UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Dual Band Long-Term Evolution (LTE) Directional Antenna

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

By

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

Signature: …….

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ABSTRAK

Dalam beberapa tahun yang lepas, komunikasi tanpa wayar kian berkembang lalu mendorong akan peningkatan teknologi antenna. Bermula dari band tunggal kepada dwi band frekuensi serta menggunakan antenna yang bersaiz padat dan prestasi yang optimum dalam aplikasi tanpa wayar. Projek ini membincangkan tentang prestasi *microstrip patch* antena berarah yang mampu beroperasi dalam frekuensi LTE di Malaysia, yang meliputi Band 3 dan Band 7. Pembangunan projek ini terbahagi kepada dua bahagian, iaitu merangkumi perisian dan perkakasan. Pembangunan perisian adalah dengan menggunakan alat perisian CST. Dimensi yang sesuai harus digunakan untuk membina *patch antenna*. Sementara itu, pembangunan perkakasan termasuk jenis substrat, kaedah *feeding* dan proses fabrikasi. Prosedur pengujian melibatkan *network analyzer* dan ruang anechoic untuk mendapatkan *return loss,* corak radiasi, jalur lebar, *gain* dan VSWR antena yang telah direka. Akhir sekali, antena diuji menggunakan aplikasi sebenar untuk mengukur kekuatan isyarat dan kualiti.

ABSTRACT

In the past few years, the appeal of the wireless communication has driven a new enhancement of an antenna technology. From a single band antenna into dual band frequency band coverage with a prerequisite of compact size, potent and optimal performance in wireless applications. This project discussed about the performance of designed directional microstrip patch antenna which can be operate in LTE operations in Malaysia, that covers both frequency band 3 and 7. The development of this project is divided into two parts, software and hardware development. The software development including the design of the microstrip patch antenna by using the CST software tools. The suitable dimensions of the patch antenna are required. While the hardware development inclusive of determining types of substrate, feeding method, and fabrication process. Testing part involving network analyzer and anechoic chamber to obtain the return loss, radiation pattern, bandwidth, gain and VSWR of the designed antenna. Lastly the antenna is tested with real application to measure the signal strength and quality.

DEDICATION

This report is dedicated fully to my backbones which is my family, my lecturers, my fiancé and all my course mates who has involved directly or indirectly.

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LTE	-	Long- Term Evolution
CST	-	Computer Simulation Technology
FDD	-	Frequency Division Duplex
TDD	-	Time Division Duplex
MIMO	-	Multiple Input Multiple Output
SISO	-	Single Input Single Output
VSWR	-	Voltage Standing Wave Ratio
CFR	-	Consumer Forum of Malaysia
Mbps	-	Megabits per second
kbps	-	kilobits per second
MHz	-	Megahertz
GHz	-	Gigahertz
RF	-	Radio frequency
HPBW	-	Half-power beamwidth
dB	-	Decibel
dBi	-	Decibel isotropic
R_r	-	Radiation resistance
R_l	-	Loss resistance
PCB	-	Printed Circuit Board
1G	-	First-generation
2G	-	Second-generation

3G	-	Third-generation
4G	-	Fourth-generation
5G	-	Fifth-generation
OFDMA	-	Orthogonal Frequency Division Multiple Access
IP	-	Internet Protocol
SNR	-	Signal-to-Noise Ratio
MCMC	-	Malaysian Communication and Multimedia Commission
GSM	-	Global system for Mobile
UMTS	-	Universal Mobile Telecommunications System
GPS	-	Global Positioning System
RFID	-	Radio Frequency Identification
WLAN	-	Wireless Local Area Network
WiMAX	-	Worldwide Interoperability for Microwave Access
FR4	-	Flame Retardant 4
FTKEE	-	Faculty of Engineering Technology
FKEKK	-	Faculty of Electrical and Electronic Engineering Technology
RSSI	-	Received Signal Strength Indicator
RSRQ	-	Reference Signal Received Quality
RSRP	-	Reference Signal Received Power
ε_r	-	Dielectric constant
e	-	Radiation efficiency
Γ	-	Reflection coefficient

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter give an overview of the project regarding background of the project, the wireless networking advancement, the basic design of the microstrip patch antenna, problem statement of the project, objectives to achieve, scope of the project and the thesis organization.

1.1 Background of Project

Over the years, technology of wireless system has rapidly growth in frequency allotment, techniques and procedures of operations to improve the performance of the wireless system. Starting from 1G in 1981 which uses the analog cellular, it enabled the user to utilize the voice applications. Next, 2G that started to roll out in 1992 which come with an improvement of digital cellular technology. It provides both voice and texting applications. After that, 3G appeared in 2001 providing voice, texting and data applications which allow the user to access the internet with a speed from 200 kbps to a few Mbps (Communications & Multimedia Consumer Forum of Malaysia (CFM), 2017). According to (Abed, Ismail, & Jumari, 2012) moving to the current network technology, 4G started in 2013 provides greatest and faster rate that reaches up to 300 Mbps with a delay of radio network less than milliseconds.

The intention of universal LTE smartphone demand immense challenges on the antenna system. Future technologies require a very small antenna which can accommodate higher applications. Due to the advanced of the integrated technology and the demand of many band operations, various applications working at different frequencies in one wireless device are developed. Wireless device terminology considers antenna which cover more than one communication bands as a dual band antenna. Dual band antenna can operate at different frequencies which is useful for transmitting data and it can be used for more than one application. Therefore, antenna that simultaneously cover the range of frequency from 1710 to 1880 MHz and 2500 to 2690 MHz bands, which can provide LTE multifunctional services are necessary for recent communication systems. To apply this, in the antenna design, different part of the antenna is active for different band.

Microstrip patch antenna is one of the antenna implementation which currently become useful because it allows compact antenna with low manufacturing cost, easily fabricated and offer high reliability. The technology used based on printed circuit to produce flat emitting structures. Patch antenna, ground plane and microstrip transmission line are made of high conductivity metal. On top of the substrates comprises of length (L), width (W) and thickness (h) with permittivity (ε_r).

1.2 Problem Statement

Each telecommunication service provider in Malaysia provide various frequencies for LTE or band allocation and bandwidth. Most of LTE coverage reception throughout the nation covers dual band frequency, which are 1800 MHz and 2600 MHz. Generally, the presence of obstructions such as high buildings, trees, metallic structure nearby or high density solid wall concrete will degrade the LTE coverage. The band 3 and band 7 are greatly used for the LTE communication but it suffers the coverage radius due to its frequencies. To minimize these limitations, the enhancement of an external LTE antenna shall be designed using the RF microwave software application such as CST simulation tools. It is predicted to have lower return loss, better radiation pattern, bandwidth, gain and VSWR.

1.3 Objectives

This project aims to make the measurement of the antenna which suitable to the current wireless technology in Malaysia. Therefore, several objectives are stated to attain the purpose of the project. The main objective for this project:

i) To study and improvise an antenna that covers one band to dual band operation.
ii) To design directional microstrip patch antenna that is capable to operate at LTE frequency band (1800 MHz and 2600 MHz).
iii) To measure and analyze the performance of the newly design antenna in terms of return loss, radiation pattern, bandwidth, gain and VSWR.