar and military communications. This system offers a great instant bandwidth and the potential for quite simple application. In addition, the broad bandwidth and great promise low-cost digital design make it possible for a single device to operate as a communication device, radar or locator in different ways. [2]. A significant rise in professional interest occurred when a judgment was issued by the Federal Communications Commission (FCC) that UWB might be used for data communication. The effectiveness of UWB systems in the joint frequency spectrum is currently being investigated by regulatory bodies worldwide.

The patch antenna usually has a spurious frequency and defected ground structure (DGS) is created on the ground plane of the transmission to overcome it.

The DGS at the ground behaves as a low pass filter to decide the frequency which can be passed through the transmission line [3].

1.2 Problem Statement

The demand has increased over the years of large capacity of data and high-speed data transmission rate [4]. The limited bandwidth for wireless communication system is a drawback for the requirement of large capacity of data rate. In addition, there is often a need for small size and compact profile antennas, broadband antennas, to cover multiple bands at once. [5]. As a high data rate wireless communication technology, UWB is progressing quickly. A slot UWB antenna is designed to have a larger bandwidth with large capacity of data and high-speed data transmission rate.

To eliminate the false frequency, it is proposed to use Defected Ground Structure (DGS) for its ability of effectively suppressing this kind of frequency That is used in

the patch antenna transmission line as it is easy to construct and fabricate [6]. CST software is used to run the simulation of the antenna.

1.3 Objectives

- I. To design and implement Ultra-Wideband (UWB) microstrip patch antenna for UWB application by using defected ground structure method.
- II. To analyze the suitable design that should be capable operating with bandwidth requirement from 4 GHz to 12 GHz with gain 3dB.

1.4 Scope of Work

Scope of this project can be divided into four parts which are:

I. Literature review

The study of ultrawide band fundamental and characteristic of antenna on the frequency bandwidth, return loss, radiation pattern and antenna gain which must be taken into consideration in antenna patch design.

II. Design and simulation

The antenna is designed and simulated at range 4 GHz to 12 GHz using CST software and optimization will be performed to get the best result.

III. Fabrication

The fabrication of the UWB antenna was done using photo-lithographic technique. The best performance parameters result antenna was chosen to fabricate on the FR4 board as substrate.

IV. Analysis and measurement

The desired parameter has been measured by using vector network analyzer for S-parameter (S11) from proposed antenna and is compared with the simulation result.

1.5 Project Overview

The slot UWB antenna was designed by using planar slot structure and simulating by using CST Software in order to obtain the frequency bandwidth return loss, return loss, gain, radiation pattern, and directivity. Then the antenna is fabricated on FR4 board by using chemical etching technique. Finally, comparison between the simulation and the measurement result is done to validate.

1.6 Thesis Outline

This thesis is divided into five chapters which covers the complete design process of the ultra-wide band antenna. Chapter 1 includes the brief introduction of the project, problem statement, objective, scope of work and thesis outline are mentioned clearly.

Chapter 2 describes about topic and theory on antenna fundamental in regarding the previous similar project. There is also information on different method to optimize the design of antenna to fulfill the desire measurement of parameters.

Chapter 3 includes the project methodology which explained on how the project is organized and the flow of process in completing this project. It also discusses on software and hardware design.

Chapter 4 is mainly on result and discussion. It includes manual calculation and simulation result based on desire parameters. This chapter also discuss about experimental result, expected performance and limit that can be archive.

Chapter 5 is on conclusion and future work. This chapter summarizes the result of the antenna designed and discusses about the recommendation or future development of the project and cost that involved in the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews a few earlier works related to it. Literature review is an important part of improving the specifications of the patch antenna framework. For this project, literature review is among the methods used to build up ultra-wideband antenna with defected ground structure method. The literature review help to explain on the antenna and the basic antenna operation, basic antenna parameter, the basic technique.

2.2 Antenna and history

The antenna is the transition from a transmission line to free space. Its primary aim is to transform the energy of a guided wave as effectively as possible into the energy of a free space wave or vice versa, while the emitted power has a certain