Design and Development of Planar Antenna for GSM Application

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This report is submitted in partial fulfillment of requirements for the award of Bachelor Degree of Electronic Engineering (Wirelesscommunication Electronic Engineering) with honours

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DECLARATION

"I hereby declare that this thesis entitled "Design And Development Of Planar Antenna For GSM Application" is a consequence of my own research idea concept for works that have been cited clearly in the references."

Signature	:	…..……
Name	:	Abdulhadi Hasan Aljoumah
Date	:	……..……..……

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APPROVAL

"I, hereby declare that I have read this report and in my opinion, this report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Wireless Communication) with Honors."

Signature	:	…..……
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Date	:	……..……..……

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To my beloved family

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ABSTRACT

In GSM system, an antenna considers as a very significant part that used to transmitting and receiving signals. However, there are several Types of antennas which can be used for GSM application, but not all of them are capable of being used for the mobile device. whereas, the characteristics of planar antenna provide a solution for that in term of size and performance. This project aim is to design an antenna that provides a good performance and has a small size so that this antenna can be attached to a portable device. In this design, a CST Studio Suite software has been utilized to design a Planar Inverted-F antenna (PIFA) which operates at 868 MHz. Furthermore, once the design is completed the optimization is done using CST software prior to the fabrication process that is carried out in the laboratory of the university. Once the procedures of simulation and fabrication completed, the comparison between the simulation and measurement is carried out for all parameters, which are gain, return loss, bandwidth, and radiation pattern. Planar Inverted-F antenna (PIFA) is designed to operate at 868 MHz with return loss less than -16 dB and bandwidth up to 220 MHz. this design of Planar Inverted-F antenna (PIFA) can be used for the sake of GSM application and also can be used for Short Range Communication system.

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ABSTRAK

Dalam sistem GSM, antena menganggap sebagai bahagian yang sangat penting yang digunakan untuk menghantar dan menerima isyarat. Walau bagaimanapun, terdapat beberapa jenis antena yang boleh digunakan untuk applikasi GSM, tetapi tidak semua antenna yang boleh digunakan untuk peranti mudah alih. Manakala, ciri-ciri antena satah menyediakan penyelesaian untuk itu dari segi saiz dan prestasi. Ini matlamat projek adalah untuk mereka bentuk antena yang memberikan prestasi yang baik dan mempunyai saiz yang kecil supaya antena ini boleh dipasangkan kepada peranti mudah alih. Dalam reka bentuk ini, perisian CST Studio Suite telah digunakan untuk mereka bentuk antena Planar Inverted-F (PIFA) yang beroperasi di 868 MHz. Tambahan pula, apabila reka bentuk selesai pengoptimuman dilakukan dengan menggunakan perisian CST sebelum proses fabrikasi yang dijalankan di makmal universiti. Sebaik sahaja prosedur simulasi dan fabrikasi selesai, perbandingan di antara simulasi dan pengukuran dijalankan untuk semua parameter, “gain”, “return loss”, “bandwidth”, dan “radiation pattern”. Planar Inverted-F antena (PIFA) direka untuk beroperasi pada 868 MHz dengan “return loss” kurang daripada -16 dB dan “bandwidth” sehingga 220 MHz. reka bentuk ini Planar Inverted-F antena (PIFA) boleh digunakan untuk kepentingan permohonan GSM dan juga boleh digunakan untuk sistem Jarak Dekat Komunikasi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Wireless communication has become as one of the most famous and commonly used applications nowadays, such as personal communication services (PCS), cellular communications, satellite communications, broadcasting, High-Definition TV (HDTV), Personal Digital Assistant (PDA), wireless LAN, Bluetooth… etc. Global System for Mobile (GSM) is a second-generation cellular system standard. It's considered as the first cellular system which provides a specification for the digital modulation and network-level architecture and services. Radio Frequency (RF-ICS) for GSM standard started at 1900. GSM which was firstly introduced in Europe in 1991, is now considered as the most commonly used cellular standard. In addition, GSM is widely utilized in the world [1][2].

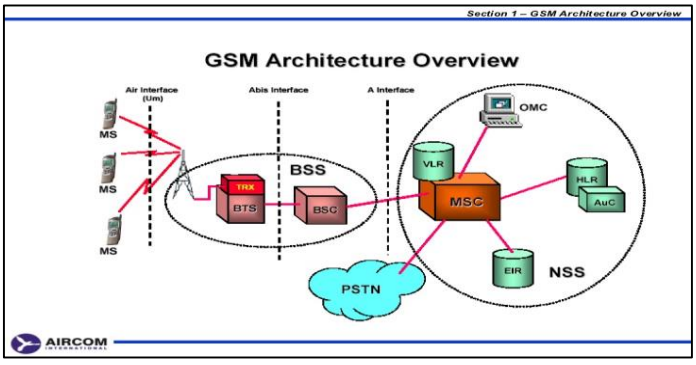

Figure 1.1: GSM structure

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In the wireless communication systems, Antenna is considered as a significant part which plays an important role in GSM application [3]. However, there are many Types of an antenna which used for GSM application, since not all type of antenna can be used for mobile, the most popular antenna that can be used are the microstrip antenna and planar antenna due to their significant characteristic. This project will introduce a planar antenna which suits mobile phone with a set of specifications.

1.2 Problem statement

Nowadays, modem and future wireless systems are placing greater demands on antenna designs. The communication equipment requires small size antenna so the weight and size of this equipment would be decreased to improve the physical appearance. There are many types of the antenna but not all of them are capable of being used in a mobile phone for GSM application. Therefore, this project proposed a small size planar antenna design for GSM phone application which has the advantages of:

i. Providing a small antenna size which can be easily attached to mobile phones.
ii. Maintaining the performance in term of (gain and return loss).

1.3 Objectives

The objectives of the project are:

i. To design planar antenna at operating frequency of 868 MHz for GSM application with bandwidth 800 to 900 MHz.
ii. To simulate and fabricate the planar antenna.
iii. To validate and verify the simulated results through experiment results.

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1.4 Scope of project

This project will mainly focus on the design, simulation and fabrication of planar antenna for GSM application at frequency of 868 MHz. However, this project will not cover dual band or wide band frequencies. In addition, once the design process is done, CST (computer suite studio) software will be used to simulate the antenna. The next procedure is to fabricate antenna and do testing and measurement. Finally, the simulation and measurement results will be compared.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter covers the background and the fundamentals of antenna parameters that affect the performance of the antenna in any wireless system. In addition, this chapter present the researched journals that were reviewed about antenna deigns to achieve our specification at frequency of 868 MHz. After going through the desired journals, a comparison was done to ensure the best method is selected to complete the project.

2.2 Critical Literature Review

The literature review was performed by referring to some journals to collect the related information and facts that can be used in the design process of this project. Prior to design process; research was carried out by performing a review of the literature in several journals related to research the topic of design and development of planar antenna for GSM application. In this part, firstly, every journal will be explained.

2.2.1 Planar Dipole Antenna Design at 1800mhz Band Using Different Feeding Methods for GSM Application

The proposed of this design is about planar dipole antenna which is designed to operate at 1800MHz.Whereas, in this design different feeding methods are used for GSM application.

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In addition, this paper focused on designing and simulation of planar dipole antenna at 1800 MHz. However, two types of feeding configuration have been used to feed the antenna in order to match 50-ohm transmission line, the via-hole integrated balun, and quarter wavelength open stub. As a result, the via-hole integrated balun shows maximum return loss of -25db and bandwidth can be improved up to 25% and 30%. VSWR of 1.116 v at a length of 59 mm and width 4 mm. While the quarter wavelength open stub provides max return loss of -47.88db with VSWR 1.008 << 2 and also shows a better radiation pattern. For implementation, the quarter wavelength open stub method is very convenient and suitable, since it does not require soldering through it and also has narrow bandwidth but again it depends on the application requirements [3][4] .

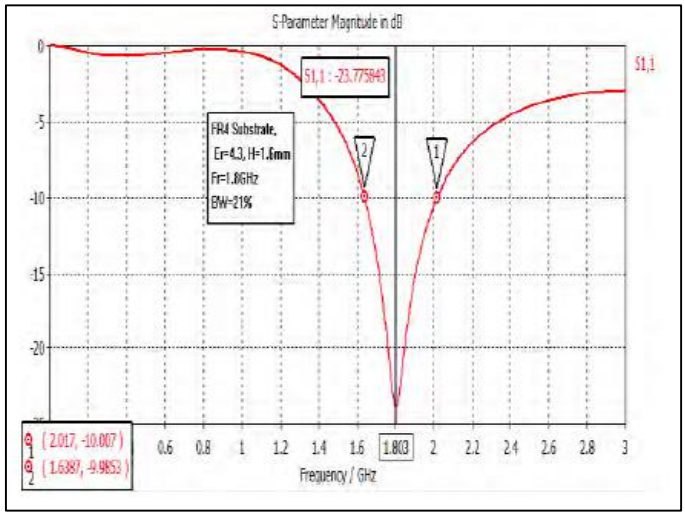

Figure 2.1 Return Loss 1800 MHz of antenna

2.2.2 Broadband Planar Antenna Based On CRLH Structure for DVB-H and GSM- 900 Applications

The research work of this paper proposed a broadband planar antenna based on a CRLH structure which has been developed for DVB-H and GSM-900 handsets application. whereas, the resonant frequencies of the antenna are determined by the four CRLH parameters, which are independent of the size of the antenna. As a result, it has been found that the planar antenna can achieve a bandwidth of more up to 70% covering the frequency range from 470 to 960 MHz. In

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addition, the broadband performance of the planar antenna has been demonstrated by simulation and experiment. Finally, the measured gain, efficiency, and radiation pattern meet the requirements for DVB-H and GSM-900 applications[5][6].

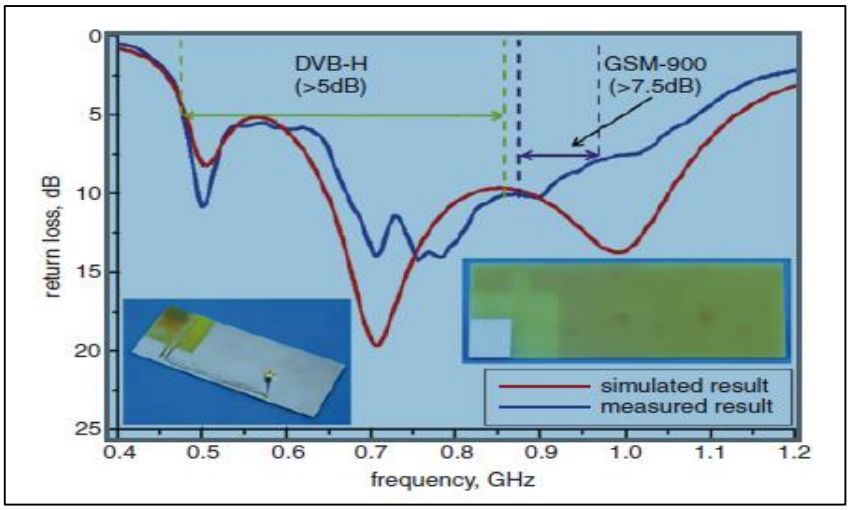

Figure 2.2 Measured return loss of proposed antenna compared to simulated result

2.2.3 Band Miniaturized Microstrip Fractal Antenna for A Small GSM1800 + UMTS Mobile Handset

In this paper, the author introduced a novel design of a fractal miniaturized mobile terminal antenna. A miniaturized fractal edge patch in a PIFA configuration has been used as a method to design the antenna. However, the patch element length reduced down to 0.17h, which is 38% of a common rectangular patch. In this design, the ground plane is used with a small handset size. In addition, this design meets the requirement of handset applications for mobile communications. As a result, the structure matched to 50 R, the size (1 0~4. 5c m) and radiation pattern with the low directivity. (VSWR 5 3) in the frequency range covering GSMl800 and UMTS operating bands. The results have matched and validated the requirement of the antenna design by following the procedure[7][8].

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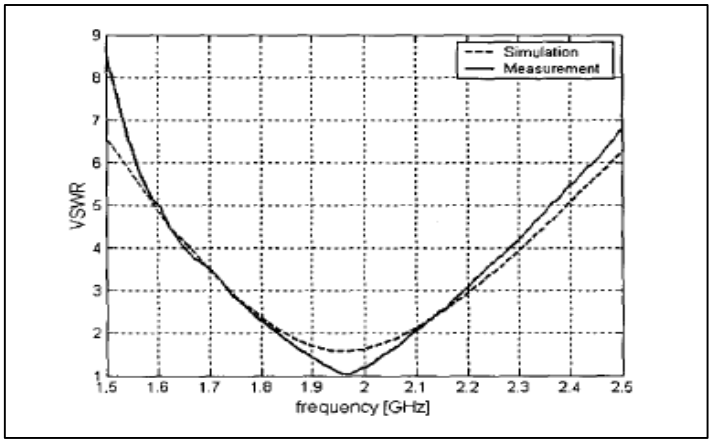

Figure 2.3 Comparison of simulation and experimental VSWR results

2.2.4 Planar Compact Bidirectional Dual Wide Band Antenna for GSM and UWB Communications

The study of this research proposed a planar compact bi-directional antenna configuration for dual wideband operation with a wide lower band and ultra-wide higher band. The technique used in this paper is integration technique. In addition, it shows a characteristic with significant compactness. however, this configuration has been analyzed using finite integration technique based on commercial software CST studio. An antenna is optimized for 865 MHz to 1.42 GHz lower operating band and 2.5 GHz to 20 GHz higher operating band. The frequency domain analysis provides a good study about different characteristics of the SPSTMA. As a result, it has been concluded that the shorting strip reduces the size of the antenna and can be used to tune the operating frequency band.

In this case, because of the shorting strip, we get an additional GSM 900 band, which is the most significant observation in this study. As an advantage, the combination of GSM band and UWB makes the antenna suitable for various wireless communication applications. In term of design, the measured return loss agrees with the simulated result. The effect of shorting the radiating patch to obtain compactness and tuning operating[9][10].

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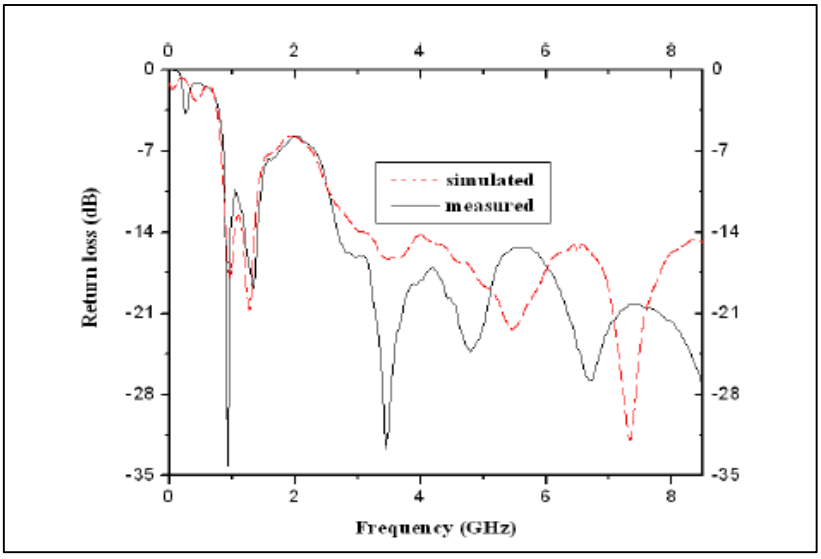

Figure 2.4 Simulated and measured return loss for SPSTMA

2.2.5 Dual Band Micros-Trip Patch Antenna for GSM And WiMAX Application

The author of this paper proposed a microstrip line fed single frequency microstrip patch antenna for GSM 1800 Band and WiMAX application that has been designed and simulated using CST Microwave Studio software. The operating frequency that covers the GSM 1800 from 1.78 GHz – 1.84 GHz, while 5.37 GHz to 5.62 GHz covering WiMAX communication standard. Slotting technique "U SLOT" was used to design this system. In term of the simulation, the simulated impedance bandwidth at the 1.8 GHz band is around 69 MHz with the corresponding value of return loss as -18 dB and simulated impedance bandwidth at the 5.5 GHz band is around 253 MHz with the corresponding value of return loss as -18 dB at 5.5 GHz which is small enough and frequency is close enough to the specified frequency band feasible for WLAN application. This return loss value i.e. -43 dB show that there is good impedance matching at the frequency point below the -10 dB region. An omnidirectional radiation pattern result has been obtained which seems to be adequate for the envisaged applications. For a better performance, Work is going on to get even better results with good axial ratio over a wide bandwidth [11][12].

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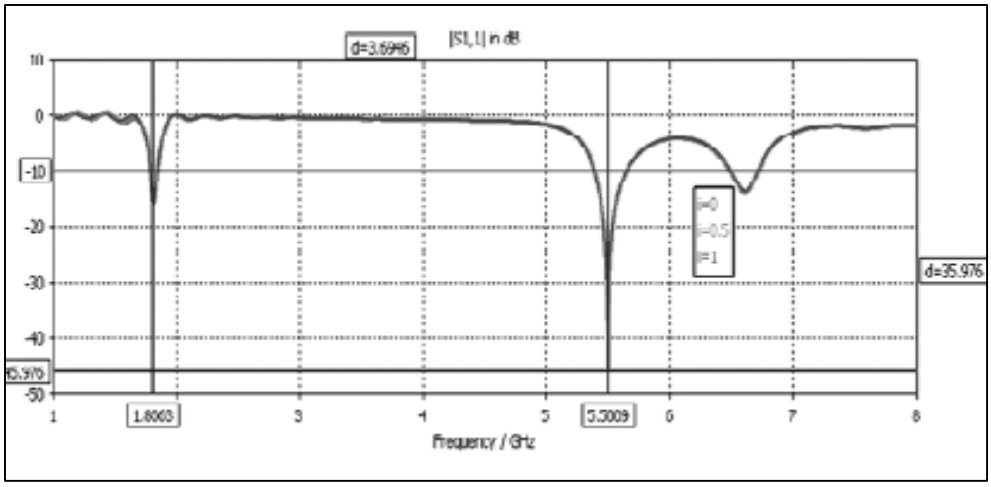

Figure 2.5 Simulated Return Loss Curve

2.2.6 Electrical Characteristics of a Dual-Band Micros-Trip Patch Antenna for GSM/ UMTS / WLAN Operations:

In this paper, the research of work focused two single rectangular patch antennas with a slot which are designed and analyzed theoretically based on the concept of multi-cavity structure for GSM, UMTS and WLAN system applications. Basically, a thick substrate is used to increase the antenna bandwidth with a good impedance bandwidth performance. The simulation of this antenna has been made by advanced design system (ADS) in the band of frequency between 50 Hz and 3.2 GHz; for that the simulation results show the presence of three resonant frequencies (fr1, fr2, fr3) and having the behavior of a dual band frequency antenna for GSM, UMTS and WLAN system applications. As advantage, this antenna gets a good effectiveness on the totality of the three covered bands respectively, GSM, UMTS, and WLAN frequency bands. However, this work needs to be studied further to have more precise [13][14].

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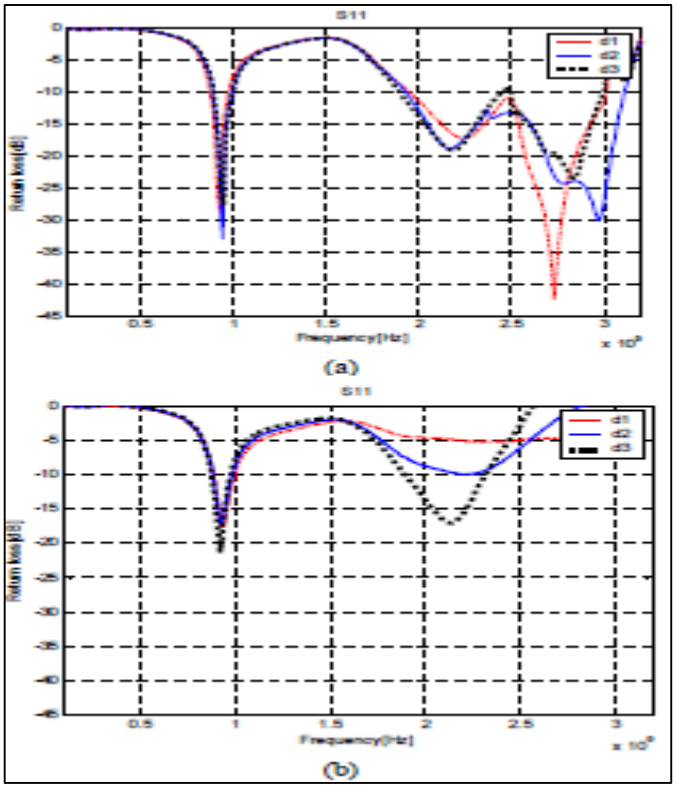

Figure 2.6 Comparisons of the simulated return loss for different distances

2.2.7 Dual-Band Micros-Trip Antenna for GSM Applications

In this paper, the authors have proposed a dual band antenna for applications in GSM 900 and 1800 bands. For that, the dual resonance was obtained by perturbing the resonant frequency of the third mode which was obtained by adding a narrow slot in the quarter wavelength patch and optimizing the dimensions of the slot and the patch. Measurements on the prototype were performed. As observation, it was figured that there was a satisfactory impedance matching in both GSM bands that was obtained and it was found that the Measured gain was around 3.8 dB in lower band and around 9 dB in the upper band. The comparison between The calculated and the measurement showed a good agreement in term of results. For both bands, similar radiation characteristics were observed which conforms to usual demands on dual-band antennas. In addition, the current distribution for both models was analyzed and compared with the case when the slot was not present. The slot strongly affects the current pattern of the upper resonance while exhibiting smaller influence on lower resonance. As

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advantage, using the described antenna design, a good impedance matching is obtained in both bands using a single feed because of simplicity [15][16].

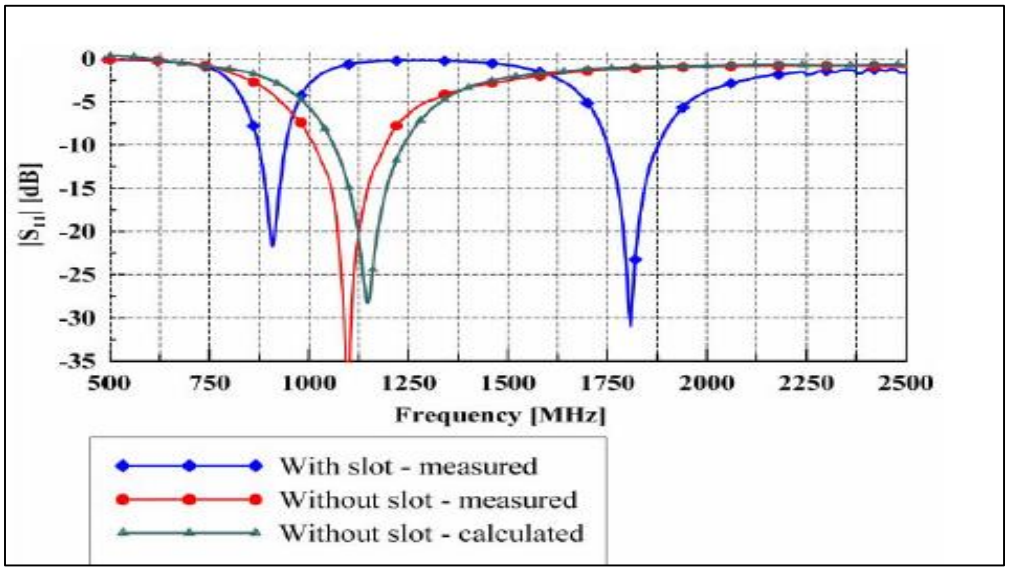

Figure 2.7Calculated and measured magnitudes of the input reflection Coefficient (S_{11}) for the final antenna design

2.2.8 A Small Patch Antenna for GSM Applications

The research work in this paper proposed a small GSM patch antenna which designed to meet the specification of automatic GPS tracking system in order to be able to communicate at GSM 850/90011800 applications. In this design, a Combination of three structures are used including small holes, "fingers", and the meandered lines is used in order to enhance the return loss of the antenna in both low and high GSM bands. To improve the impedance and to reduce the return loss in both lower and upper bands, the holes were added. In addition, to improve the antenna operation in GSM lower band, the three "fingers" were added. In this research, small GSM patch antenna satisfied the -lOdB recommendation. The results show that, the return losses for the fabricated antenna at 850MHz, 900MHz, and 1800MHz are -11.18dB, -12.02dB, and -11.31dB, respectively [17][18].

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