



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN, SIMULATION AND FABRICATION OF  
MICROSTRIP PATCH ANTENNA ARRAY FOR WI-FI  
APPLICATION**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

**NUR SHAMIMI BINTI OTHMAN**

**B071510294**

**951024-04-5312**

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING  
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Disahkan oleh penyelia:

NUR SHAMIMI BINTI OTHMAN

Alamat Tetap:

Bt 20 ½ Jln Chinchin

Lorong Terentang 3

77000 Jasin Melaka

Tarikh:

PN WAN HASZERILA BINTI WAN

HASSAN

Cop Rasmi Penyelia

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## APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

Signature: .....

Supervisor : PN WAN HASZERILA BINTI WAN  
HASSAN

Signature: .....

Co-supervisor: EN MOHD ERDI BIN AYUB

## ABSTRAK

*Antena patch microstrip (MPA) telah digunakan secara meluas kerana kelebihannya iaitu mempunyai profil yang rendah, mudah dibuat dan juga kos rendah. Ciri-ciri persembahan MPA tunggal dapat ditingkatkan dengan menggunakan array antena patch microstrip. Terdapat beberapa cara untuk meningkatkan prestasi antena patch microstrip seperti teknik slotting, struktur tanah yang dibatalkan atau menjadikannya sebagai tatasusunan. Dalam projek ini, tatasusunan telah dipilih untuk meningkatkan prestasi MPA. Oleh itu, projek ini dijalankan untuk memberikan analisis perbandingan antara satu MPA dan 2 x 1 segi empat tepat MPA array untuk aplikasi Wi-Fi. Kedua-dua antenna ini telah direka dan disimulasi pada operasi frequency 2.45GHz. Substrat yang digunakan ialah FR-4 dielektrik dan simulasi dilakukan dengan menggunakan Perisian CST. Antena kemudian direka untuk mengesahkan prestasi antena dengan melakukan pengukuran. Teknik suapan MPA berbentuk empat segi adalah inset fed untuk dipadankan dengan galangan beban dengan antena untuk memaksimumkan pemindahan kuasa atau meminimumkan isyarat pantulan dari beban. Hasil simulasi dan pengukuran menunjukkan bahawa terdapat peningkatan parameter antena. Jalur lebar bagi array antena dari simulasi dan pengukuran masing-masing adalah 0.07894GHz dan 0.11GHz. Selain itu, simulasi keuntungan adalah 5.42dB dan 6.425dB keuntungan dari pengukuran untuk array antena. Berdasarkan keputusan, antena dapat digunakan dalam aplikasi Wi-Fi yang mempunyai jarak frekuensi antara 2.3GHz hingga 2.5GHz.*

## ABSTRACT

The microstrip patch antenna (MPA) are widely used as the advantages were low profile, easy to fabricate and also low cost. The performances characteristics of a single MPA can be improved and enhanced by using microstrip patch antenna array. There are several ways to improve the performances of the microstrip patch antenna such as slotting technique, defected ground structure or by making it as an array. In this project, array have been chosen to enhance the performances of MPA. Therefore, this project was conducted to give a comparative analysis of between a single MPA and 2 x 1 rectangular MPA array for Wi-Fi application. Both of the antenna were designed and simulated at 2.45GHz operating frequency. The substrate used was FR-4 dielectric and simulations are performed by using CST Software. The antennas then was fabricated to validate the performances of antenna by doing measurement. The feeding techniques of rectangular MPA was inset feed as for matching the impedance load with the antenna in order to maximize the power transfer or minimize the signal reflection from the load. The results of simulation and measurement show that there were enhancement of the parameters of the antenna. The bandwidth for antenna array from simulation and measurement were 0.07894GHz and 0.11GHz respectively. Other than that, the gain of simulation was 5.42dB and 6.425dB of gain from the measurement for antenna array. Based on the results, the antenna can be applied in Wi-Fi application which is frequency range between 2.3GHz to 2.5GHz.

## DEDICATION

*Special dedication to my beloved parents,*

***EN. OTHMAN BIN IBRAHIM  
PN. NORHAYA BINTI MOHD NOR,***

*My Family,*

***(Qamarul Afiq Bin Othman, Ahmad Qusyairi Bin Othman, Khairil Faiz Bin Othman,  
Saiyidah Nadiah Binti Othman, Ainul Madihah Binti Othman)***

*My beautiful supervisor,*

***Pn Wan Haszerila Binti Wan Hassan.***

*My beloved friends,*

***(Noor Syazwan Bin Noor Azizi, Nur Farhana Binti Tajul Arus, Hafizah Auni Bt  
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Muthanna Bin Jumadil, Mohamad Faiq Bin Rosli, Mohamad Izzat Bin Kamal Izani,  
Abdul Hadi Bin Salleh)***

*Thank you for all your love, care, and support also believe in me.*

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## LIST OF SYMBOLS

## **LIST OF ABBREVIATIONS**

<b>MPA</b>	Microstrip Patch Antenna
<b>CST</b>	Computer Simulation Technology
<b>VSWR</b>	Voltage Standing Wave Ratio
<b>UV</b>	Ultra Violet
<b>PCB</b>	Printed Circuit Board

## **LIST OF PUBLICATIONS**

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

This chapter will explain about the background of this project entitle Design, Simulation and Fabrication of Microstrip Patch Antenna Array. Computer Simulation Technology (CST) was used to design and fabricate the antenna. This chapter include background, problem statement, objective and scope of the project.

### 1.2 Background

Antenna are one of the important key of any wireless system. An antenna acts as a device that will transmit or receives electromagnetic waves. Almost all antenna operates efficiently on a relatively narrow frequency band. Tuning the antenna to the same frequency band is a must in order to connect to the radio system that operates as it is to avoid any reception or transmission being impaired. One of the way to transmit and receive the electromagnetic waves is by tuning the wire to be effective. To tune the wire to be effective, is by ensuring the length of the wire is half from the wavelength of the operating frequency. Microstrip Patch Antenna (MPA) are most widely used type of antenna. This type of antenna consist of four parts which are patch, ground plane, substrate and feeding part. To design a microstrip patch antenna, a lot of substrates with dielectric constant in the range of  $2.2 < \epsilon_r < 12$  can be used. Usually,

for a better antenna performance, a thick substrate with low dielectric constant are most likely preferred as it offers a better efficiency, larger bandwidth and loosely bound fields for radiation into space.

Therefore, in this project the main things aimed is to design a linearly polarized rectangular microstrip patch antenna array. The aim of using linear polarization is because a linear polarized antenna radiates in a plane contain the propagation direction

### **1.3 Problem Statement**

In order to fulfil the problem occurred, an antenna is developed hence upgraded for advanced technologies. Microstrip antenna is easier to design compared to conventional antenna. Other than that, conventional antenna also require more cost to build. As for microstrip patch antenna, it has simple structure and easy to fabricated. Although it has various shapes, but the most popular configuration usually used rectangular shape. In this project, Flame Retardant 4 (FR4) will be used as dielectric substrate of the antenna.

## **1.4 Objective**

The objective of this project are:

1. To design and simulate a MPA array using Computer Simulation Technology (CST) software.
2. To fabricate the MPA by using Flame Retardant 4 (FR4).
3. To analyse the performance of the antenna

## **1.5 Scope**

This project consist of two parts which is software and hardware. For software part, Computer Simulation Technology (CST) software was used to design and simulate the MPA. As for hardware, after the simulation, the MPA will be fabricate using Flame Retardant 4(FR4). Finally, the MPA will be measured using network analyser to measure the value hence compared to the simulation values.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter provided review on previous study and research which closely related to development of antenna working on MPA. All information is obtained from journal, books and internet. This literature review will discussed about types of antenna used, details explanation about microstrip antenna, shape of the MPA and feeding technique. The variation of antenna type and its feeding technique is compared and analysed so that this project can be carried on.

#### 2.2 Microstrip Antenna

Microstrip antenna also referred as a patch antenna that has simplest configuration and consisting radiating patch on a side of a dielectric substrate which has a ground plane on the other side as in Figure 2.1. The ground plane that connected to the supply's ground terminal is act as a direct connection for the current in the antenna. The material of the patch conductors usually is gold and copper. To design microstrip antennas, a number of substrate are used. The range of dielectric constant substrate usually at  $2.2 \leq \epsilon_r \leq 12$ . According to (Bhalla et al., 2013), Thick dielectric substrate are genuinely used for antenna as it has low dielectric constant hence providing better efficiency, larger bandwidth and better radiation, thus good for antenna performances.