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A Novel Tri Band Planar Inverted F Antenna for Wireless Communication

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Abstract: A Novel tri-band Planar Inverted F Antenna is presented in this paper. This antenna covers GSM, Wimax and WLAN bands. Features of each band can be easily optimized by changing the position, shape and size of the antenna parameter and by introducing slots in the radiating patch. Overall size of the proposed design is 19 mm×18 mm×2 mm on a 50 mm. In the proposed design, the slot has been introduced in the radiating patch for making the antenna to operate in different frequency. Structural dimensions of the proposed antenna are optimized by using CAD FEKO. Details of the tri band PIFA characteristics are presented and studied.

Key words: Multi band · Slot · Short pin · Stub

INTRODUCTION

In the recent world the need of wireless device has been increased. Antenna plays a vital role in the wireless device in order to use the wireless bands efficiently. The development of wireless technologies and mobile communications has included considerable research work on the development of small, low cost and easily adaptable antennas. One such antenna, the PIFA (Planar Inverted F Antenna), is mostly used in mobile and wireless communications. The merits of using this type of antenna in wireless communications is its compact size, it can used in the mobile handsets, low profile and multiband.

Planar inverted-F antenna can cover one or more standard frequency bands and due to their patch planar structures, they have been mostly used for cellular phone handsets [1-2]. On the other hand, it is shown that the lower and upper frequencies of a conventional PIFA can be optimized by using a shaped slot on the radiating element [3]. The operational bandwidth is increased because the length of the ground plane increases when meandering or open-end shape slots are used on the ground plane, although its physical size is fixed [4]. In addition to that, to cover the multiband services, L-shaped patch with two slants slits at the right edge is added. The slots have been implemented in the upper plane through which the antenna covers GSM, DCS and Bluetooth frequencies [5]. The Planar Inverted F Antenna which is compact antenna and it can be used in wireless and mobile application, but narrow bandwidth is a major problem faced in the antenna. The drawback can be overcome by using slots in the patch plane. The bandwidth and the antenna size are generally mutually different properties, that is, degradation of one of the characteristics normally results in improvement of the other parameter and hence the low cost and compact size antennas are needed for mobile handsets with improvement in bandwidth. By varying the place and slot size of the antenna, the length of the ground plane can be adjusted to the optimal lengths of the lower and higher bands, which enhance the bandwidth of PIFA antennas for both the lower and higher bands [6]. The resonance frequency depends inversely on the slot length and feed point, the resonant frequency various with increasing the slot width and feed pin of the planar antenna. Transmission line feeding is provided for the excitation to antenna and RF module.

The paper work is organized as follows. Section II gives the structure and design parameter of the Conventional PIFA and the PIFA with Slots. In the Section III it is briefly discusses the measured results for its reflection coefficient, Gain and radiation patterns of the Conventional PIFA and Proposed PIFA. Finally in the Section IV the conclusion and summary of the work is provided.

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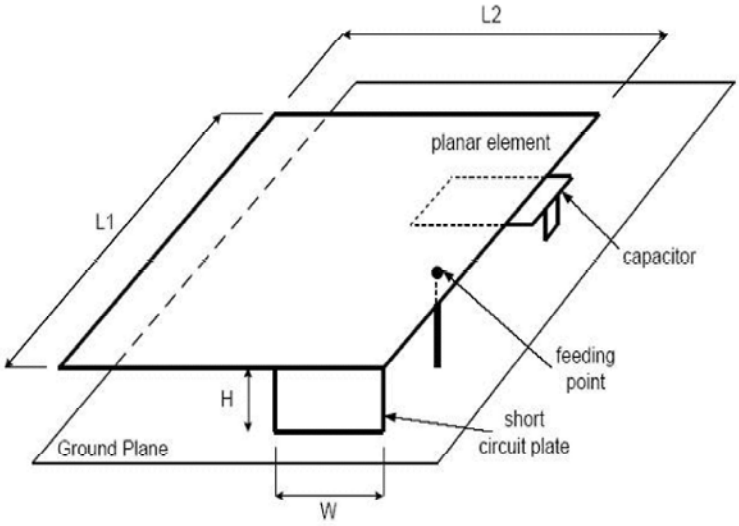

Fig. 1: PIFA Structure

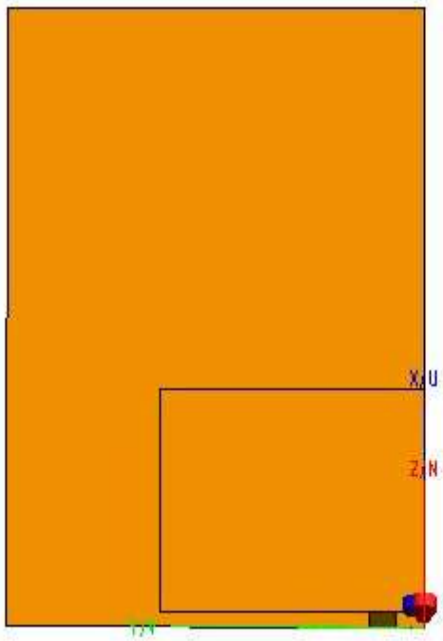

Fig. 2: PIFA Structure

Antenna Design: The structure of the Planar Inverted F Antenna has been shown in the Figure 1. The antenna has two planes which decide the structure of the antenna. The Ground Plane of size L1xW1 in mm and the patch plane size of L2xW2.The patch and the Ground Plane has been connected using the stub and edge feed have been used for the feeding of the antenna [7, 8].

$$L1 + L2 = \frac{\lambda}{4} \quad (1)$$

where
L1-Length of Patch Plane
L2-Width of the Patch Plane
W-Width of the stub
H-Height of the stub

Conventional PIFA in FEKO: As seen in the Figure 2, the dimensions of the patch are radiating (W1, L1) = (19, 18) mm, while the dimensions of the Ground Plane are (W2, L2) (50,30) mm, then the distance between the ground plane and the Ground plane is 2 mm.

Slotted PIFA in FEKO: In order to overcome the narrow bandwidth of the Planar Inverted F Antenna, the slots have been introduced in the radiating patch of the antenna. By introducing the slots, the antenna can be made to operate in different frequency.

Specifically, the resonant frequency of the lowest band is decided by the size of the patch and the resonance frequency for the higher band is decided mainly the size and position of the slot. In the Figure. 3 the antenna with single slot has been shown. The u slot has been introduced in the patch plane. The radiating patch is inserted with the U shaped slot for the purpose of obtaining multi band frequency. The antenna has been design in the simulation software and the structure has been illustrated in the Figure 2. It is designed to work at frequencies 2 GHz band, respectively. Figure.5 shows the reflection coefficient of the antenna. Here the antenna has been designed, where it can operate in the single band. For the feeding of the antenna the Edge feed have been used and it is efficient than the line wire feed antenna.

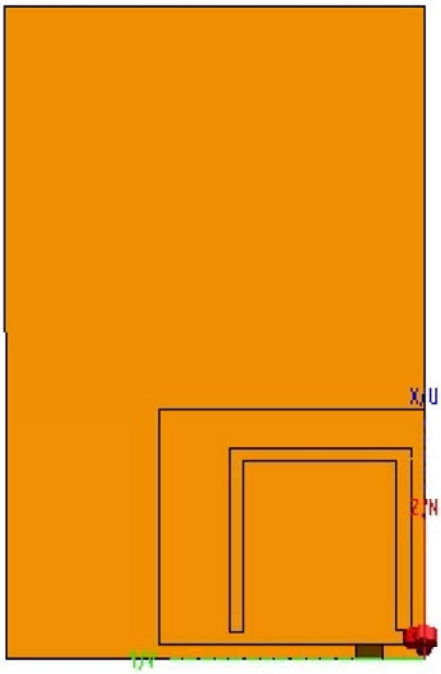

Fig. 3: PIFA Structure with single slot

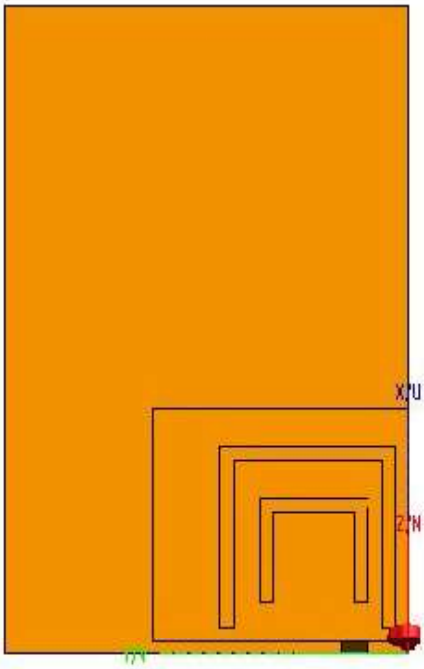

Fig. 4: PIFA structure with two slots

Here in the proposed method, the U shaped slot has been introduced in radiating patch, through which the antenna can made to operate in multiband. By shaping the certain parts of a radiation element by slots can allow new resonant frequency. In the Figure 4, the two slotted planar inverted F antenna has been shown.

RESULT AND DISCUSSION

The antenna is designed and analyzed using method of moments (MoM's).CAD FEKO have been used to obtain simulation results. In this simulation, we consider perfect conductor for the radiation element, the ground plane, stub and edge feed. The proposed antenna structure is changed in order to provide enough impedance bandwidths to cover GSM, Wimax, WLAN and UWB frequency bands and with acceptable radiation patterns. Figure 8 shows the simulated return losses of three various cases for the proposed antenna. From the simulation, results shows the influence of the slots on the antenna radiating patch has been shown, simulations of the conventional PIFA without slots were conducted. The height of the radiating patch was fixed at 2mm space from the ground plane and the other parameters were kept at same position except slot on the patch plane of the antenna [9, 10].

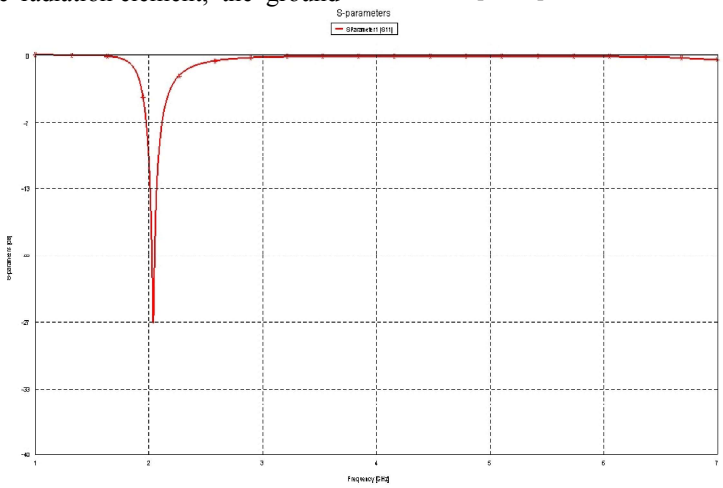

Fig. 5: PIFA without any slot in radiating patch

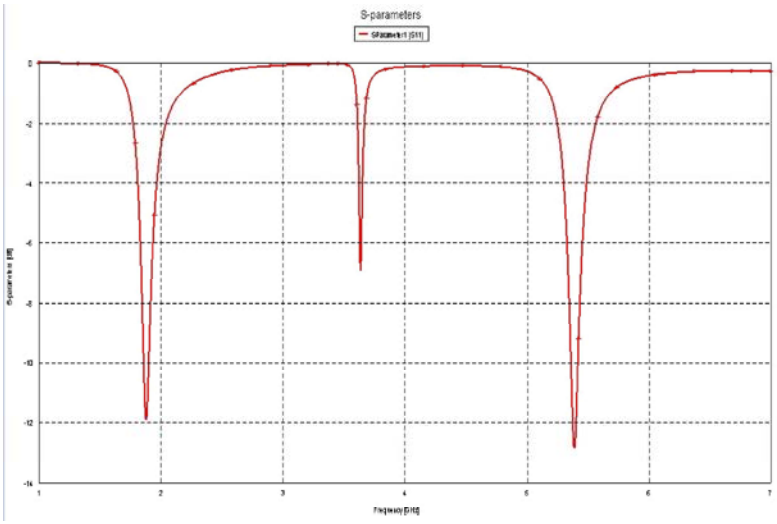

Fig. 6: Return loss of PIFA with single slot in radiating patch

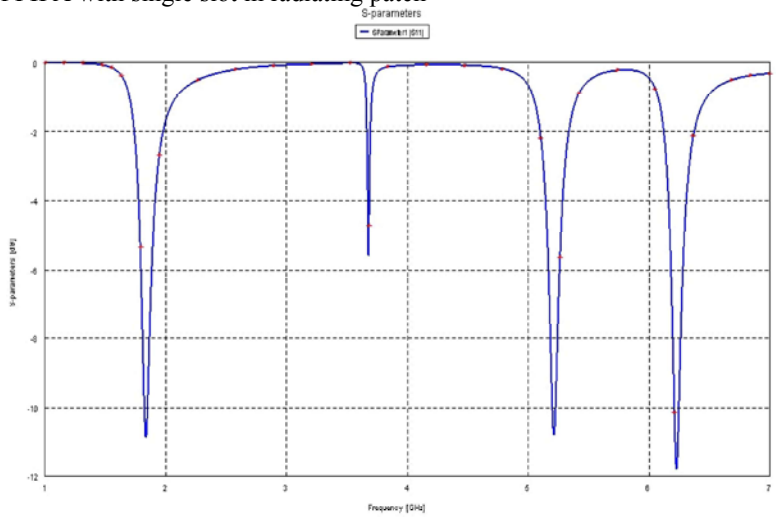

Fig. 7: Return loss PIFA with two slots in radiating patch

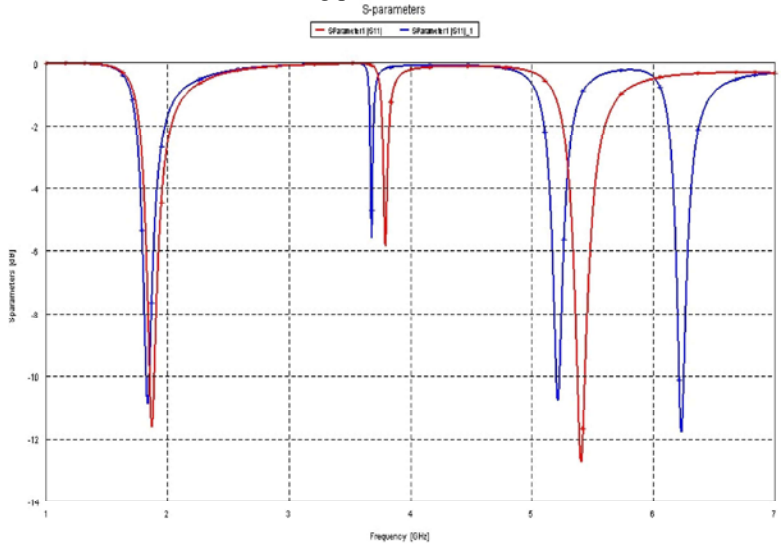

Fig. 8: Comparison of PIFA with single and two slot in radiating patch

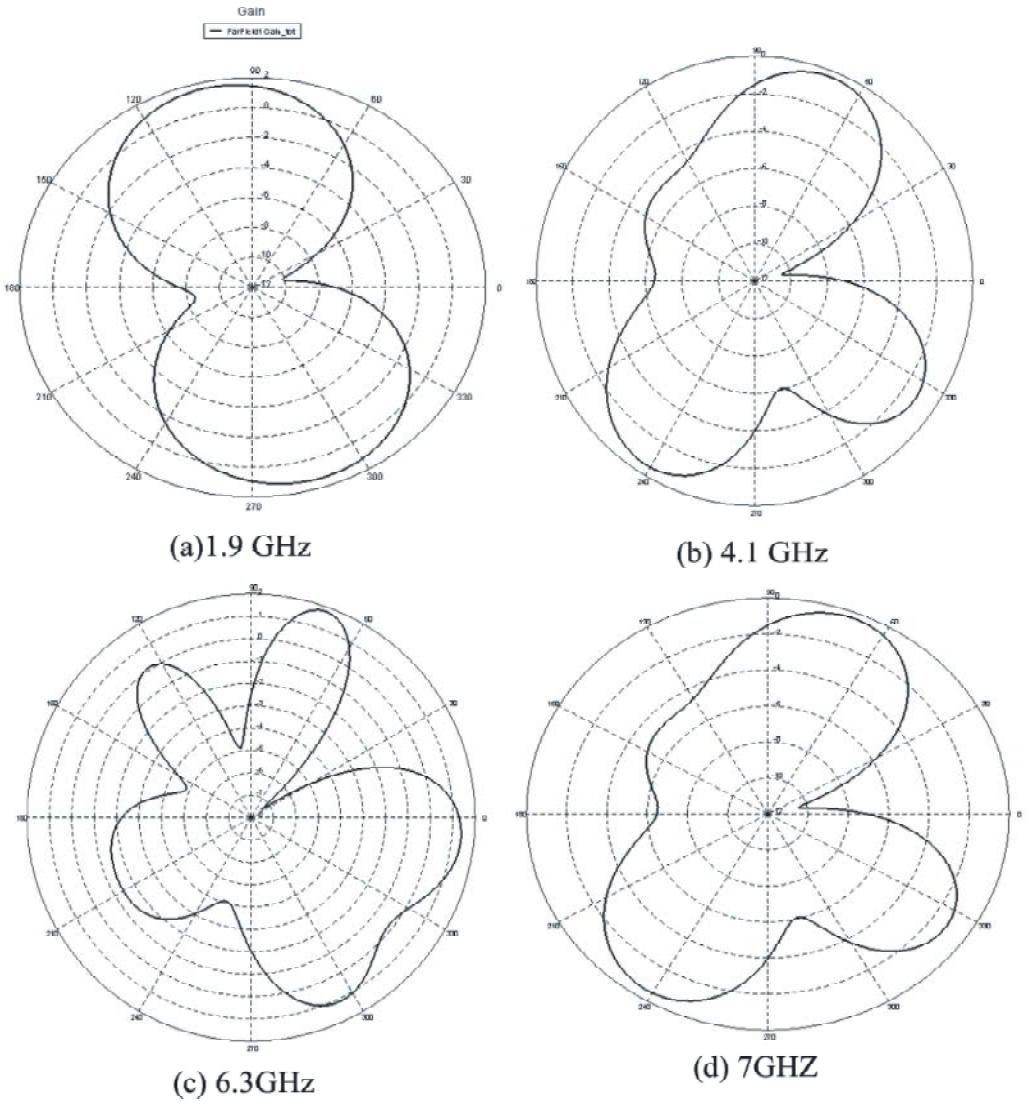

Fig. 9: Simulated 2-DRadiation patterns of the proposed antenna

Table 1: Resonant Frequency Comparison

S.No	Antenna	Resonant Frequencies(GHz)
1	Conventional Planar Inverted F Antenna	2
2	Single slotted Planar Inverted F Antenna	1.85,3.7,5.3
3	Two slotted Planar Inverted F Antenna	1.8,3.6,5.2,6.2

The Planar Inverted F Antenna have been designed for the resonant frequency 2 GHz which the illustrated in the Figure 5, which it can be used for the GSM Application.

The antenna By introducing single slot in the antenna radiate three resonant frequencies 1.85GHz, 3.7GHz, 5.3GHz and which can be used in the wireless communication which have been shown in Figure 6.

Here the Figure. 7 represent the PIFA antenna with single slots. Through this the antenna can give out four resonant frequencies 1.8GHz, 3.6GHz, 5.2GHz and 6.2GHz

The influence of the feeding structure on antenna performance is also studied. Figure 8 depicts the return loss comparison of the proposed PIFA antenna and the antenna with the single slot. It can be concluded that the slots has large impact on gain and resonant frequency of the antenna [11-15].

The Table 1 shows the resonant frequency of the proposed antenna with the Planar Inverted F Antenna.

Figure 9 shows the 2 D radiation pattern of the proposed antenna and it have been given in polar chart. In the Figure (a) it shows the pattern for the 1.9GHz the GSM band. The Figure (b) shows the pattern for 4.1 GHz

and Figure. (c), (d) gives the radiation pattern of the individual frequencies. Through the pattern the antenna directivity and gain can be analyzed

CONCLUSION

A novel compact Planar Inverted F Antenna tri-band has been presented in the paper which covers bands and supports mobile handset application and wireless communication. The antenna with low profile and compact structure which satisfies the requirements of mobile and wireless communication. By varying electrical length of the Ground plane can be adjusted through which optimal length can be obtained. With the help of the proposed technique a compact tri-band has been presented. The resonant characteristics of the proposed an antenna having a total size of 19x18x2mm have been verified by using Simulation tool. By varying the slot placement in the radiating patch the resonant frequency can enhanced and the operating area of each resonant band can be varied by placing slots in different position in the patch. By the help of other shape slots with proper position of slot can improve the tri band to multi band antenna.

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