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A MULTIBAND PLANAR INVERTED–F ANTENNA WITH SLOTTED GROUND

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ABSTRACT

In this paper the patttern and simulation of Planar Inverted F Antenna (PIFA) with slotted ground Plane is proposed. The proposed antenna is designed using HFSS 12.1on a FR4 (Epoxy Glass) Substrate of size 100mm x 40mm x 3.6mm. The radiating patch has also slots to increases the Frequency bands. The proposed antenna is covering both GSM and CDMA and some other Bands of GPS, GSM1800, and CDMA800 with the bandwidths of 1.4GHz. 5GHz and 4.3GHz respectively

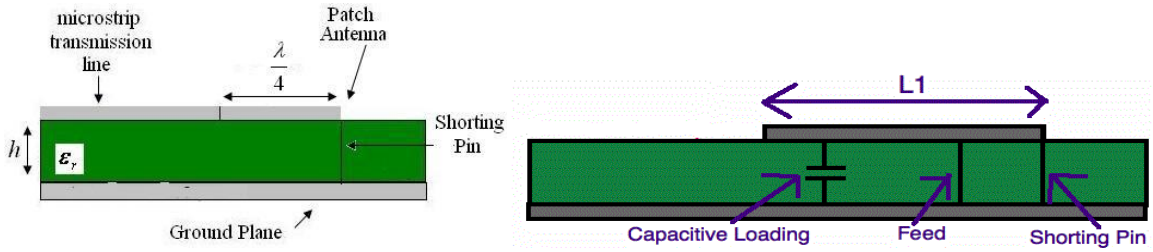
Keywords: PIFA, Mobile Antenna, GSM, CDMA.

I. NTRODUCTION

In wireless communication the development of multiple wireless standards and portable communication, devices lead to fast growth. The key to the operation of these devices is the antenna and hence there is a great demand of developing miniaturized antennas that can be easily resemble within the space available inside the portable devices. Such antenna should be small and compatible with these devices. The Planar Inverted-F Antenna (PIFA) has been increasing integrated into the mobile phone world due its smaller size, low profile and Omni-directional pattern. This antenna design consists of a rectangular planar element that is located above a ground plane, a shorting plate, and a feeding point.[1,2] The shorting Pin is added to have good impedance match with the top conducting pale and it is less than λ/4. [12]

The inverted-F antenna is the most common embedded antenna in use today in wireless devices in the 900 MHz to 6000 MHz frequency range. It has excellent multi-band capability, and can be made highly effective. The inverted-F has evolved into a low-profile multi-band antenna than can be integrated into today's small and complex product designs. [4,5]

In its most basic form, the inverted-F is a quarter-wave long conductor parallel to and within a few mm of the RF ground plane, grounded at one end, and has a 50-ohm feed point close to the grounded end. The quarter-wave conductor can be a thin wire, a trace on a PCB, or a 3D surface and can be straight or folded into complex shapes. The 3D edition is commonly called a PIFA, or Planar Inverted-F Antenna. An IFA can be referred to as a two-dimensional antenna while the PIFA would be a three-dimensional antenna. The following photos show sheet metal and printed versions of Inverted-F type antennas. The sheet metal antenna is a PIFA and the printed antenna is an IFA. [6, 7, 8]



(a) **(b)**

Fig. 1. Design of PIFA Antenna (a) side view (b) side view with a shorting pin and a feed point[13]

IFAs of all types are ground-plane based antennas, meaning that the size and shape of the local ground plane and the relatively close spacing of the ground plane to the antenna element are both an entire part of the antenna design. PIFAs are considered "psuedo-omni" antennas, meaning there is no predominant direction of radiation. These antennas radiate in both orthogonal polarizations, depending on the direction. The micro strip patch antenna is another common low-profile antenna. The patch antenna requires a ground plane beneath it and can exist much closer to the local ground plane than the IFA.

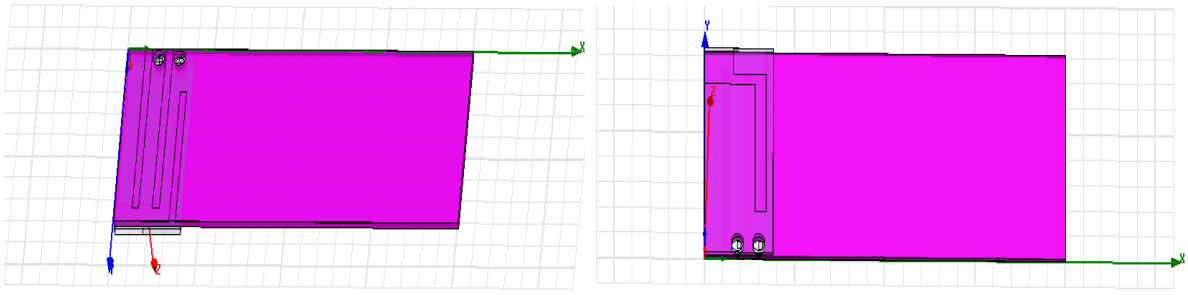
The Planar inverted-F antenna (PIFA) is currently in use as an embedded antenna in some radiotelephone handsets, especially in Japan. It is one of the most promising antenna types because it is small and has a low profile, making it suitable for mounting on portable equipment. The PIFA typically consists of a rectangular planar element, ground plane, and short-circuit plate of narrower width than that of the shortened side the planar element. [7, 8, 9, 10]

PIFA has a several advantages over conventional antennas. They are easy to fabricate, have a simple structure, small volume and low manufacturing cost, easy to hide in the casing of mobile handset. PIFA has reduced backward radiation towards user's head and body which further minimizes SAR and improves performance.[11]

In this paper the design of Planar Inverted F-antenna (PIFA) working in GPS, GSM1800, and CDMA800 bands is presented.

II. ANTENNA DESIGN

Antenna design the PIFA contained of a ground plane, a patch and a shorting pin that is connected with a ground plane. The antenna is fed by lumped port between ground and patch. The addition of shorting pin allows good impedance matching. [6,]The designed antenna has a rectangular radiating patch which has length equal to 40 mm and the width 19mm. the patch is placed at a height equal to 0.4 mm from the ground plane. The design also has slotted ground plane to enhance the bandwidths of the covered frequency bands. [6]



(a) **(b)**

Fig. 2. Antenna design: (a) ground plane view and (b) radiating patch view with all dimentions.

The patch is matched with ground plane via a rectangular shorting pin. The antenna is designed using a dielectric material as FR4 which has loss tangent, δ=0.02, dielectric constant ε_r =4.4 and substrate height is 1.6 mm. the ground plane are 100 X 40 mm2. Height of the antenna is 3.6 mm. Total antenna dimensions are represented in a Table 1.

Table 1: Detailed Dimensions of Proposed Antenna

S.No.	Parameter	Length in mm	Width in mm
1.	Ground plane	100	40
2	Patch	40	19
3	Shorting pin	3.6	1
4.	Feed point	3.6	1
5.	Slot 1	9	2
6.	Slot 2	15	2
7.	Slot 3	5	2

III. SIMULATION RESULT

Result the simulation and analysis of the proposed antenna is done using High Frequency Structure Simulator (HFSS) hfss12.1. In simulated result we observed the reflection coefficient (S2) plot. The antenna covers CDMA800, GSM850 and GSM1900 bands.

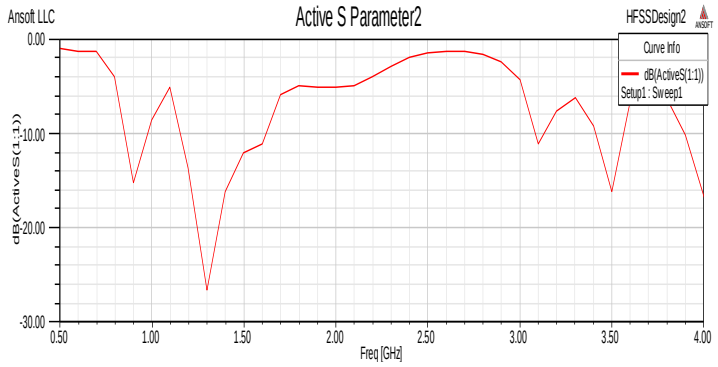


Fig. 3 The simulated S2 (dB) of proposed antenna

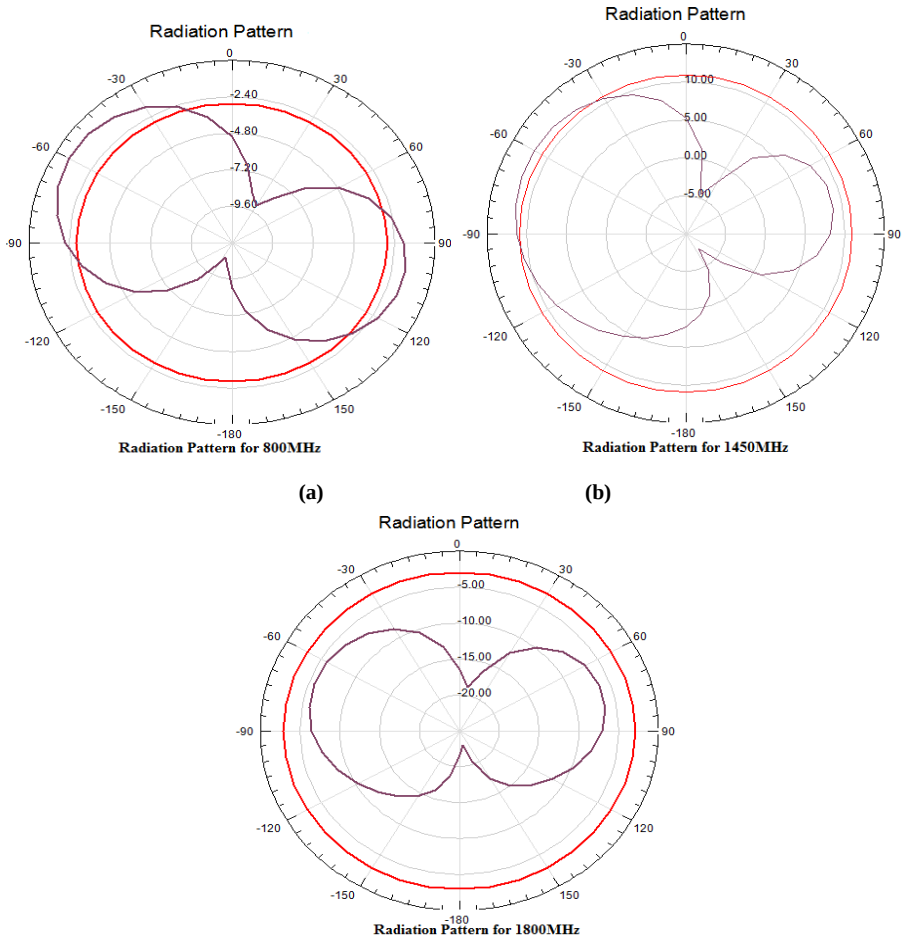
The bandwidth in the plot is specified as BW1, BW2 and BW3. Bandwidth range is specified in Table 2.

Table 2: Bandwidth of Proposed Antenna

S.No.	Bandwidth	Range of bandwidth in MHz	Bandwidth in MHz
1.	BW1	760-980	1400
2.	BW2	1150-1650	5000
3.	BW3	3400-3560	4200

The radiation pattern defines the variation of the power radiated by an antenna as a function of a direction away from the antenna. This power variation as a function of a arrival angle is observed in the antenna's far field.

Radiation pattern at different frequencies are given in Fig. 4. It can be seen that an omni-directional radiation pattern is obtained at resonant frequency 1800MHz

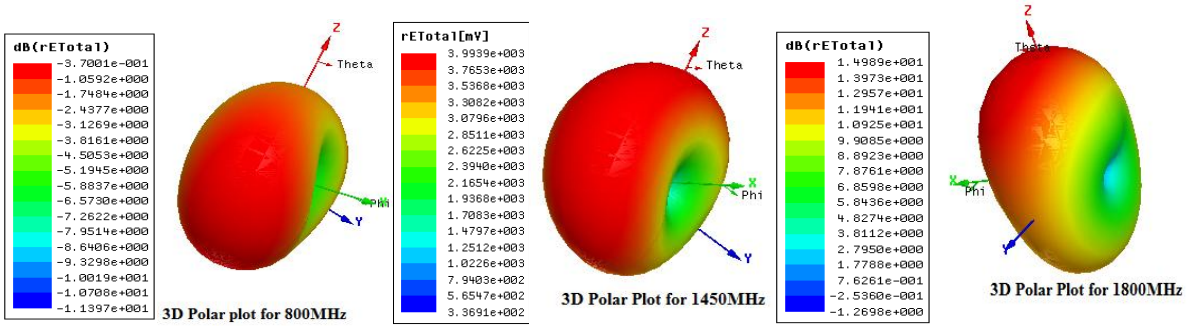


(a) **(b)**

(c)

Fig. 4 Radiation patterns for different frequencies (a) for 800MHz (b) for 1450MHz and (c) for 1800MHz.

The simulated 3D polar plot at different resonating frequencies are shown in Fig.5



(a) **(b)** **(c)**

Fig. 5 3D polar plot for different frequencies (a) for 800MHz (b) for 1450MHz and (c) for 1800MHz.

The radiation pattern is the relative distribution of power radiated as a function of direction. Usually radiation pattern is determined in the far field region. It can be seen that the antenna has an omni-dirctional radiation pattern at 1800Mhz frequency and a near omni-directional at 800MHz and 1450MHz.

IV. CONCLUSION

A Muti-Band Planar Inverted-F Antenna (PIFA) was proposed to operate under GSM1900, GPS and CDMA bands giving an Omni directional radiation pattern which is an important parameter of PIFA Antenna. The proposed antenna has a slotted ground plane which is used to improve the bandwidth both at low and high frequencies without increasing the size of the antenna of the antenna. The antenna is covering GSM and CDMA Bands of GPS, GSM1800, and CDMA800 with the bandwidths of 1.4GHz. 5GHz and 4.2GHz respectively

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