

DESIGN OF QUAD BAND ANTENNA FOR MOTOROLA TRANSCEIVER
SYSTEM

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ABSTRACT

A rapid growth of personal communication has led to the need for more compact antennas. In addition, the increase in the capacity and quality of the new services provided by mobile communications requires the development of new antennas with wider bandwidths. At the same time, due to miniaturization of the transceivers, the antennas should have small dimensions; low profile and the antennas should have the possibility to be embedded in the terminals. This project involves the design of quad-band antenna for a transceiver system of Motorola Penang. Available antennas are for specific application and there is an immediate need to enhance these for quad-band application. The operating frequencies of the antenna that will be looked into are the 800 Mhz/ 900Mhz, the GPS frequency of 1.5 GHz and 2.4GHz is WLAN s used for potential dual mode iDEN-WLAN product Transmission line technology will be employed. The operating frequencies will be controlled by different radiating structures of the proposed antenna. Specific geometrical ratio of the individual segregated segment will be applied. Hence, the frequency ratio of two adjacent resonant frequencies can be easily tuned to the desired value of the wireless application. Simulations will be performed on the designed antennas for good quad-band operation with low reflections. The work involves simulations using SEMCADX simulation tool. This simulation tool is a 3-D EM solver and is capable of representing data in time and in frequency domain .The results obtained was analyzed.

ABSTRAK

Peningkatan drastik kualiti dan kapasiti pelbagai servis baru dalam dunia telekomunikasi, mewajibkan rekabentuk antenna baru yang bersaiz kecil dengan saluran "bandwidth" yang lebih lebar. Dalam masa yang sama, disebabkan size transeiver yang semakin kecil, rekabentuk antenna perlu mempunyai dimensi dan profil yang kecil untuk dimuatkan dalam terminal. Projek ini mendokumentasikan rekabentuk antenna "Operasi Empat Frekuensi" untuk sistem transeiver Motorola Penang. Antena sedia ada dalam pasaran kini adalah untuk applikasi spesifik dengan frekuensi berasingan. Frekuensi operasi antena yang akan direkabentuk ialah frekuensi GSM 800 MHz/900 MHz, frekuensi GPS 1.5 GHz dan frekuensi WLAN 2.4 GHz. Teknologi talian transmisi akan digunakan. Frekuensi operasi ini akan dikawal dengan struktur radiasi antena yang akan direkabentuk untuk memudahkan applikasi tanpa talian spesifik disambungkan. Simulasi akan dibuat pada antena yang akan direkabentuk untuk "Operasi Empat Frekuensi" dengan nilai refleksi yang rendah. Kajian ini akan dibuat dengan alat simulasi SEMCADX ialah alat simulasi 3D yang digunakan untuk penyelesaian elektomagnetik serta boleh membuat representasian data dalam domain masa dan frekuensi. Hasil simulasi telah dianalisis.

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CHAPTER 1

INTRODUCTION

This chapter presents an introduction, which includes the problem statement, background of the project, overview of mobile antennas, scopes and objective of the project. The thesis outline is then given.

1.1 Problem Statement

In the past decade, cellular based communications have become a necessary part of everyday life. Mobile communications are becoming increasingly integrated into both terrestrial and satellite based radio systems with the impetus being personal voice conversations [1]. The cellular infrastructure has developed and matured into a reliable system that is utilized by many different types of communication systems. Considerable effort has already been invested in developing the respective end-user devices that work on the cellular system.

The development of cellular radio system has been rapid. Alongwith, demand in the civilian use of terrestrial position-location systems has been rapidly increasing. The civilian Global Positioning System, GPS, is quickly becoming the standard for personal and commercial navigation and position location. The traditional applications useful to professional navigators and surveyors have now permeating the routine aspects of consumer life.

Existing consumer GPS applications are void of convenient method to transmit the GPS determined position and velocity information to a remote location. The GPS system of receive merely saw an obvious need to include transmit capabilities over a wireless band to relay the data to a remote location. Many different technological advances were introduced to facilitate the increased appearance of personal communication devices; i.e., faster and more highly integrated circuits, compact high-resolution display screens and lightweight powerful batteries. These have experienced a similar reduction in size. The expansion of wireless applications has also lead to an immediate need for reduced size multi-functional antennas that operate over broad bandwidths or multiple independent bands.

With the increase in applications that operate at different frequencies, there is a need for advanced antennas and antenna systems with new capabilities and better performance. The use of multiple antennas adversely increases design complexity, cost and size requirements, as shown in Figure 1.1 [2]. Therefore, there is a need for a single multi-band operating antenna.

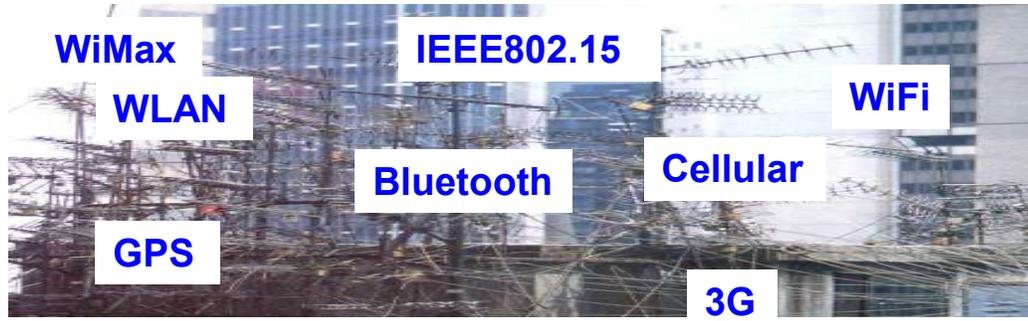


Figure 1.1: Multi antennas in a typical mobile environment [2].

1.2 Overview of Antenna for Mobile Phones

Antennas provide the transition between wireless communications interfacing the free-space medium and the RF electronic of transceiver systems. The overall perspective of wireless communication systems plus the pertinent details on the state-of-art aspects of associated technology show that, in modern deployment profile, the manufacture of mobile phones antennas poses multidisciplinary considerations. The characteristics of antennas used for mobile phones are as follows [3]:

- i. minimum occupied volume concerning portability and overall size minimization of the mobile terminal and shape.
- ii. light weight
- iii. multi-band operation for different communication standard
- iv. adequate bandwidth covering the frequency range used by the system, including a safety margin for production tolerances.
- v. good return loss, bandwidth, gain and radiation pattern, operating frequency and diversity

The design considerations have led antenna designers to consider a wide variety of antenna structures to meet the often-conflicting needs for wireless

applications. To date, relatively small antennas have found acceptance in the rapidly growing cellular phone market. Examples include monopole, loaded monopole, loop, helical, Planar inverted-F antenna (PIFA), patch or slot type and multiple antennas for diversity. Monopole antenna, is one of the latest antenna configurations [4]. It is sensitive to dual polarization as well as possesses dual frequencies characteristics. These make it even more appealing as one prime choice for growing telecommunication industry. The antenna can be generally regarded as an omnidirectional, low gain and low profile antenna. It also uses the volume sharing principle where, the longer arm can be used to resonate at a lower frequency band, while the shorter arm can be used to resonate at a higher frequency band. Another advantage of using monopole over other internal antennas is the ease of fabrication and it has favorable electrical performance such as wide bandwidth. Figure 1.2 shows the current frequency bands used by mobile phones [5].

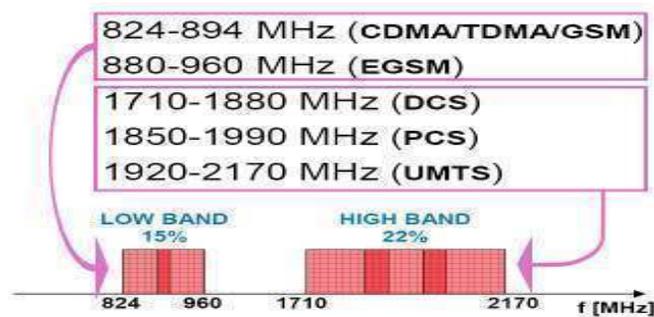


Figure 1.2: Current frequency bands used by mobile phones [5].

1.3 Objective of Project

The objective of this project is to design a quad band antenna that is suitable for a transceiving system of Motorola Penang, Malaysia. The folded monopole technology has been selected for the desired application.

1.4 Scopes of Project

The scopes of the project are as follows:

- i. Design single operating monopoles at four different bands i.e., 800 MHz and 900 MHz (mobile), 1.5 GHz (GPS), and 2.4 GHz (WLAN).
- ii. Simulate the single operating monopoles for comparison purposes.
- iii. Modify existing antenna to operate at quad band.
- iv. Simulate and perform parameteric investigations for optimum performance using SEMCADX [6].
- v. Conclude the findings.

The proposed antenna is initially designed with individual arm to resonate at the desired frequency Then, two arms are simulated together, followed by three arms which can then operate as a quad band antenna. The final configuration is then selected and further analysed by performing parameteric investigations of the ground plane size, element thickness and adding plastic to the antenna. The designed monopole antenna for Motorola Penang configurations are listed below:

- Single Arm Monopole configuration
- Double Arm Monopole configuration
- Folded Arm Monopole configuration
- J-Folded Arm Monopole configuration
- Triple Arm Monopole Configuration

The design specification of the antenna is as follows:

- (i) operating frequencies of 890 MHz to 915 MHz, 935 MHz to 960 MHz, 1.575 GHz and 2.4 GHz

- (ii) voltage standing wave ratio, $VSWR < 3$
- (iii) good return loss of < -5 dB
- (iv) input impedance of 50 ohm
- (v) efficiency of > 60 %

The chosen microwave board has the following parameters:

- (i) microwave board : RT/Duroid 5870
- (ii) thickness of substrate , h : 1.6 mm
- (iii) relative permittivity of substrate, ϵ_r : 2.33
- (iv) loss tangent of substrate, $\tan \delta$: 0.0013
- ~~(iv)~~(v) thickness of conductor, t : 35 μm

1.5 Organization of Thesis

This chapter presents an introduction, which includes the problem statement, background of the project, overview of mobile antennas, scopes and objective of the project. The thesis outline is then given.

In chapter 2, internal mobile antenna technologies are reviewed. This is followed by brief discussion on the fundamentals of antennas.

Chapter 3 presents the undertaken design methodology. Numerical simulations are described next.

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