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Low Profile Planar Inverted-F Antenna with Triangular Ground Plane

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Abstract

The design of miniaturized micro strip antenna plays a very vital role in the development of portable wireless communication systems. The resonance frequency, bandwidth and gain of an antenna directly depend on its dimensions. The idea is to find best geometry and structure which can be accommodated in the typical space available in a communication device. The planar inverted-F antenna is very popular for such portable wireless devices because of its small size and low profile. In this paper, a planar inverted-F antenna (PIFA) with a small triangular shape ground plane and square shape radiating element has been introduced to work on 1.32 GHz. This antenna is low cost, simple in design and easy to fabricate. The bandwidth provided by the PIFA is wide as compared to a conventional micro strip patch antenna of half wavelength. The dimensions of antenna have been optimized to have a wide bandwidth.

Keywords*: Planar inverted-F antenna, PIFA, triangular ground plane*

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INTRODUCTION

In the design of PIFA, the most popular model for a ground plane is a perfect ground plane which is assumed to be a perfectly conducting infinite size planar ground. The real ground plane is metallic planar ground with finite size. Therefore there is compromise between geometry of antenna and ground plane size with electrical performance. The PIFAs are mostly used in portable and static wireless devices as they are capable of working in wireless bands [1-4].

The geometry of PIFA requires very small ground plane so that it can be incorporated in small devices. The PIFA in this design is consisting of a conducting plate called radiating patch. It is used parallel to a ground plane and is connected to ground by shorting pin making it able to radiate to the frequency corresponding to quarter wavelength ($\lambda/4$) [1]. The single probe feed has been kept at optimized distance from shorting pin.

ANTENNA DESIGN

The structure of PIFA is shown in Figure 1 with its top view. The dimensions of radiating patch are 20x20 mm². Its height from ground plane is 10 mm. The separation between shorting pin and feed is 3 mm and radius of probe feed is 1.0 mm. The dimensions of triangular ground plane are (60x60x60) mm. The dielectric used between top and ground plane is air. The top plate is made up of copper with thickness of 0.5 mm. The standard formula for PIFA dimensions is [2–8]:

$$F=c/4(L+W)$$

Where,
f is the resonant frequency,
L is the length of radiating patch,
W is the width of the radiating patch and
c is the velocity of light in free space.

The length of top plate and length of shorting pin make the antenna size equal to quarter wavelength (λ/4) monopole. Hence this antenna is known as an unbalanced antenna[5-7].

DESIGN ANALYSIS

The proposed antenna has been optimized and simulated on IE3D Zealand 10 software [3]. The results of reflection coefficient and VSWR on resonant frequencies are shown in Figures 2 and 3 respectively. The total E field at Φ=0 and 90 degree is shown in Figure 4. The efficiency of antenna at resonant frequency is 90% as shown in Figure 5. The 3-D radiation pattern is shown in Figure 6[7, 8].

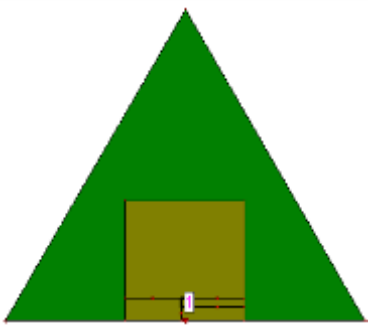

Fig. 1: *Top View of PIFA Structure.*

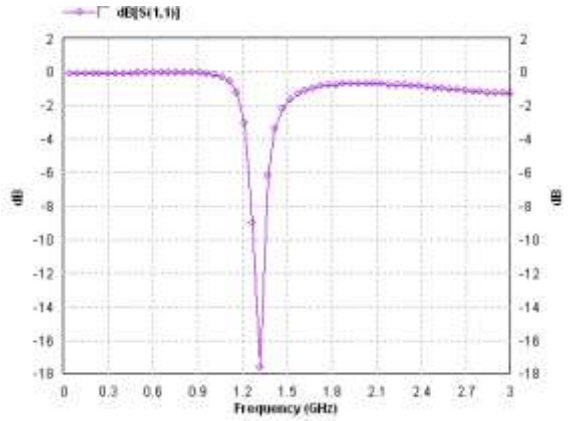

Fig. 2: *Return Loss at 1.32 GHz.*

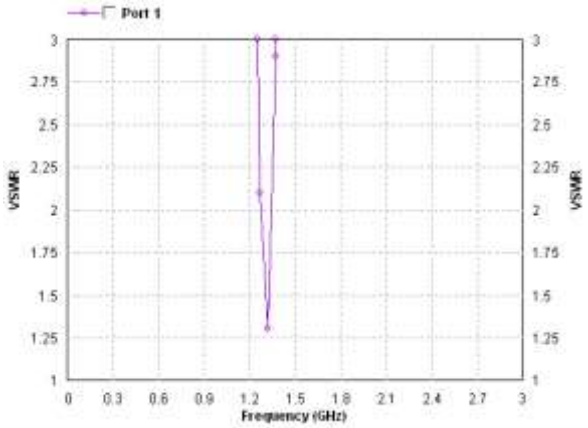

Fig. 3: *VSWR at 1.32 GHz.*

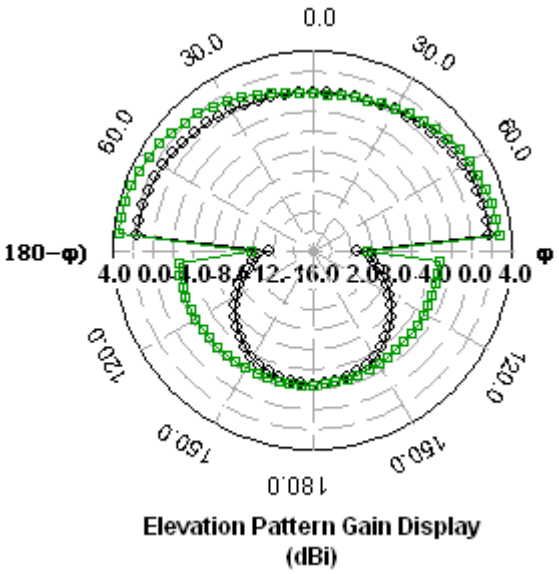

Fig. 4: *Total E at Φ=0, 90 Degree.*

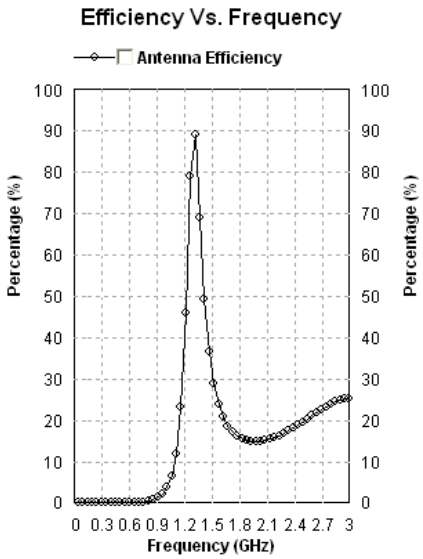

Fig. 5: *Efficiency at 1.32 GHz.*

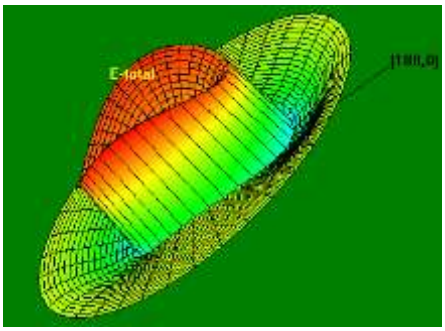

Fig. 6: *3-D Radiation Pattern of PIFA.*

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RESULT AND DISCUSSION
The simulations using IE3D software on finite ground plane of equilateral triangular shape (60x60x60) mm and radiating patch of square shape (20x20) mm were performed. The bandwidth obtained is 90 MHz. The return loss of –18 dB, VSWR of 1.25 and efficiency 90% shows that this antenna will have good performance in its bandwidth.

CONCLUSION
The designs of PIFA may be useful in various static wireless devices. It can be used for communication in L3 band of GPS. The gain increases as the ground plane size increases. Therefore it is always a trade-off between ground plane size and performance of antenna.

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Author Biography

Devendra Kumar was born in 1969 in India. He received the BE degree in Electronics & Communication from Institution of Engineers (India) in 2002 and M Tech in Electronics & Communication from MITS Gwalior (India) in 2009. His area of interests include Microwave Antenna, Filters and Radar. He worked on Radio, Radar and Navigational systems in defense sector from 1987 to 2007. Presently he is working as Assistant Professor in department of electronics & communication engineering in Rustamji Institute of Technology ,Gwalior (India) since 16 Aug 2010.