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Multiband PIFA Antenna with Ground Plane Slots

Mr. Sameer Datkhore, Research Scholar, Imperial College of Engg. & Research(University of Pune), Pune.

Dr. Swapnil Lahudkar, Guide,Imperial College of Engg. & Research(University of Pune), Pune.

Abstract

Modern telecommunication system requires antennas with wider bandwidth and smaller dimensions than conventional antennas. Operators are looking for systems that can perform over several frequency bands. This has initiated antenna research in various directions, one of which is by using fractal shaped antenna elements. Traditionally, each antenna operates at a single or dual frequency bands, where different antenna is needed for different applications. This causes a limited space and place problem. Planar inverted F antenna is proposed in the design. The proposed antenna is a multiband antennas and small in size. The antenna is designed to cover the GSM band, CDMA band and

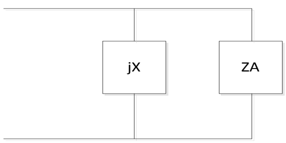
1. Introduction

The mobile industry is now evolving. The present day mobile phones should be multifunctional. The conventional mobile used to have external antennas. The external antenna made the assembly difficult to handle and heavy. Because of the disadvantages of the external antenna, there was need that the antenna assembly should be inside the handset. So many internal antennas like monopole and Microstrip antennas came into picture. Later came the IFA's and PIFA.

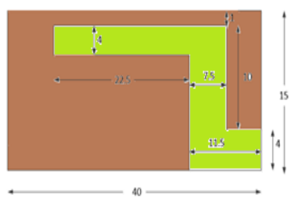
Also with the increase in technology the requirements of antenna operations are also increasing. Now, the present day mobile phones need to cover a large frequency range. The Microstrip antennas are easy to manufacture and the investment is also less. The Microstrip patch antenna can be used to cover single frequency band. The Planar inverted F Antenna is basically PIFA antenna which is a type of Microstrip antenna; is designed to operate on multiple frequency bands. The Microstrip antenna forms the basis of PIFA antenna. The Microstrip antenna finds variety of application in the field of mobile communication. The behaviors of the antenna are investigated with respect to the parameters such as return loss, VSWR. The initial stage of the design started with the simple PIFA and then the modification in the ground plane have been made.

2. Antenna Configuration

The antenna consists of a ground plane and the suspended patch with F shape slot inserted. One shorting pin is connected in between the patch and the ground. There is air gap of 6mm between the ground plane and patch. Also one feed is given of same height and connected between the patch and ground. This is shown in fig.1. Because the patches are high frequency devices, the shorting pin actually introduces a parallel inductance. The effect of parallel inductances shifts the resonance frequency of antenna. In particular, the two components in parallel would result in their admittances adding. Hence, the admittance of the patch has a 1/(jX) added to it as shown in fig1. The antenna is simulated using glass-epoxy material with relative permittivity, ε_r= 4.4, substrate thickness, d = 1.6mm where the radiating element is the copper clad.



(1)



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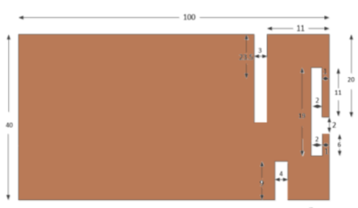

(3)

Fig 1: Showing the admittance of the Patch
Fig 2: Actual Patch Design
Fig 3: Ground Plane of Antenna

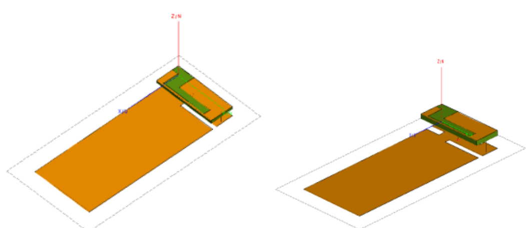

Fig 4: Two different views showing the patch and slots on Ground Plane

3. Simulation Results:

CADFEKO has been used to obtain simulation results. In this simulation, we assumed perfect electric conductor for the radiation element, the ground plane and coaxial feed line. The proposed antenna structure is tuned to provide multi-frequency bands with return losses less than or equal to -10 dB, VSWR ≤ 2 and with acceptable radiation patterns. To emulate a real environment, the PCB is simulated over a thin layer of FR-4 which is the substrate commonly used.

3.1 Reflection Coefficient:

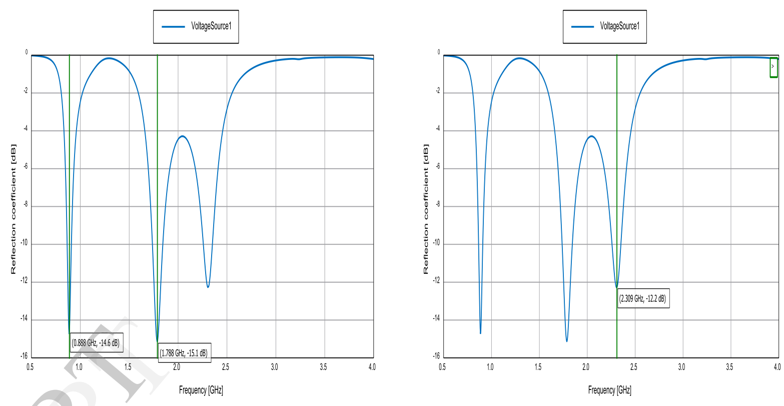

Fig 5: shows the results of return loss for the three different band of frequency

Table 1 Frequencies at which minimum return loss occur.

	Frequency	Return Loss
1st band	0.888 GHz	-14.6 dB
2nd band	1.788 GHZ	-15.1 dB
3rd band	2.309 GHz	-12.2 dB

3.2 VSWR:

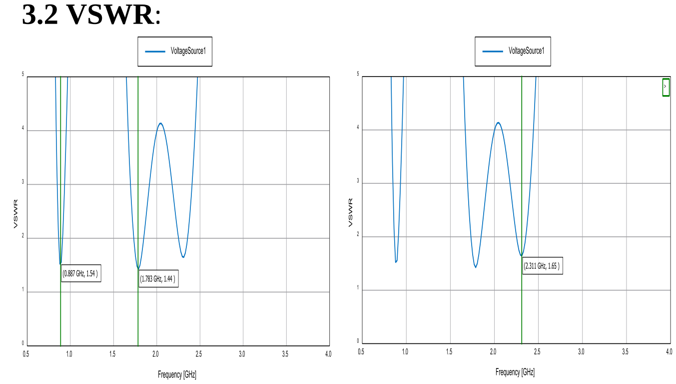

Fig 6: shows the results of VSWR. The resonant frequencies are obtained at 0.88 GHz, 1.78 GHz, 2.30 GHz.

Table 2 Frequencies at which minimum VSWR occur.

	Frequency	VSWR
1st band	0.88 GHz	1.54
2nd band	1.78 GHZ	1.44
3rd band	2.30 GHz	1.65

3.3 Bandwidth:

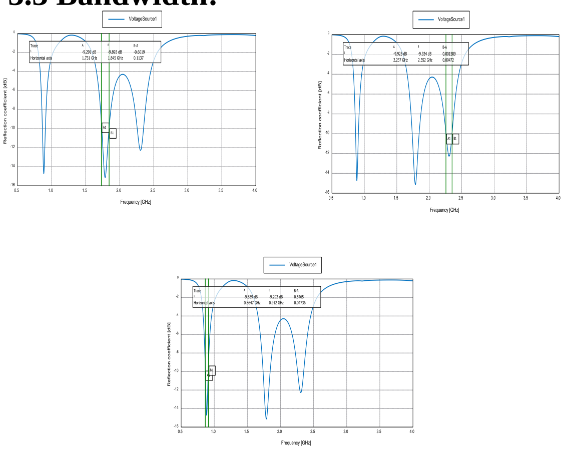

Fig 7: Graphs showing the bandwidth at different frequency ranges

Table 3 Bandwidth acquired by the antenna

	Frequency	Bandwidth
1st band	0.88 GHz	47MHz
2nd band	1.78 GHZ	113MHz
3rd band	2.30 GHz	94MHz

3.4 Gain:

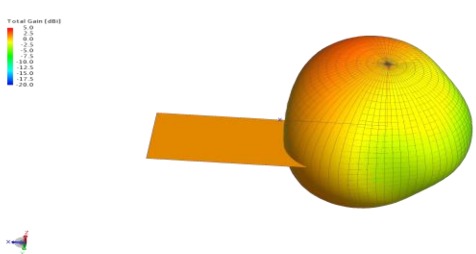

Fig 8: The gain acquired is 5 dB

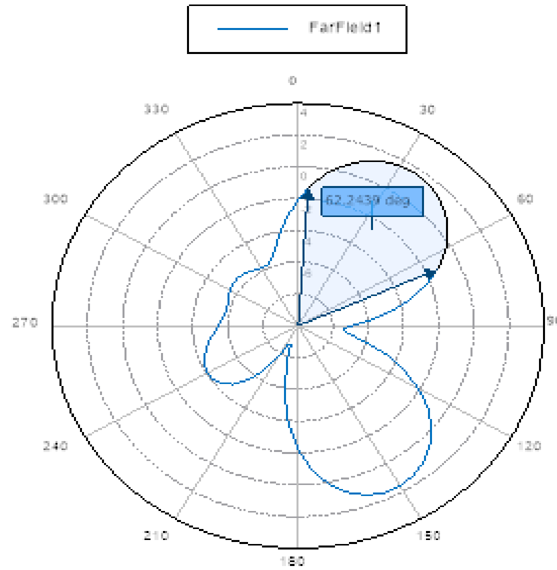

Fig 9: Total Gain [dBi] (Frequency = 1.93182 GHz; Phi = 0 deg) - 3band

4. Conclusion:

In this paper we have presented antenna covering GSM 850 and GSM 900 and the continuous bandwidth spanning from the DCS1800 to the Bluetooth bands. In this antenna, a slotted ground plane is used to improve the bandwidth at both low and high frequencies without increasing the volume of the antenna. At low frequencies, the slot is below resonance, but forces the ground plane mode to be excited so as to increase the bandwidth at low frequencies; on the other hand, the slots are comparable to at high frequencies, and therefore they enhance the bandwidth. In this new antenna, a slotted ground plane is used to improve the bandwidth at both low and high frequencies without increasing the volume of the antenna. At low frequencies, the slot is below resonance, but forces the ground plane mode to be excited so as to increase the bandwidth at low frequencies; on the other hand, the slots are comparable to at high frequencies, and therefore they enhance the bandwidth. From the results it is clear that PIFA can be used for multiband operation. The operational flexibility is high for PIFA and also the bandwidth acquired is also high at each frequency output. Also the observational parameters like reflection coefficient, VSWR and the gain shows better results. Hence PIFA can be used in mobile handsets.

Reference:

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