UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF MICROSTRIP DIAMOND ANTENNA FOR DUAL BAND APPLICATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology
Department of Electronic and Computer Engineering Technology

By

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TAJUK: **Optimization of Microstrip Diamond Antenna for Dual Band Application**

SESI PENGAJIAN: **2016/2017 Semester 1**
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor's Degree in Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

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MADAM RAHAINI BT MOHD SAID

(Project Supervisor)

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MD. ASHADI B. MD. JOHARI

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ABSTRAK

Antena mikrostrip kebiasaan digunakan di dalam bidang teknologi telekomunikasi. Antena mikrostrip adalah rekaan antena yang menggunakan teknologi mikrostrip dicetak papan di atas (PCB). Kaedah ini boleh digunakan di dalam frekuensi gelombang mikro. Walaubagaimanapun, kegagalan dalam menerima perambatan gelombang dari pemancar menyebabkan berlakunya kehilangan perambatan seperti ketidaksesuaian frequency, tidak cukup dari segi jarak, ketinggian antena juga punca kehilangan perambatan semakin tinggi. Matlamat projek ini adalah untuk mencipta antena mikrostrip berbentuk berlian dan mengoptimumkan kombinasi parameter iaitu dimensi, sudut polarisasi, frekuensi dan jarak untuk mengurangkan kehilangan perambatan mengunakan kaedah "2^4 Factorial Design Expert". Analisi dari perisian "Design Expert" telah mengenal pasti bahawa sudut polarisasi berinteraksi dengan jarak dan dimensiadalah kesan interaksi utama dalam semua sifat. Tetapan optimum untuk kuasa keluaran adalah 2.5cm untuk dimensi, 180 ° untuk sudut polarisasi, 800MHz untuk frekuensi dan 15cm untuk jarak.

ABSTRACT

Microstrip diamond antenna is a common used in telecommunication technology. Microstrip antenna is a fabricated antenna using microstrip technology printed on board (PCB). This method can be used in microwave frequencies. However, the defect in receiving propagation wave from transmitter causes the propagation loss occurred such as mismatch of frequency, insufficient on term of distance and height of the antenna also causes of the propagation loss become high. The aim of this project is to design microstrip diamond antenna and optimize the combination of parameter of dimension, polarization angle, frequency and distance to reduce the propagation loss using 2^4 Factorial Expert Design method. Analysis of Design Expert software identified that polarization angle interact with distance and dimension the main interaction effect in all properties. The optimal setting for output power are 2.5cm for dimension, 180 ˚ for polarization angle, 800 MHz for frequency and 15cm for distance

DEDICATION

To my beloved parents

Nordin bin Saad and Norita binti Arshad

To supervisor and co-supervisor

Mdm. Rahaini bt. Mohd Said and Sir Md. Ashadi b. Md. Johari

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TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATION, SYMBOLS AND NOMENCLATURE

ANOVA	-	Analysis of Variance
ADS	-	Advanced Design System
EM	-	Electromagnetic
AUT	-	Antenna Under Test
DoE	-	Design of Experiment
EMC	-	Electromagnetic Compatibility
SPC	-	Spatial Polarization Characteristic
MoM	-	Method of Moment
VSWR	-	Voltage Standing Wave Proportion
PCB	-	Printed Circuit Board
RF	-	Radio Frequency

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Antenna is an electrical devices assigned to transmit or catch the electromagnetic (EM) waves by converting the electric signal into wave signal and vice versa. In transmission, a radio transmitter supplies an electric current swaying at radio frequency to the antenna's terminals, and the antenna emanates the vitality from the present as electromagnetic waves (radio waves. In gathering, an antenna captures a portion of the force of an electromagnetic wave so as the deliver a little voltage at its terminal that is connected to a beneficiary to enhanced. There are many types of antenna and the most famous among other is microstrip antenna, microstrip antenna is an essential element which offers an optimal solution(Mahesh, Gulbarga, 2014). Microstrip antennas is a sort of antennas used to handle ultra-high frequency signals. It is frequently utilized as a satellite radio or wireless beneficiary or is mounted on an airplane or shuttle. This sort of antennas has the point of interest that is cost little to make yet the burden that is has restricted data transfer capacity.

The first step to design an antenna, is describing its properties as a transmission line load (input impedance) and the distribution of the electromagnetic energy as it emanates into space (radiation pattern). There are various key parameters and ideas that can be use to describe the antenna properties, for example, the gain, which describes the directionality of the fields as they emanate far from the antenna, and the radiation resistance, which speaks to the part of the power input to the antenna port that transmits into space as opposed to being absorbed by the antenna through ohmic losses or reflected down the feeding transmission line.

Advanced Design System (ADS) one of the famous software design and simulate the microstrip antenna. ADS is an electronic design automation software system produced by Keysight EEsof EDA, a division of Keysight Technologies. It gives a powerful design environment to designers of RF electronic products such as mobile phones, pagers, wireless networks, satellite communications, radar systems, and high-speed data links.

1.2 PROBLEM STATEMENT

Nowadays, antenna technology is growing align with advancement in communication technology where the size of each component become small. Microstrip antenna is most famous among the other antenna because of its physical structure is small size, suitable with the minimal effort and minimized setting for wireless system technology. Microstrip antenna has been utilized in variety functions that also give contribution in communication technology. But in specific uses such as in dual band application.

Unfortunately, execution on producing microstrip antenna in dual band application is rarely found in the wireless system technology. Therefore, this project is proposing to implement a microstrip diamond antenna that specific on dual band application. The purpose of this project was created is develop the microstrip antenna and to analysis the performance antenna and optimum level for dual band application are identified. Last but not least, this microstrip antenna could contribute to be among of the accomplishment in the antenna technology towards the improvement of antenna innovation and the performance for wireless system technology.

1.3 OBJECTIVES

In this research, the main objectives of this project are:

i. To study and develop microstrip diamond antenna for Dual-Band applications.
ii. To identify a significant effect of microstrip diamond antenna parameter for Dual-Band applications.
iii. To optimize the best combine of microstrip diamond antenna properties for optimizing the performance

1.4 SCOPE

The main scope of this project is to develop a diamond microstrip antenna by optimize the diamond microstrip antenna for Dual-band applications. There is two scope will be cover in this project which are conduct some research and simulation to obtain the most suitable properties. The parameters consist of dimension, distance, frequency (800 MHz and 1900MHz) and angle, the absolute measurements for each parameter would be optimized the diamond microstrip antenna. For example, size of antenna is the main role to optimized microstrip antenna with exact measurement whether small or big. These properties will be simulating by using Design of Experiment software (DoE). The antenna will be design by using Advance Design System (ADS) Software and will be print on the negative strip board by etching the antenna pattern into metal trace.

CHAPTER 2
LITERATURE REVIEW

2.1 ANTENNA PARAMETERS

2.1.1 Radiation Pattern

Antenna radiation pattern are generally polar awesome circle or equatorial pattern, 2D or 3D patterns. In antenna theoretical one examines the far-field measurement parameters i.e., directivity, gain, phase, polarization and standardized radiation pattern. The latter is the most regularly measured parameter. Exact estimation of radiation pattern includes consideration of various components, for example, the physical and electrical size of the antenna, its operational frequency band, and the environment in which it is to work. Antenna pattern measurement alludes to the determination of the radiation pattern of an Antenna Under Test (AUT). It is the measurement of the relative greatness and phase of an electromagnetic sign got from the AUT. The antenna is a complementary device so the pattern data could be gotten by utilizing it as either the transmitter or receiver. although complex antenna pattern measurement have been a typical necessity in the microwave antenna enclosure for a long time, it has just as of late turn out to be more normal to different ranges, for example, Electromagnetic Compatibility (EMC) and wireless telecommunications (Ullah, Flint, & Seager, 2AD).

2.1.2 Bandwidth

The paper presents the model of the antenna on which the impact of parameters on antenna bandwidth simulation was led (the impact of changes permittivity and thickness of each layer). A standout amongst the most essential parameters which have

been calculated is the data transmission. Its worth relies on upon antenna parameters (thickness and permittivity of each layer). Therefore, the paper shows that as a result of optimization which has been shown we can make a planar antenna with extensive variety of work. The analysis procedure of multilayer microstrip antenna is complex and time consuming (Przesmycki, Bugaj, Nowosielski, & Wnuk, 2011).

2.1.3 Polarization

The value of polarization data has as of now been built up in most remote sensing, target detection, polarization enhancement, polarization filtering, and target recognition applications. Furthermore, the fancied polarization of antenna radiation (i.e. the principle polarization), still can transmit the orthogonal polarization (cross polarization) sign of expectation, and the radiation intensity of cross polarization increments with the deviation of azimuth angle increments. That is to say, the antenna polarization changing in various positions and arranged headings is known as Spatial Polarization Characteristic (SPC) of antenna. (Jianling, Huanyao, Depei, Wenzhao, & Bo, 2015).

2.1.4 Return Loss

The return loss might be characterized as the loss of the sign power because of discontinuity in the transmission line or the optical fiber i.e. "Return Loss" alludes to that portion of a sign that can't be consumed before the end of line termination, or can't cross an impedance at some point in the transmission system .This part of the sign is reflected from the impedance discontinuity and goes go down the line starting there, since it can't be consumed by the termination, or transverse the impedance inconsistency. This causes two signs to show up on the coaxial cable, one going in one direction and the other in the opposite direction. These two signs cancel and include along the line at different point. At the point when these cancelations happen at a receiving terminal end of the cable, information might be lost until forever (Sharma, Bhushan, Gupta, & Kaur, 2013).

2.1.5 Voltage Standing Wave Ratio (VSWR)

Voltage Standing Wave Ration VSWR is characterized as the ration of the maximum to minimum voltage of the antenna The reflection coefficient ρ characterize as a proportion between incident wave amplitude Vi and reflected voltage wave amplitude Vr, and by utilizing the meaning of a voltage reflection coefficient at the input terminals of the antenna Γ, as appeared below where Z0 is the characteristic impedance of the antenna. On the off chance that the Equation is solved for the reflection coefficient, it is found that, where the reflection coefficient ρ is the absolute vale of the magnitude of Γ (Elrashidi & Elleithy, Hassan Bajwa, 2012).

$$r = \frac{zinput - zo}{zinput + zo} \qquad \rho = |r| = \frac{VSWR - 1}{VSWR + 1} \qquad VSWR = \frac{|r| + 1}{|r| - 1}$$

2.2 MICROSTRIP ANTENNA

The further study on microstrip patch antennas has gained an awesome ground in the late years. Comparison with the traditional antennas, microstrip patch antennas have more advantages and better prospects. For this days, next generation peoples require high data rate and size of devices are become smaller. By definition, an antenna is a devices used to change a RF signal, going on a channel, into an electromagnetic wave in free space. The IEEE Standard Definitions of Terms for Antennas (IEEE Std 145-1983) characterizes the antenna or aerial as a method for transmitting or receiving radio waves. In other words, it is a transitional structure between free space and a controlling device that is made to effectively transmit and get receive electromagnetic waves. Modern printed circuit manufacture techniques have made it conceivable to fabricate low profile antenna that are to a great useful. Such antennas are alluded to as microstrip or printed circuit antennas. Microstrip antennas are planar resonant cavities that break from their edges and transmit. Printed circuit methods can be utilized to etch the antennas on delicate substrates to create minimal effort and repeatable antenna a position of safety (Salkim & Yilmaz, 2010).

2.2.1 STRUCTURE OF MICROSTRIP ANTENNA

A Microstrip patch antenna comprises of a metal trace on one side of a dielectric substrate which has a ground plane on the other side and design of microstrip patch antenna appeared in figure 2.1. The patch usually is made from conducting metal for example copper or gold and it can be form any possible shape as shown in the figure 2.2. (Parmar, Saxena, & Nayak, 2014).

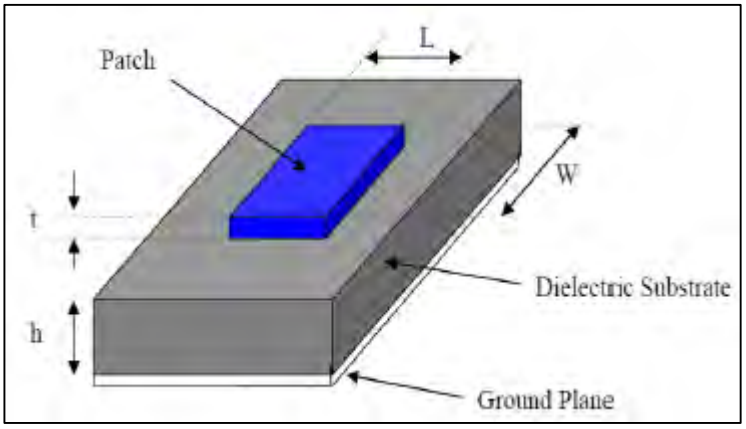

Figure 2.1: Structure of microstrip patch antenna

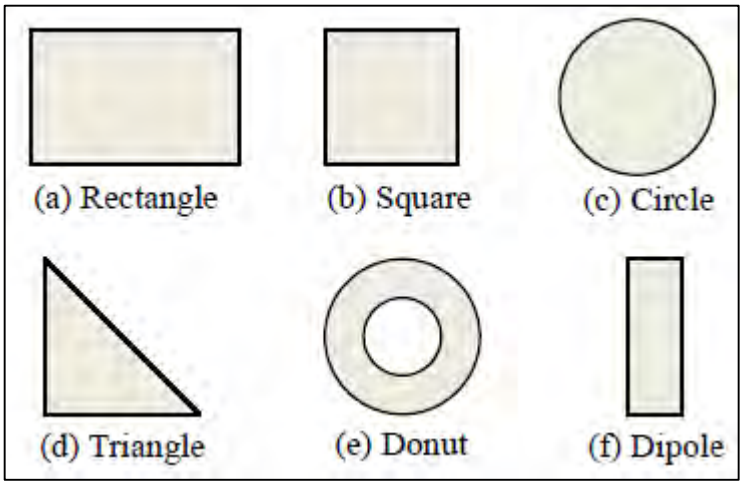

Figure 2.2: Common shapes of microstrip antenna.

Microstrip patch antenna transmit principally as a result of the fringing fields between the patch edge and the ground plane. On the other hand great antenna performance, a thick dielectric substrate having a low dielectric consistent is desirable since this gives better effectiveness, bigger bandwidth and better radiation (Irianto, Mutiara, & Shappe, 2011). In order to squeeze the transverse dimension of

patch antennas, high dielectric consistent substrate, for example, ceramic oxide materials are utilized as host substrate. However, their utilization results in some natural issues like trouble in impedance matching, poor effectiveness and narrow bandwidth, excitation of surface waves that could bring down the radiation proficiency and weaken the radiation pattern. To expand the limited bandwidth and radiation proficiency of patch antennas, stacked or slotted patch antennas can be utilized. Bandwidths of 10%-20% have been accomplished with test probe fed stacked patches, and 18%-23% bandwidths have been accomplished for aperture coupled stacked patches (Singhal & Jaimini, 2013).

2.2.2 FEEDING TECHNIQUE

There are several of methods to feed the microstrip patch antennas, these methods can be group into two main categories which are contacting methods and non-contacting methods. For contacting methods, the radio frequency power is feed directly to the radiating patch utilizing a connecting element for example microstrip line. For non- contacting method, the electromagnetic field coupling to exchange power between the microstrip line and the emanating patch. There are four most well-known feed techniques which are for microstrip line, coaxial probe feed, these technique is classified as contacting methods. For non-contacting are coupling and proximity coupling. A summary of comparison of the various feeding techniques are shown in the Table 2.1 below (Bernard, Paul, & Iloh, 2013).

Table 2.1: Comparison of different feeding methods

Characteristics	Microstrip Line Feed	Coaxial Probe Feed	Aperture Coupled Feed	Proximity Coupled Feed
Spurious feed radiation	More	More	Less	Minimum
reliability	Better	Poor due to soldering	Good	Good
Ease of fabrication	Easy	Soldering and drilling needed	Alignment required	Alignment required
Impedance matching	Easy	Easy	Easy	Easy
Bandwidth (achieved with impedance matching)	2 – 5 %	2 – 5 %	2 – 5 %	13%

Advantages of Microstrip Antennas

The major advantages of microstrip antennas are:

- Light weight
- Low volume
- Low-profile planar configuration which can be easily made conformal to host surface
- Capable of dual and triple frequency operations

Disadvantages of Microstrip Antenna:

Microstrip patch antennas suffer from a number of disadvantages as compared to conventional antennas (Bernard et al., 2013).

- Narrow bandwidth
- Low efficiency
- Low gain