UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN OF SQUARE SHAPE FLEXIBLE ANTENNA FOR 5G APPLICATION

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BACHELOR OF ELECTRONICS ENGINEERING TECHNOLOGY (TELECOMMUNICATIONS) WITH HONOURS

2020

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Faculty of Electrical and Electronic Engineering Technology

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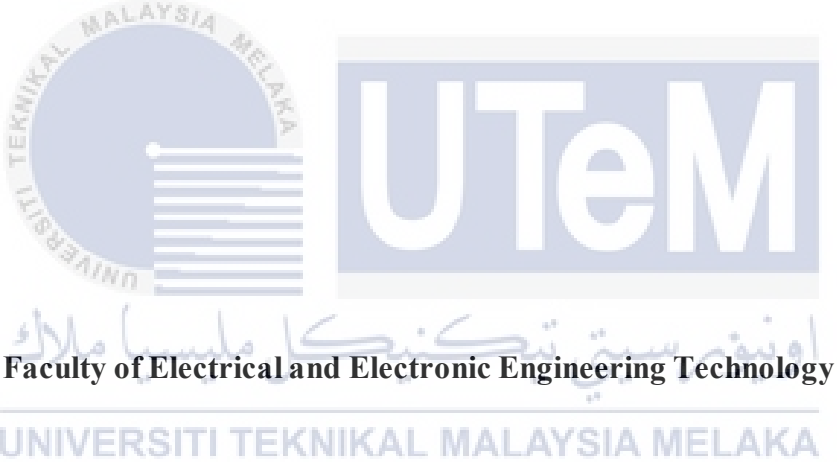
A project report submitted
in fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunication) with Honours



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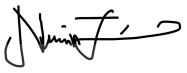
Signature : 

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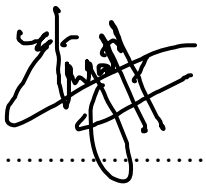
Date : 18/02/2021

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunication) with Honours.

Signature: 

Supervisor: Eliyana Binti Ruslan

DEDICATION

This dedication is for my parents. Special thanks to my father, Baharuddin bin Hussin and my mother, Zainun Asmah binti Osman who always give support and motivate me to finish this project.

ABSTRACT

Square-shaped antennas have recently become increasingly significant in the wireless communication system because it has provided a decent advantage. Microstrip patch antenna has gotten extremely popular and has attracted a lot of attention to the researcher for these reasons. Microstrip patch antenna has more benefit and greater possibility compared with the old traditional antenna. A square shape antenna is presented in this thesis. A square shape flexible antenna has been designed and simulate for 5G application. The operating frequency has been chosen as 3.5 GHZ for 5G application. This antenna is designed on Kapton substrate with dielectric constant of 3.5 has been chosen due to its flexibility and durability. The main radiating patch is embedding the with a square shape and inset feed technique is used. Simulation is done on Computer Simulation Technology (CST) software to get the best parametric design.

ABSTRAK

Antena berbentuk segi empat sama baru-baru ini menjadi semakin ketara dalam sistem komunikasi tanpa wayar kerana telah memberikan kelebihan yang baik. Antena Mikrojalur telah menjadi sangat popular dan telah menarik banyak perhatian kepada penyelidik atas sebab-sebab ini. Antena Microjalur mempunyai lebih banyakfaedah dan kemungkinan yang lebih besar berbanding dengan antena tradisional lama. Antena berbentuk segi empat sama ditunjukkan dalam tesis ini. Antena fleksibel berbentuk segi empat sama telah dirancang dan disimulasikan untuk aplikasi 5G. Kekerapan operasi telah dipilih pada 3.5 GHz untuk aplikasi 5G. Antena ini dirancang pada substrat Kapton dengan pemalar dielektrik 3.5 telah dipilih kerana fleksibiliti dan ketahanannya. Tampalan terpancar utama adalah menyisipkan bentuk segi empat sama dan teknik umpan sisipan digunakan. Simulasi dilakukan pada perisian Computer Simulation Technology (CST) untuk mendapatkan reka bentuk parametrik terbaik.

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Last but not least, from the bottom of my heart a gratitude to my beloved parents for their endless support, love and prayers. Finally, thank you to all the individual(s) who had provided me the assistance, support and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

ε_r	-	Dielectric Constant
f	-	Frequency
hs	-	Thickness of Kapton
ht	-	Thickness of conductor
W	-	Width of patch
L	-	Length of Patch
Wg	-	Width of ground plane
Lg	-	Length of ground plane
Leff	-	Effective Length
Wf	-	Feedline width
Fi	-	Feedline distance
Gpf	-	Inset-fed
ε_r	-	Relative Permittivity of the Dielectric Substrate
ε_{eff}	-	Effective dielectric constant
ΔL	-	Patch length extension
C	-	Speed of light 3×10^8
dB	-	Decibel

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, the overview of the project will be briefly discussed. This chapter also emphasizes the problem statement, objectives of the project, scope, and the organisation of the whole report.

1.2 Background of the Project

The ongoing patterns show how wireless communication works at a rapid rate. The fifth-generation (5G) wireless communication has developed to be the latest innovation these days (Verma *et al.*, 2016). As previously studied by (Hong *et al.*, 2017), major research institutions and wireless providers have ventured out to plan the next-generation, for example, the fifth-generation (5G) wireless system. There is different organizational field has embraced the 5G innovation, along with, Internet of Things (IoT), advance MIMO structure, advance small cell technology, and so on (Hong *et al.*, 2017). Mobile 5G systems have expanded their spectrum to support a high data rate. The frequency of 3.5 GHz is one of the suggested frequency band that is below 6 GHz in (Ferdous *et al.*, 2019).

An antenna is a device conceivable of correspondence. It lessens the trafficking in communication. Antenna is a kind of transducer which is utilized to convert electrical energy in RF energy. Antenna is a fundamental device for any communication setup. Antennas are vital in any communication system where electromagnetic radiation is to be radiated or absorbed. The transmission line for the antenna may take the form of microstrip transmission

line, strip line, coaxial, and it is used to convey electromagnetic energy from the transmission source to the antenna. Otherwise, from the antenna to the receiver. The antenna performance likewise fluctuates among various people. In any case, antenna design can be particularly challenging for antenna that should be work in closeness body or to be worn.

Microstrip antennas have significant applications particularly in the field of clinical, military, military, portable and satellite communication. Microstrip antenna is a low profile, light weight antenna and it is ideally suited for aviation and mobile communication. When designing the microstrip antenna, there are several significant parameters. In microstrip antenna, it consists a patch with any suitable shape, ground plane and chosen substrate (Chandra *et al.*, 2019).

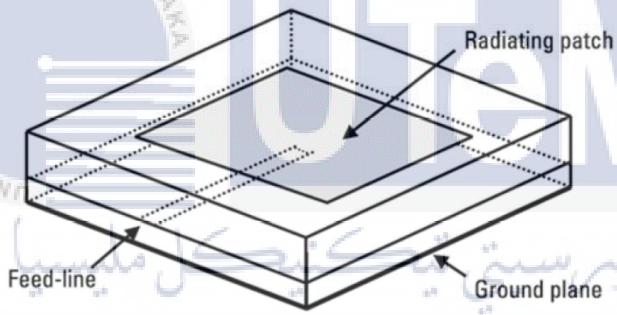

Figure 1.1: Microstrip Patch Antenna

Referring Figure 1.1, this is the example of microstrip patch antenna. For the patch, it may be round, rectangular, elliptical or some other shape (Srivastava and Pradhan, 2017). In this paper, a square patch is considered due to effortlessness of the connection. According to (Rufus, 2014), square patch antenna depends on its length and width for the resonant frequency. In this paper, Kapton will be substrate for the square shape flexible antenna. Kapton material structure fascinating substrate since it is generally utilized in the electronic market.

1.3 Problem Statement

Microstrip patch antennas have recently become increasingly significant in the wireless communication system because it has provided a decent advantage. A square shape flexible antenna is purpose in this project report. The basis requirement of flexible is chosen the right flexible substrate and the material for the ground plane. Most of the previous designed square patch antenna can function well with common substrates such as FR4, Rogers, RT Duroid and others. In order to do another analysis, Kapton will be chosen as substrates for this square shape antenna. Kapton tends to be a flexible material, possibility to use very thin layers, low cost, very high durability and mechanical strength components. The design of microstrip antennas as low-cost radiators for mobile communications can be challenging. According to the observation, student is desire to measure the antenna efficiency by measuring its radiation pattern.

In response to this problem, the study purpose is to design a square shape flexible antenna for using at 3.5 GHz frequency for application. The aim for this project is to have high gain and efficiency to ensure maximum data transfer.

1.4 Objectives

This study has been developed based on several objectives which are:

1. To design a square shape flexible antenna that capable to operate at 3.5 GHz for 5G application using Computer Simulation Technology (CST) software.
2. To simulate a square shape flexible antenna for using at 3.5 GHz frequency for 5G application.
3. To analyse the performance of antenna based on flexibility, directivity and efficiency of antenna for 5G application.

1.5 Scope of Project

In this project, Computer Simulation Technology (CST) software is used to design and simulate the square shape flexible antenna. Besides, this design is using Kapton as a substrate with operating frequency at 3.5 GHz. This paper focuses on the design of a square shape flexible antenna. The nominal operating frequency band of the antenna is from 3.4 GHz to 3.8 GHz. The principal requirements for this project are simulation the square antenna, the use of frequency at 3.5 GHz for 5G application, the thickness of the substrate and the dielectric constant (ε_r) of the substrate. Finally, simulations of different antennas, curvatures and their effects are observed.

1.6 Thesis Outline

Based on this report, it consists of five chapters in order to complete the full report. All the idea, process, flows and the concepts of project will be discussed in the chapter required. Initially, the first chapter briefly describe the introduction of this project. The review about the basic platform of project concisely explained. This chapter also clarify the background of the project, problem statement, objectives to achieve and the scope of project.

In this second chapter, literature review is done by reviewing journals, books and article which is related to square shape flexible antenna for 5G application. Other than that, this chapter will make a summary for all the journals that have been review. This chapter also will cover about the study and idea based on square shape flexible antenna as well as the concept.

For chapter 3, the overall process and method used for designing the antenna are discussed. It starts from antenna design specification of parameters, dielectric constant of substrate, feeding method and run the simulation were determined. Then, the software

development and measurement using Computer Simulation Technology (CST) software are addressed from this chapter. The Kapton that act as substrate for this antenna also will be discussed in this chapter.

For chapter 4, there will be the design of square shape flexible antenna, the exact parameter, and the result for simulation. Lastly, the final chapter will conclude the overview of overall project process. The recommendation for future work also will be discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is an essential part before beginning any project because it provides all required data related to the project. Based on that, the correct direction in developing the project can be performed proficiently. In this chapter, topic will be explained are the system that going to be implemented and previous related work.

2.2 Previous Related Study

2.2.1 Square Microstrip Patch Antenna at 2.4 GHz and Comparison between Unslotted and Slotted Version

Microstrip patch antenna has a variety of application because of the low profile, low cost and high performance. Circular, rectangular and square patch antennas are more desirable because of their radiation characteristics advantageous compared to other microstrip patch antenna model. The authors in (Majed, 2015) proposed to design a square microstrip patch antenna with 2.4 GHz operating frequency. However, microstrip have limitations regarding the bandwidth and efficiency because of the presence of the dielectric substrate material. In this paper, there is two comparison between the slotted and unslotted version of the antenna. For the slotted version, it having a slotting shape of letter (P) as in Figure 2.1. For feeding technique of this antenna, the author used the coaxial feed.