UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UMTS ANTENNA DESIGN

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

by

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I hereby, declared this report entitled “UMTS Antenna Design” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Projek ini membincangkan mengenai reka bentuk antena yang mengawal jalur UMTS bagi aplikasi selular. Rekabentuk antena ini dibuat dengan menggunakan teknologi perisian komputer CST microwave studio 2011. Antena ini terdiri daripada empat lapisan iaitu satah bumi, substratum, tembaga dan dwikutub terlipat. Bumi dan antena diperbuat daripada tembaga dimana ketebalannya adalah 0.07 mm dan 0.32 mm manakala substratum papan cetak FR4 yang mempunyai ketebalan 1.6 mm. Antena ini menyediakan jalur lebar 15% pada S11 < -10 dB dari 1885 MHz hingga 2250 MHz, yang merangkumi jalur frekuensi UMTS iaitu dari 1920-2170 MHz. Konfigurasi asas antena ini adalah terdapat bahagian pada antena yang dilipat dan slot berbentuk segiempat. VSWR, galangan masukan, corak sinaran dan prestasi S11 digunakan untuk analisis konfigurasi yang berbeza. Galangan masukan yang digunakan adalah hampir kepada 50 Ω. Di masa akan datang, projek ini diharap dapat menyumbang kepada teknologi telekomunikasi kerana antena ini bersaiz kecil dan menghasilkan prestasi keseluruhan yang baik.

ABSTRACT

The aim of this project is to design compact UMTS antenna for cellular application. The feeding method used for this project is coaxial probe feed. The antenna consists of four layers which are the ground, substrate, copper and folded dipole. The ground and dipole fully employ copper with 0.32 mm thickness while the FR4 substrate has 1.6 mm thickness. The antenna provides a 15% bandwidth at S11 < -10 dB from 1885 MHz to 2250 MHz, which completely encompasses the desired UMTS frequency band (1920-2170 MHz). The basic configuration of this antenna is four folded edge and slotted rectangular antenna. The VSWR, input impedance, radiation patterns and S11 performance are used for the analysis of different configuration. Feed point on the dipole gives a good match of 50 Ω impedance. In the future, this project will bring advantage in telecommunication technology as it comes with a small size and good overall performance.

DEDICATION

Special dedications to:

My beloved mother, father, siblings and friends who encouraged and inspired me throughout my journey of education.

My Supervisor,Mr. Win Adiyansyah Indra

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

UMTS	Universal Mobile Telecommunication System
PCB	Printed Circuit Board
CST	Computer Software Technology
MWS	Microwave Studio
EM	Electromagnetic
S_{11}	Return Loss
dB	Decibels
BW	Bandwidth
VSWR	Voltage Standing Wave Ratio
HPBW	Half Power Bandwidth
SMA	Sub Miniature A
FR4	Fire retardant 4
RL	Return Loss
Γ	reflection coefficient
Zo	characteristic impedance
Hz	hertz
K	kilo
h	height
l	length
w	width
ε r	dielectric constant of the substrate
c	speed of light $3x\ 10^{-8}$ m/s
mm	Milimeter

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CHAPTER 1
INTRODUCTION

1.1 Objective

Over the recent years, the need to expand the bandwidth of antennas in mobile handheld devices follows from the ever-increasing data rates, and hence spectrum requirements, of mobile devices. The implementation of antenna design causing minimised coupling with the human head and hand, hence minimised SAR would be attractive to many consumers, thus increasing the market acceptance of devices using such antennas. A good candidate is a balanced antenna [1]. An antenna with symmetrical structure that is fed with balanced currents to make it electrically symmetrical is said to be a balanced antenna. Dipoles and loops are the most commonly encountered balanced antennas [2, 3].

Compact UMTS antenna is designed in this work to cover the frequency bands for Universal Mobile Telecommunication System (UMTS). UMTS is a third generation mobile cellular technology for network based on the GSM standard. The UMTS antenna is proposed due to its application for the third generation and ideal for the users in the modern world. Once it is implemented, the users can be constantly attached to the internet as they travel and have the same set of capabilities no matter where they travel to.

With the recent advances of telecommunication, the need for small antennas has greatly increased. Various techniques have been proposed to develop a size of a folded dipole antenna. This geometry of the proposed antenna is four folded edge and slotted rectangular antenna. In this case, it is called folded dipole antenna. The

dimension of this antenna has the value of less than 30 × 30 mm. In addition, it has a 15% bandwidth with return loss of less than -10 dB from 1885 MHz to 2250 MHz. All the criteria must be achieved while developing the antenna.

1.2 Objective

The objectives for this project are:

1.2.1 To investigate a balance antenna for mobile handset application with enhanced bandwidth performance, which cover UMTS frequency bands.

1.2.2 To achive the criteria that was given to this project such as bandwidth and return loss.

1.2.3 To design and fabricated compact UMTS antenna.

1.3 Problem Statement

In the past, various techniques have been proposed to develop a size of folded dipole antenna for UMTS application. However, most of the design is quite big and consume a lot of space inside the handset mobile user. In this work, a compact UMTS antenna is proposed with small size and good overall performance.

1.4 Project Scope

The scope of this project is to design an antenna that fulfills the desired frequency of UMTS which is can operate at frequency from 1885 MHz to 2250 MHz.

(a) Hardware

The geometry of this antenna is folded dipole antenna. The material for ground plane and dipole is copper which is has a thickness of 0.32 mm. The feed point is by using coaxial connector.

(b) Software

The software that is used to design this antenna is Computer Simulation Technology design microwave (CST 2011). It is used to design an antenna with suitable parameters to get the simulation of return loss versus frequency.

1.5 Thesis Outline

This report comprises of five chapters and the structural outline of every chapter will be highlighted in here. Chapter I covers the introduction of the project. A brief explanation of the project will be discussed here. Chapter II presents the literature review of folded dipole antenna. It discusses the structure of a folded dipole antenna, antenna characteristics, feeding methods, methods of analysis, polarization, size reduction techniques, bandwidth enhancement techniques, advantages and disadvantages. The concept of UMTS system is also covered in here. Chapter III mainly focuses on the project methodology and development. The fundamental process required in the design, and simulation of the folded dipole antenna is explained in this chapter. Chapter IV provides the measurement results that are obtained from the antenna measurement and compared with the simulation results of the folded dipole antenna. Chapter V explains the conclusion and suggestion for further study.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

An antenna is capable of radiating and capturing radio waves. It is used to interface transmission line to free space, free space in transmission line, or both [4]. An antenna can be any shape or size. A list of some common types of antennas is wire, aperture, microstrip, reflector, and arrays. Each antenna configuration has a radiation pattern and design parameters, in addition to their benefits and drawbacks. In this section we will describe common antenna types and their benefits and drawbacks.

The transmission line couples energy from a transmitter to an antenna or vice versa. Then, the antenna couples the energy from the transmission lines into the earth atmosphere and from the earth atmosphere to the transmission line. At the transmit end of a wireless communication system, the antenna converts electrical energy travelling along the transmission line into an electromagnetic waves that are emitted into space. While at the receiving end of a wireless communication system, the antenna converts electromagnetic waves in the space into electrical energy on a transmission line.

The transmitter can be modelled as a Thevenin source consisting of voltage generator and series impedance which delivers a transmit power to the transmit antenna. The transmit antenna radiates a spherical wave which, at large distances, approximates a plane wave, at least over a localized area. The receive antenna intercepts a portion of the propagating wave and delivers a receive power. Figure 2.1 shows the basic operation of transmitting and received antenna.

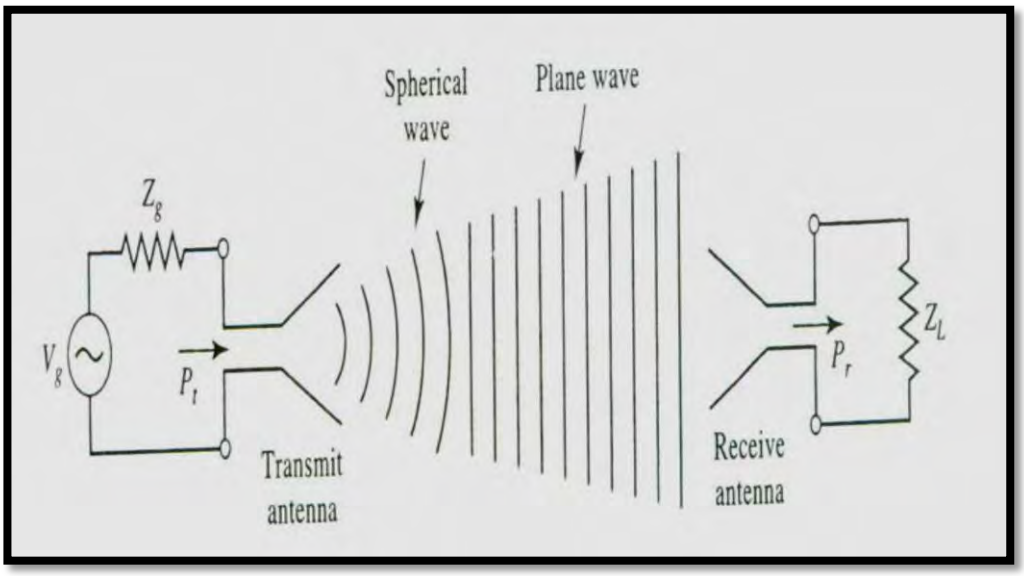

Figure 2.1: Basic operation of transmit and received antenna

2.2 Basic Characteristic of Microstrip

Microstrip patch antenna is usually in the form of layered planes which known as dielectric substrate. Printed Circuit Board (PCB) is used in fabricating this type of microstrip patch antenna such as Flame Retardant 4 (FR4), Rogers RT and Duroid 6010. This antenna consists of a radiating patch on one side of the dielectric substrate and ground plane on the other side. A basic structure of microstrip patch antenna is shown in Figure 2.2. The radiating element can be various shapes depending on its operating signal and its application in which the antenna is applied. This radiating element generally made from conductor materials such as gold or copper. The electrical characteristics of the antenna are largely determined by its permittivity and thickness. Figure 2.2 shows the basic structure of microstrip patch antenna.

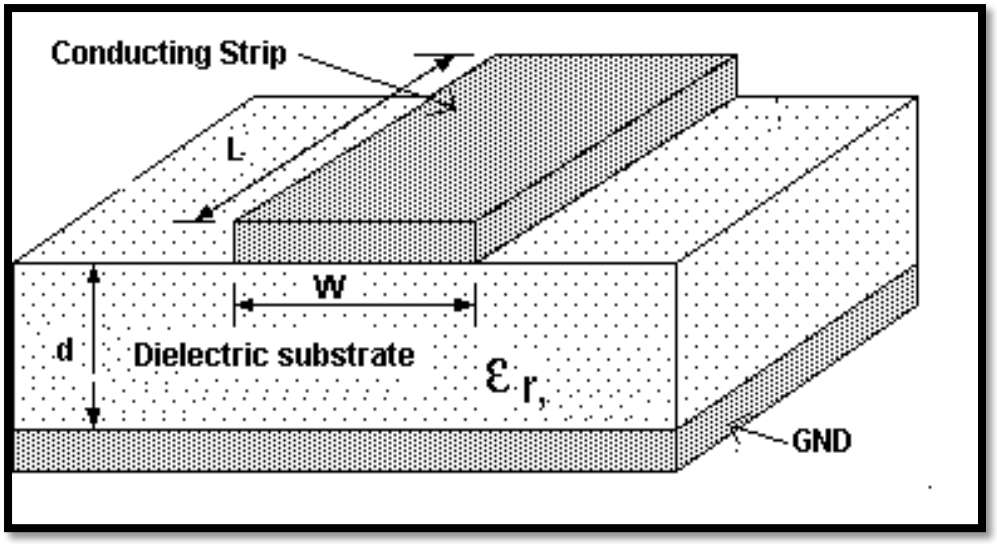

Figure 2.2: Basic structure of microstrip patch antenna

The bottom layer of the dielectric is completely covered with copper and it is known as the ground plane. The topside of the dielectric is partly metalized or patched whereby antenna or circuit pattern can be printed. Figure 2.3 shows the different shapes, which the radiating patch element may take the form. The attractive radiation characteristics, especially low cross polarization radiation make the square, rectangular, dipole and circular shapes the simple and common in terms of analysis and fabrication.

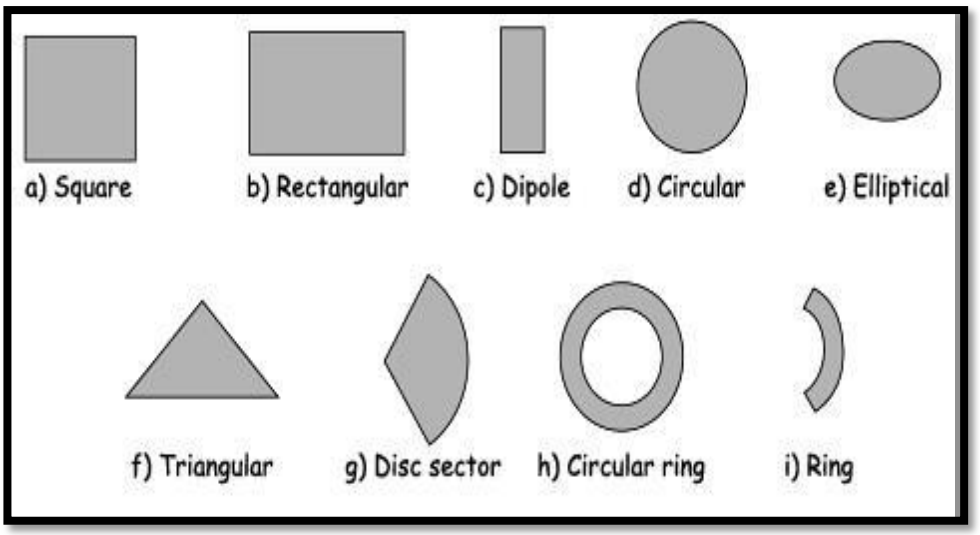

Figure 2.3: Different shapes may represent the patch

2.3 Antenna Properties

Although there are many antenna types and geometries, the most important parameters that characterize all antenna designs need to be considered. These parameters provide information about the properties of an antenna.

2.3.1 Radiation Pattern

The radiation pattern is defined as the graphical representation of power radiated or received by an antenna in a function of the angular position and radial distance from the antenna [5]. It is a representation of how the signal propagates from the antenna. In other words, the radiation pattern is a graphical representation of the relative field strength transmitted from or received by the antenna. Radiation patterns of an antenna are usually measured in the far field region in most of the cases where the distributions of radiated power are independent of the distance. It can be determined in the 2-D or 3-D plot.

The elevation pattern is when the radiation pattern in looking from the side, y-z plane, known as H-plane, and an azimuth pattern when looking for the above, x-y plane, known as E-plane. The combination of both patterns shows a 3D graphic of the radiation. The E-plane is the plane containing electric field vector meanwhile the H-plane is the plane containing magnetic field. Figure 2.5 shows the radiation pattern of the antenna. There are three types of radiation pattern to describe the antenna radiation characteristic which is isotropic, omnidirectional and directional [5].