DESIGN AND SIMULATION OF PIFA ANTENNA FOR COMMUICATION APPLICATION

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ABSTRACT

A PIFA antenna has been designed to meet the coverage requirements of the DCS, PCS, UMTS and WLAN bands. The antenna consists of a main patch, rectangular feed, shorted ground. The radiator side rectangular feed, shorted ground, using simple feed lines with broadband characteristics. The handset represents the finite ground plane, and a pin is situated across the feeding point for tuning purposes. Initial tuning was obtained by placing lumped capacitors, instead of the varactor, over the radiator. good agreement is obtained between the predicted and measured input return loss, gain and radiation pattern over the tuned frequency range.a new planar inverted-f antenna with a tri-band frequency starting from 1500 MHz ,1900MHz 2.2 GHz is proposed as an alternative for high performance mobile phones intended to cover the major part of the mobile phone frequencies worldwide. A prototype of the antenna was constructed on HFSS and the return loss and radiation patterns were measured to demonstrate an adequate radiation performance. The antenna dimensions are compatible with the requirements imposed by the most recent commercially available smart phones.

I. INTRODUCTION

The planar inverted-F antenna (PIFA) remains as one of the most popular antennas used in mobile phones today [1, 2]. It is extensively employed owing to its small size, low profile, excellent performance, simple fabrication and relatively low specific absorption rate (SAR) [3, 4]. However, a conventional PIFA has an inherent narrowband that has to be enhanced in order to fulfil the increasingly bandwidth requirements imposed by the new handsets. If a mobile terminal is designed for global coverage and international roaming, the antenna should be able to operate in dozens of frequency bands to cover the many 2G, 3G, and 4G networks around the world [2]. Achieving this is not an easy task considering that the new smart phones demand more space for the electronics associated to multiple functionalities that these terminals, leaving small room to accommodate the antenna system. In the past, several techniques have been used to improve the bandwidth of PIFA antennas. The introduction of various resonant elements in order to create a multiband PIFA is a very common approach [4,6]. Another method calls for the addition of parasitic patches with resonant lengths close to the frequency band where the bandwidth improvement is required [7,9]. The inclusion of slots in the ground plane has also been used to enhance the bandwidth mainly in the lower frequencies of the spectrum allocated to mobile phone services [10, 12]. Finally, a combination of the previous techniques is frequently utilized to add the effects of each method and increase the PIFA bandwidth. The foregoing techniques have the ability to increase the number of bands in which a PIFA can operate or to enhance the bandwidth of some of the bands of interest. An interesting new approach that is an alternative to the well-known techniques is to design a PIFA with a tri band frequency that is capable of covering all the mobile phone bands within that single wideband. The antennas reported in [18, 19] utilize this new technique. PIFA antenna is easy to construct and have dimensions that fall within the limits of many antennas for mobile devices. However, the height of the main patch element above the ground plane in antennas is 2.5 mm. That is a construction restriction that is not allowed in many new smart phones where the very low profile of the antenna system is imperative. Besides, this antenna cannot work on the very important bands of 800 an900MHz where numerous mobile phone networks operate around the world. On the other hand, it can cover the cellular bands of 1500MHz,1900MHz and 2.2GHz as well as any band below 6 GHz. This frequency is used in mobile communication.

II . ANTENNA CONFIGURATION

A schematic diagram of the new antenna is shown in Figure 1.like conventional PIFAs where the feeding terminal is very thin, the new antenna has also thin terminal that provides a different frequency slots. However, the use of a thick feeding terminal alone, does not create a bandwidth that includes the frequencies below 1.6 GHz, approximately. If the antenna is aimed to be employed for mobile phone terminals it should also cover the bands of 2.4 GH. In the present case, the addition of slots in the ground plane seems to be the most suitable. The use of slots in the ground plane has the purpose of electrically elongating the ground plane in such a way that a new low frequency electromagnetic mode will be excited and the antenna can work properly at the lower part of the mobile phone frequencies. As seen from Figure 1, the ground plane size is 100×40 mm, close to the dimensions commonly found in smart phones. If a conventional PIFA were designed to reach the frequencies around 1500 MHz,1900 MHz and 2.2GHz the ground plane would be smaller and that size would be permitted in the vast majority of mobile phones. For that reason, the slots in the ground plane are very helpful to extend the electrical size without increasing the physical size. The size and position of the slots shown

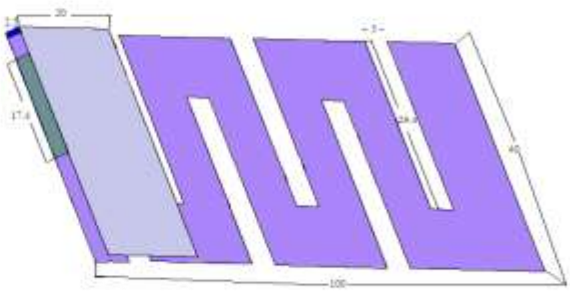


Figure1. Geometry of the proposed PIFA. All dimensions in mm.

Table 1 Antenna parameters with Dimension

S.NO.	ANTENNA PARAMETER	LENGTH Value (mm)	BREATH VALUE (mm)
1	PATCH	20	40
2	GROUND	100	40
3	PIN	1	2.5
4	RECTANGLE FEED	17.4	2.5
5	GROUND SLOT	29.4	5

Figure 2.1 is obtained after an optimization process where the different frequency are obtained. Note that the slots are located on ground plane just below the patch element although one or more than one slots exceeds the border of the main radiator element above. However, there is sufficient free space in the ground plane surface to place all the electronics needed in the mobile terminal. The slots decrease the electrical size ¸ around 1500 MHz and 1900 MHz where it has been found that a low frequency mode is excited and the antenna can work properly in the lower part of the mobile phone bands [11]. From Figure 1 it is also noted that the shorting strip between the main radiator element and the ground plane is located in one corner of the antenna structure. This short-circuit is not different from the ones used in conventional PIFAs.

III. SIMULATED AND MEASURED RESULTS

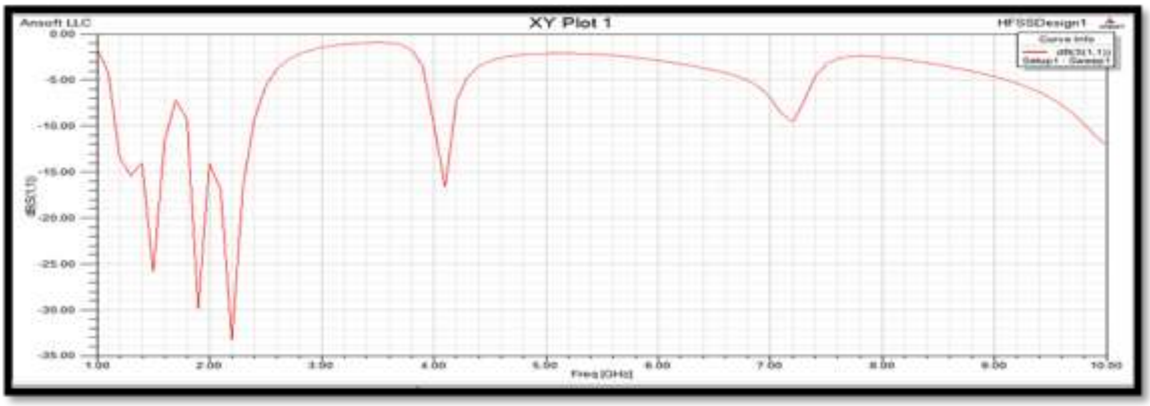
The new antenna proposed in this paper was developed and optimized with the assistance of the HFSS (High Frequency Spectrum Simulator). The structure of Figure 1 was introduced into the simulations along with a model of an SMA connector to consider the external feeding of the actual antenna. The distance between the short and the feeding terminal, the size and position of the slots, and other important dimensions were optimized to low profile frequency with the lowest possible reflection coefficient.

A. S11 parameter

S11 gives us the insertion loss of antennas. Insertion loss is proportional to the ratio of reflected to the input power of the antenna. Antennas generally radiate efficiently for particular range of frequencies. At these frequencies the radiated power should be almost equal to input power, i.e., reflected power should very small. So the expected plot of s11 for an antenna would be a flat line throughout the frequency scale with deep dip in the operating frequency range.

The dip is the central operating frequency of the antenna. The operating frequency of the antenna was found to be 1500MHz, 1900MHz and 2.2 GHz. The s11 measured at these frequency were -26.80dB,-31.40dB and -24.81 dB. For the antenna we got more than one dip. The reason for this was that our antenna, being an array of slots, was radiating at different frequencies which were very close or in range of PIFA.

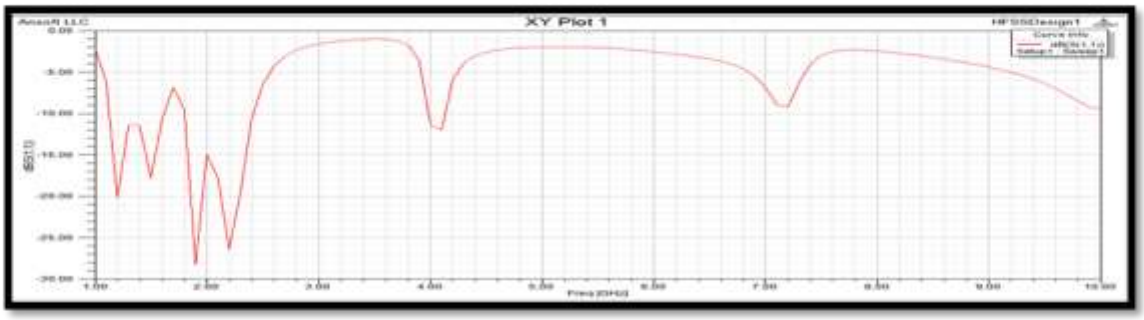
The Variation in dimension of antenna like patch length, ground slot length and position of feed the following variation in s parameter as shown below:



(a)

(b)

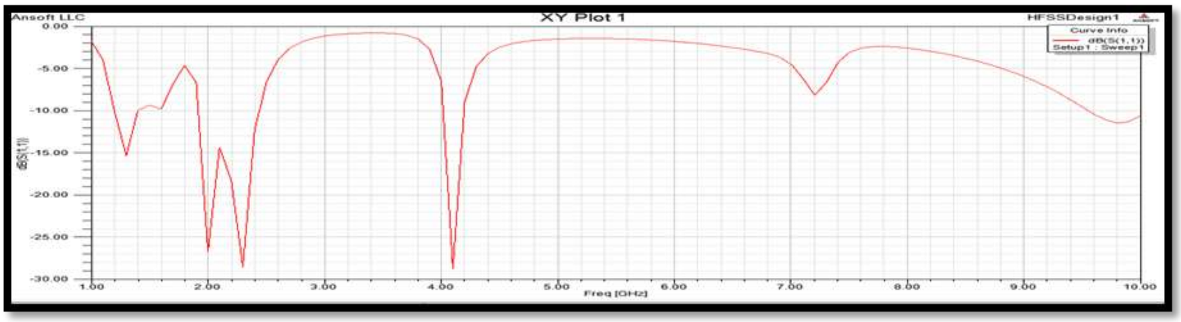
(c)



(d)

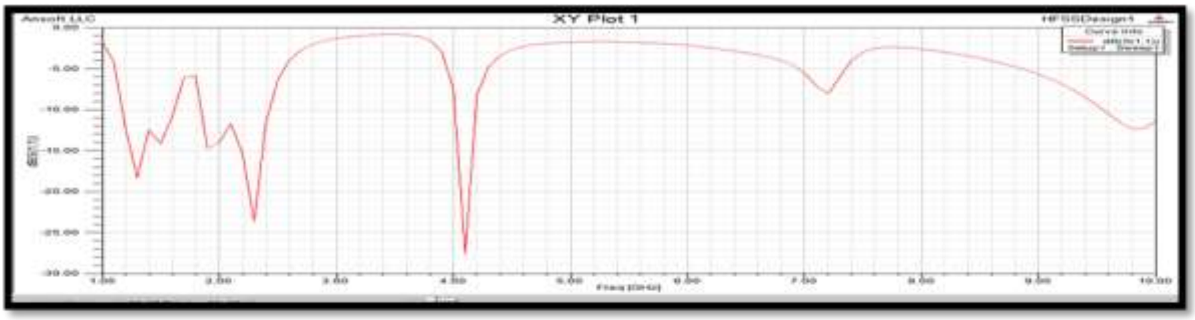
(e)

Figure2. Variation patch length (a)19.9mm, (b)20.5mm, (c)20.8mm,(d)21mm,(e)22mm,



(a)

(b)

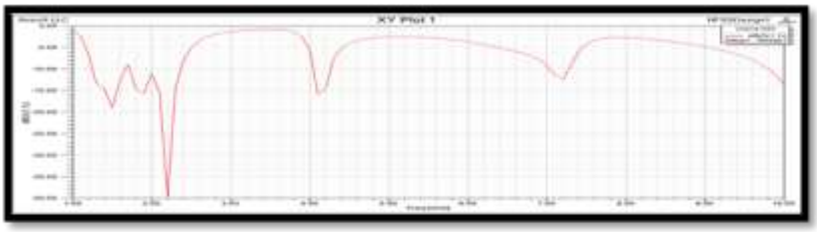


(c)

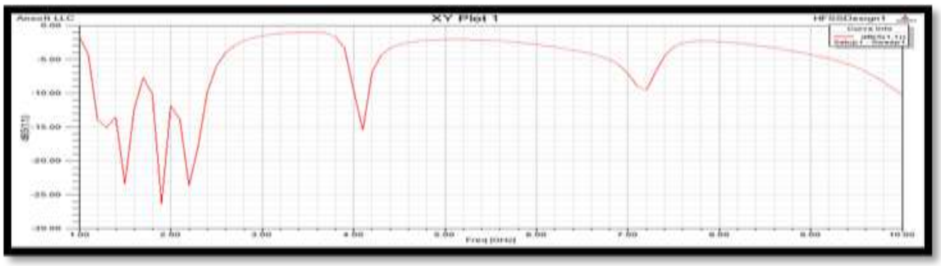
(d)

(e)

Figure3.Variation in slot x length: (a) 2mm,(b)3mm,(c)4mm, (d)5.5mm,(e)5mm,



(a)

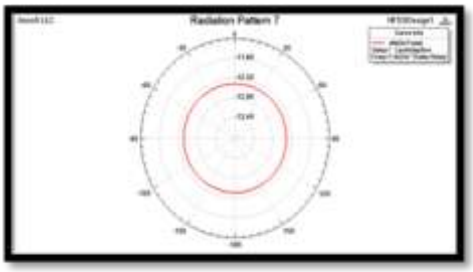


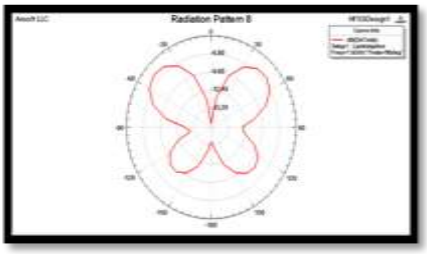
(b)

Figure 4.Variation feed point: (a) 18mm, (b) 20mm**.**

3.2.Radiation pattern

The Variation in phi angle of antenna the following variation in s Radiation pattern parameter as shown below:





. (a)

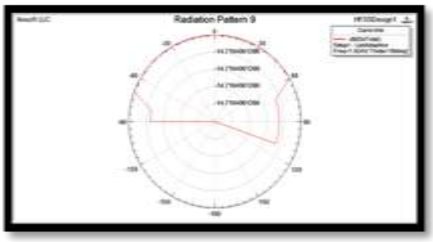
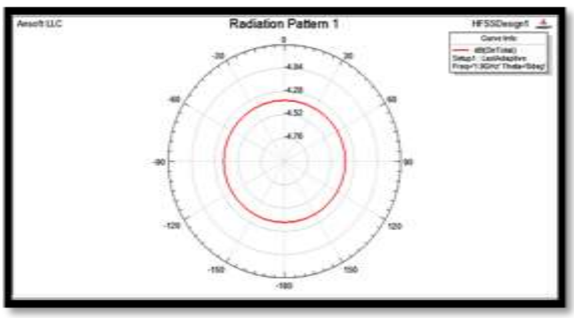
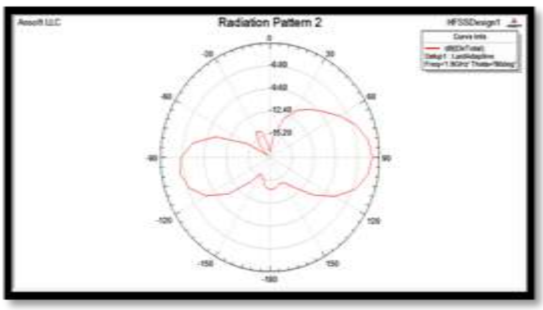
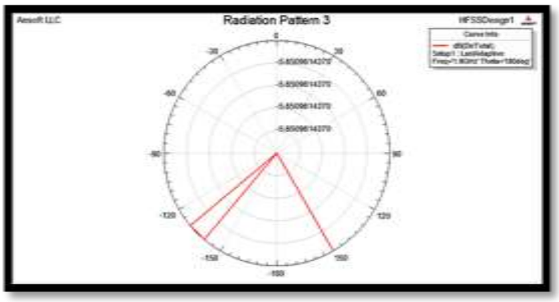


Figure3.4. Radiation patter of PIFA design at frequency 1.5GHz (a) Ø=0º (b) Ø= 90º (c) Ø= 180º

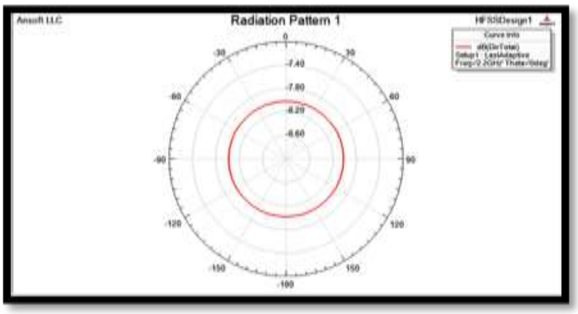




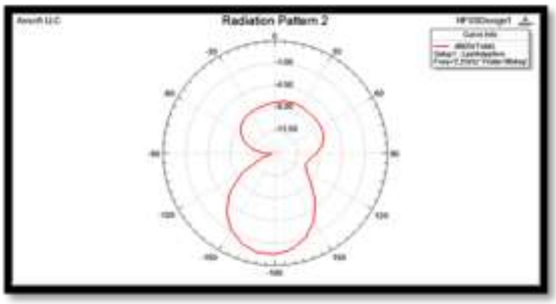


(c)

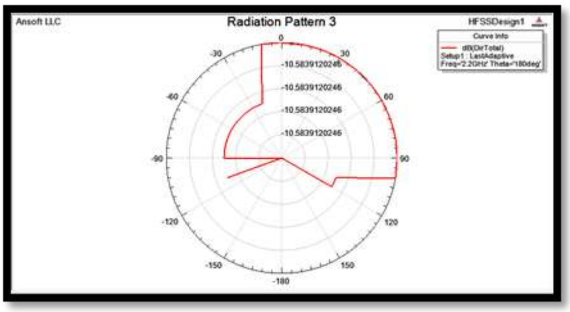
Figure3.5. Radiation patter of PIFA design at frequency 1.9GHz (a) 0^{o}D (b) 90^{o}D (c) 180^{o}D



(a)



(b)



(c)

Figure3.6. Radiation patter of PIFA design at frequency 2.2GHz (a) 0^{o}D (b) 90^{o}D (c) 180^{o}D

3.3. 3D Polar Plot

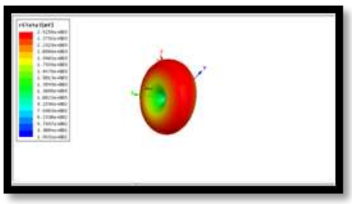


Figure3.7. 3D Polar Plot

4. CONCLUSIONS

A new slotted ground plane PIFA antenna, which covers the frequencies between 1500MHz,1900MHz and 2.2 GHz and complies with $S11 < -10$dB , has been proposed. Extensive parts of this bandwidth frequency bands where mobile phones operate in every part of the world. It can even cover the high frequencies of the future ultra-wide band (UWB) services. As far as the authors' knowledge, this new antenna has the PIFA range designed for a mobile phone antenna with acceptable characteristics of size and radiation performance. The new antenna is planar and has a simple geometry that can be implemented at low cost. Its size of $100\times40\times2.5$ mm^3 is within the limits permitted in many terminal models, including the most recent smart phones.

To measure the SWR of the antenna we use S_{11} parameter measured by the network analyzer. The SWR results showed to be comparable to the simulation's predictions. We found that the antenna had a -26.80dB,-31.40dB and -24.81dB at lower frequency 1500MHz, 1900MHz and 2.2GHz.

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