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A Study on Antennas Used in Mobile Device

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ABSTRACT*:* Main objective of this survey is to provide the readers and practitioners in the industry with a broader understanding of mobile phone antenna design. Beginning with a description of historical development of mobile phone antenna and then describes the most commonly used antenna such as folded, PIFA and monopole antennas The survey clearly defines the size, bandwidth ,return loss, and radiation parameters of antenna. To this end, this paper contributea multi-band internal folded monopole/dipole/loop antenna has been proposed.A folded dipole are more advantages than Planar Inverted-F Antenna (PIFA) and monopole antenna because it provides three resonant modes that could be generated in a single continuous loop structure.

KEYWORDS*:* Folded dipole antenna, folded monopole antenna, loop antenna, mobile antenna, multi-band antenna**.**

I. INTRODUCTION

During the past years, mobile communications have been grow in a very significant way. Nowadays, mobile handsets are multimedia device, not only make receive calls, but also take photos, play some music and so on. Technologies focused on functionalities, design and aesthetics of the handsets. Size and weight are the two main parameters that depend on antenna design.

In the past the mobile phone was big and antenna placed on the top of the phone. Nowadays the internal antenna has been using ,the main reason of that is the internal antenna has low SAR value, on the other hand the size of the mobile phone is reduced. There are manly four types of the internal antennas PIFA antenna, folded dipole, fractal antenna and monopole antenna. Those kinds of antennas cover a single band, dual band, wideband and multiband. PIFA antennas are used commonly used in mobile phone antennas design due to its advantages such as SAR rate, but it have a narrow bandwidth. Wideband and multiband PIFA antenna can solve that problem. The advantage of the fold monopole/dipole/loop antenna is that it can operate as a folded monopole as well as a folded dipole with, modes simultaneously. This can cover GSM850/900 band (824–960 MHz) and GSM1850/1900/UMTS2100 band (1710–2170 MHz) which normally cannot be readily covered by either a single PIFA or monopole antenna.

II. RELATED WORK

In this section, several existing mobile antenna are discussed. In author [1] used an, folded dual-loop antenna to meet GSM/DCS/PCS/UMTS. The antenna, formed with a bent-shaped radiator, with a pair of symmetric meander strips size of 50 (x) 9 (x) 9 (x) mm^3. By properly designing the strip length and space between the radiator and ground plane, the antenna not only provide good resonance property, but also provide two desired operating frequency bands covering 847–971 and 1670–2230 MHz .Geometry of the proposed folded dual-loop antenna, use pair of symmetric meander stripsto form two loops for GSM/DCS/PCS/UMTS operations. Antenna size, can be reduced byconstructing two perpendicular layers to obtain a bent-shaped radiator.so overall dimensions of the antenna are merely 50 (x) 9 (x) 9 (x) mm to be embedded inside a mobile handset. And a 0.2-mm-thick copperplate with a size of 90 (x) 50 (x) mm is selected as the ground plane for simulating handset application as show in fig .1

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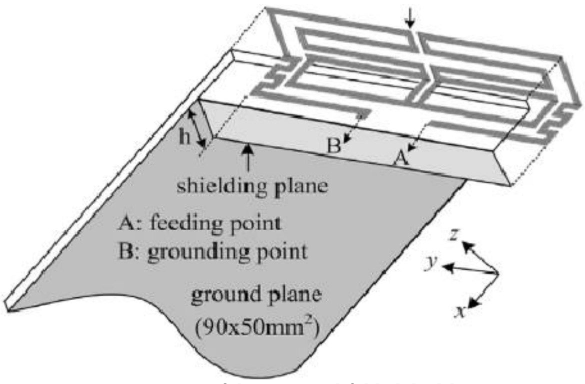

Fig. 1. Geometry of the proposed folded dual-loop antenna.

To meet the multiband demands of GSM/DCS/PCS/UMTSsystems, multiple resonance paths are required in our antennadesign. Hence, two loops of the antenna need to be developedwith different lengths, as shown in Fig. 1. We can observethat the longer loop corresponding to one wavelength at 900 MHz, is working forthe lower band. With regard to the upper band operation, theshorter loop is designed to beone wavelength at 1800 MHz. For widening the upper band,the center vertical strips having a coupling structure also cangenerate a resonant mode at 2100 MHz, where a gap amongthem is well evaluated about 1 mm to realize good radiationperformance. Consequently, two proper operating frequencybands suitable for GSM/DCS/PCS/UMTS applications canbe achieved with our antenna design. Also note that a gapbetween the feeding point A and the grounding point B isdesigned to be 8 mm, which is capable of tuning the operatingfrequencies of the antenna.Ansoft HFSS, has been used to simulate and analyse the electrical characteristics and radiation performance of the antenna. The design parameters optimized for the antenna have been eventually determined with L1=24.5 mm, W1=3mm, w2=6mm, g1=1mm, g2=8mm, and H=8.8mm.

A. DUAL-BAND PLANAR INVERTED-F ANTENNA

In this paper, the method of moments (MoM) has been used to allow modelling and simulation of the dual-band antennas. To understand the operation n with a conventional PIFA (the slot is removed) using air dielectric with dimensions (l, w) = (40, 25) mm, height h = 10mm in which the shorting strip of width w Short = 9mm is located at one end of the plate as shown in Fig. 2.

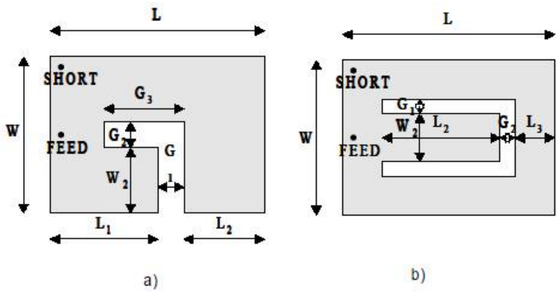

Fig. 2. Geometry configurations for L-shaped slot PIFA a), and for U-shaped PIFA b).

The coax feed is connected directly to the top plate at the same edge as the shorting strip is located. The distance of the feed location in the middle of top plate as shown also in Fig. 2. The resultant resonant frequency from the method of moments (MoM) simulations is 1.2GHz. To this conventional PIFA an L-and U shaped slot is added to determine its effects on the resonant frequencies and the bandwidth.

Two different slot shapes are used to obtain the dual-band operation. Series of simulations were used to investigate how different physical parts of the L- and the new U-shaped slot PIFAs affect the input impedance, bandwidth and resonant frequencies of the antenna. It was found that adding L-shaped slot has an effect of moving the lower resonant frequency depending on thelength of L2 and the control of the upper resonant frequency is dependent on many physical parts of the antenna. For the new U-shaped slot PIFA both the lower and upper resonant frequency can be determined

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independently, which makes the design procedure simpler. The bandwidth of these antennas were found for the lower resonant frequency as 4% and 9.6% for L-shaped slot and U-shaped slot PIFA's, respectively. The upper resonant frequency bandwidth is almost the same for the both slot shapes.

B. INTERNAL TRIPLE-BAND PLANAR INVERTED-F ANTENNA

In this paper an internal triple-band planar inverted-F antenna (PIFA) for operating at Personal Communication Services/International Mobile Telecommunications 2000/Bluetooth bands [3]proposed. The proposed antenna size can be reduced by using the radiating element with thickness and via hole. A broadband characteristic is achieved by optimizing the thickness of radiating patch and the offset gap between patch and ground plane. The dual resonant frequencies can also obtained by optimizing the slit lengths and the location of via hole. This proposed antenna is well suited to the internal antenna due to small size and wide bandwidth of about 42%, which is covered with thePCS (1.75–1.87 GHz), IMT-2000 (1.92–2.17 GHz) and Bluetooth(2.402–2.48 GHz) bands.

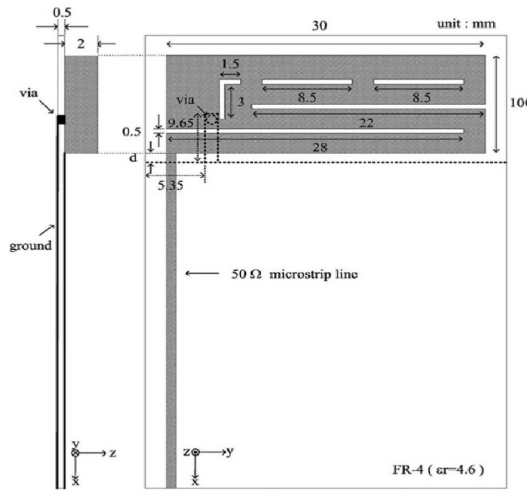

Fig. 3. The geometry of the proposed internal triple-band PIFA

The geometry of internal triple-band PIFA for operating at PCS/IMT-2000/Bluetooth bands is shown in Fig. 3. The radiating element is made by copper and is a rectangular shape with slits which adjust to the surface current paths. Its size is 30 mm 10 mm 2 mm. The proposed PIFA is soldered on the same shaped metal that is etched on the FR4 substrate with the thickness of 0.5 mm, relative permittivity of 4.6, and the size of substrate is 76 mm 38 mm. A 50 micro strip line is used to feed this proposed PIFA and etched on the FR-4 substrate. On the other side of the substrate, the ground plane is cut at away from the end of the micro strip feed line. The additional ground (1.3 mm 9.65 mm) is used to connect the patch and ground through via hole. The offset gap affects the impedance matching. The small size of proposed antenna is suitable to design in practical mobile handsets. Though the PIFAis usually used to shorting pin for guiding the surface current to the ground, this proposed antenna is used to via hole instead of shorting pin to connect the patch to the ground plane. In addition, the air gap between patch and substrate of PIFA is required more than 6 mm for impedance matching. However, this proposed antenna takes off the air gap for matching between the patch and substrate. The overall height of proposed antenna is 2 mm by using a thicker metal and via hole. The overall volume of proposed antenna can be attractive features in the internal antenna. As the thickness of radiating element is increased, the impedance bandwidth is broadened. However, the gain is decreased so the thickness of radiating element is optimized by considering the impedance bandwidth and the gain simultaneously.

C. HEXA-BAND ANTENNA FOR MOBILE HANDSET APPLICATION

In this paper hexa-band antenna for mobile handsets application is proposed and analyzed in this communication. An [5] asymmetric T-type monopole antenna with a shorted-line is used and operated in CDMA, 824–894 MHz, global GSM, 880–960 MHz, DCS, 1710–1880 MHz, PCS, 1850–1990 MHz, wideband code division multiple access (WCDMA, 1920–2170 MHz) and Bluetooth 2400–2484 MHzbands. Antenna length is 50 mm, 3 mm in height and 15

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mm in width is fabricated and experimentally investigated. For an input power of 24 dBm in CDMA, GSM and WCDMA bandsand an input power of 21 dBm in DCS and PCS bands all have theSAR limit of 1.6mW/g. The antenna structure is composed of an asymmetric T-type monopole and it is printed on a FR4 glass epoxy substrate and thickness is about 1.6 mm, with relative permittivity of 4.3 loss tangent of 0.023.

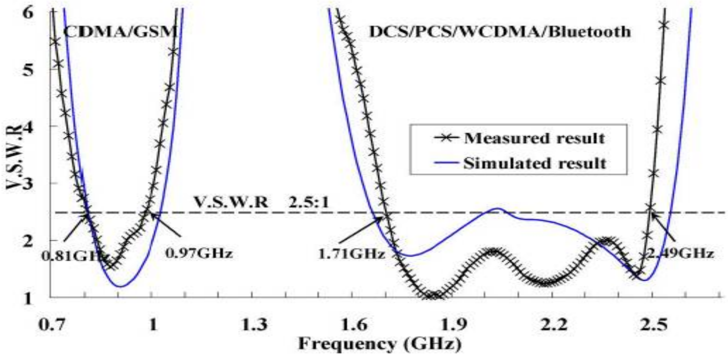

Fig. 4. The measured and simulated V.S.W.R against frequency.

In the experiment, the feeding-point and ground-plane are connected to a 50 _ SMA connector. By using the design procedure, a hexa-band antenna operate in the range of a dual operating- band: CDMA and GSM in lower operating band and DCS, PCS, WCDMA and Bluetooth are upper-operating band. Fig. 4(a) shows the measured and simulated V.S.W.R plot of the dual band antenna and theV.S.W.R bandwidths are 135 MHz (15%) and 790 MHz author found that a good agreement between the simulation and measurement is obtained.

D. HEXA-BAND FOLDED DIPOLE ANTENNA WITH FOUR RESONANCES FOR MOBILE DEVICE

Author propose a hexa-band internal folded monopole/dipole/loop antenna has been proposed. The proposed antenna has four resonances in which three of them are .5mode, .1 mode, 1.5mode, and 2 mode. Main feature of antenna is an extra folded dipole modes. All four modes cover the Low LTE700, GSM850/900 Band and the High GSM1850/1900/, UMTS2100.

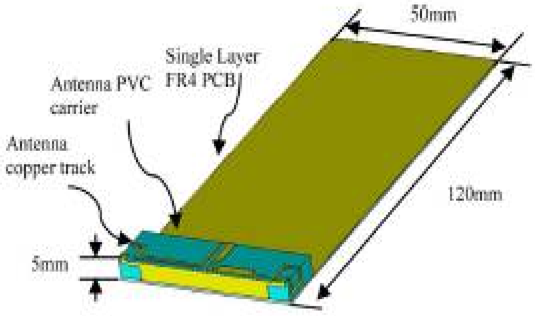

Fig. 5. Geometry of the proposed hexa-band folded monopole/dipole/loop antenna.

The configuration of the proposed antenna shown in Fig. 5 antenna with antenna carrier and identify the antenna dimensions bysmall 11mm grids. The antenna is placed on a 5 mm height carrier and it is located at the bottom of a 120 mm long printed circuit board (PCB). There is a 13 mm ground plane clearance underneath the antenna the total antenna volume is 50 x 13 x 5 mm^3. Single continuous loop element with two connections to the PCB through a feeding point anda grounding point. Where their track widths (W_A, WB, and W_C) are 2, 2.8 and 4.5 mm and track lengths (L_A, $L_B$and $L_{C)}$ are 5.8, 10 and 37.8 mm, respectively. The antenna track is folded up around the bending lines donated as dot-dash ones which are formed at the edge on the top of the antenna carrier. The PCB thickness is about

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0.8.size of FR 4 substratewith relative permittivity of 4.4 and loss tangent of 0.02. The antenna carrier is made of polyvinyl chloride (PVC) with relative permittivity of 2.9 and loss tangent of 0.005.

In order to excite the extra resonance and utilize all modes in a contiguous manner. This effectively loads or de-loads specific modes of the antenna either capacitive or inductively .Therefore, this proposed loop antenna can be potentially fabricated on 3D surfaces without relying on the complicated and expensive 3D manufacturing technology such as Laser Direct Structuring (LDS).

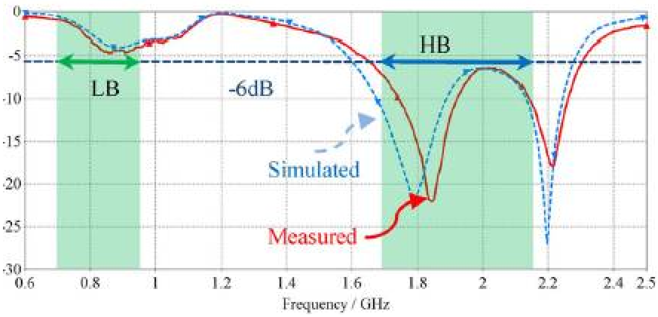

Fig. 6. Measured and simulated result.

The proposed antenna has been simulated, fabricated and measured.And antenna is resonating at low LTE700, GSM850/900 Band and the High GSM1850/1900/,UMTS2100 .Obtained by using CST Microwave Studio it can be seen from Fig. 6 that the simulated results agree favorably with the measured ones. Fig. 6 reveals the reflection coefficient at the LB is not adequate for a typical communication device because it normally requires less than 6 dB this is a fairly common phenomenon with the folded monopole antenna of the mode at the LB since its impedance is four times of that of a monopole antenna. This results in the high input impedance at the LB. ITE Therefore it is necessary to have an impedance transfer matching network.

III. CONCLUSION AND FUTURE WORK

In this paper, different mobile antenna are surveyed. There are mainly three types of antenna are used PIFA, Monopole, Dipole. By using folded dipole antenna we can increase the bandwidth. At last a novel hexa-band folded/monopole/dipole/loop antennawith four resonant modes has been developed. The main feature of the antenna is that it offers the extra balanced mode utilized to cover wide cellular bandsincluding the LTE700/GSM850/900 band (698–960 MHz) andGSM1850/1900/UMTS2100 (1710–2170 MHz) band.it allows us to mitigate end users and heads and handhold devices with embedded antennas. By comparing with conventional Unbalanced PIFA and monopole antennasdipole antenna is relatively large. Extensions can be done on the designed model to support more bands by in the wireless spectrum.

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BIOGRAPHY

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