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Design and Performance Analysis of Planar Inverted-F Antenna for RF Communication

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Abstract: In this paper a study for the designing of Planar Inverted F Antenna (PIFA) for handheld devices has been proposed. The proposed antenna includes the ground plane of dimension 35mm × 37mm and the top radiating plane of 28mm × 24mm. The final proposed antenna shows a multiband behaviour in the frequency range of 1-6 GHz covering Wi-Fi/Bluetooth 802.11g (2.4 GHz), m- Wi-MAX (2.5 GHz), Wi-MAX (3.5 GHz) and Wi-Fi 802.11a (5.2 GHz) communication standards.
Keywords: HFSS, PIFA, Shorting plate.

I. INTRODUCTION

As the dimensions of the mobile handheld devices decreases, the need for more compact antenna has increased. Planar Inverted F Antenna (PIFA) is a solution to be used as an internal antenna due to its low profile structure and multiband properties.

1.1 PlanarInverted-F Antenna

An inverted-F antenna is a type of antenna used in wireless communication. It consists of a monopole antenna running parallel to a ground plane and grounded at one end. The antenna is fed from an intermediate point a distance from the grounded end. The design has two advantages over a simple monopole: the antenna is shorter and more compact, and the impedance matching can be controlled by the designer without the need for extraneous matching components. The inverted-F antenna was first conceived in the 1950s as a bent-wire antenna. Planar inverted-F antenna (PIFA) is widely used in mobile wireless devices due its space saving properties. PIFAs can be printed using the microstrip format, a widely used technology that allows printed RF components to be manufactured as part of the same printed circuit board used to mount other components. PIFAs are a variant of the patch antenna. Many variants of inverted-F antenna, can be used as wideband or multi-band antennae. Inverted-F antenna have narrow bandwidths. A wider bandwidth can be achieved by lengthening the antenna, which increases its radiation resistance.

II. ANTENNA DESIGN

The proposed design of Planar Inverted F Antenna (PIFA) is shown in figures below. The proposed antenna consists of T- shaped slot on top radiating patch and a rectangular slot on the ground plane. Here FR4 is used for fabrication of ground and top radiating patch whose dimensions are 35mm× 37mm and 28mm × 24mm respectively. Co-axial feed is used to excite the proposed antenna. The patch of the proposed antenna is shorted to the ground plane using shorting plate.

2.1 Design 1 parameters
Patch shape: T-slotted Rectangular
Feeding technique: Coaxial feed
Substrate material (Ground plane): RT/duroid 5880
Height of the ground plane: 0.8mm
Patch material: Conducting material (Copper)

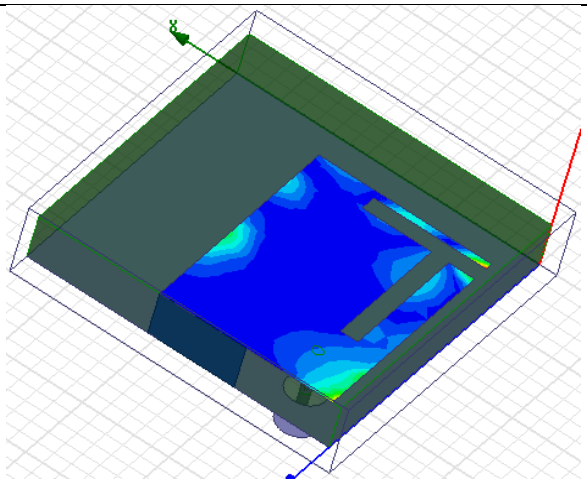

Figure 2.1: Design 1 of PIFA antenna

2.2 Design 2 parameters
Patch shape: T-slotted Rectangular
Feeding technique: Coaxial feed
Substrate material: FR4 epoxy
Dielectric constant (εr): 4.4
Height of the top patch: 1.6mm
Patch material: Conducting material (Copper)

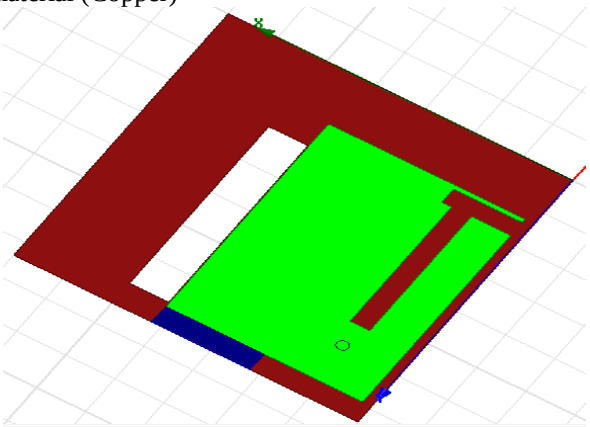

Figure 2.2: Design 2 of PIFA antenna

III. RESULTS

The antenna is designed and simulated using HFSS software for parameters like VSWR and gain. It is important to note that the slot etched on the ground plane and the patch is for making the antenna to work at multiple frequencies and obtain desired results. Figure 3.1 and 3.3 shows VSWR v/s frequency plot of design 1 and 2 respectively. The total gain obtained from the design 1 and 2 is 2.61dB and 4.98 dB respectively which is considered excellent in case of Planar Inverted F Antennas (PIFA).

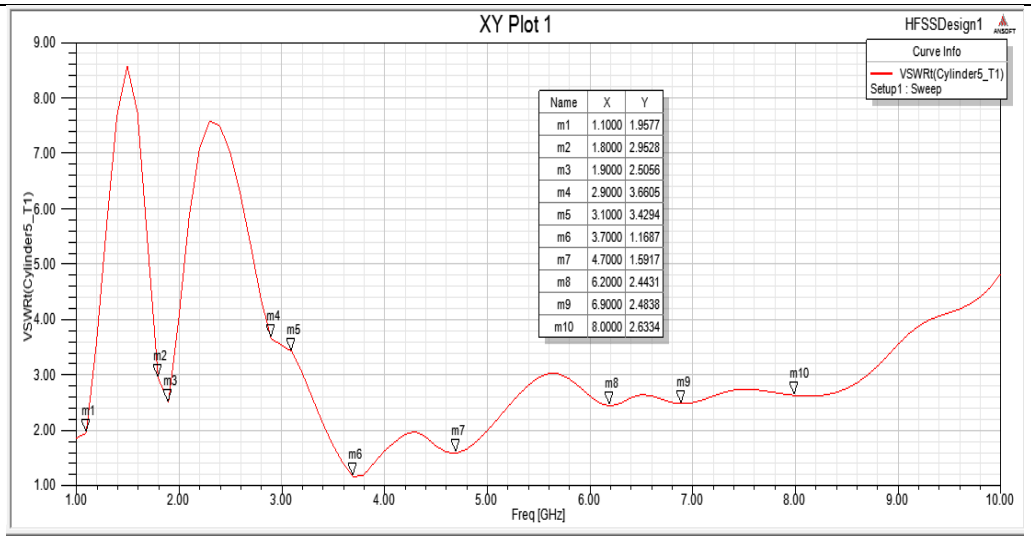

Figure 3.1: Plot of VSWR v/s Frequency of design 1

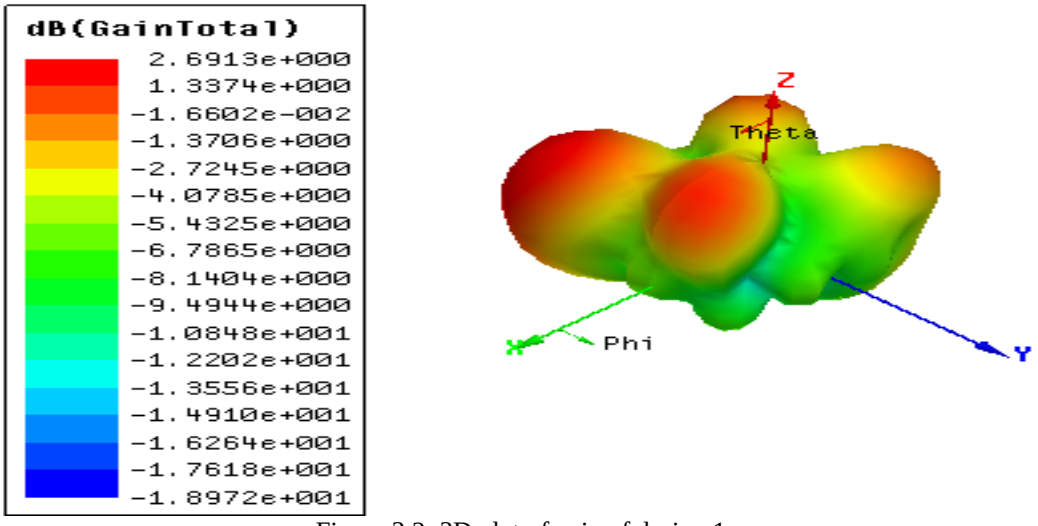

Figure 3.2: 3D plot of gain of design 1

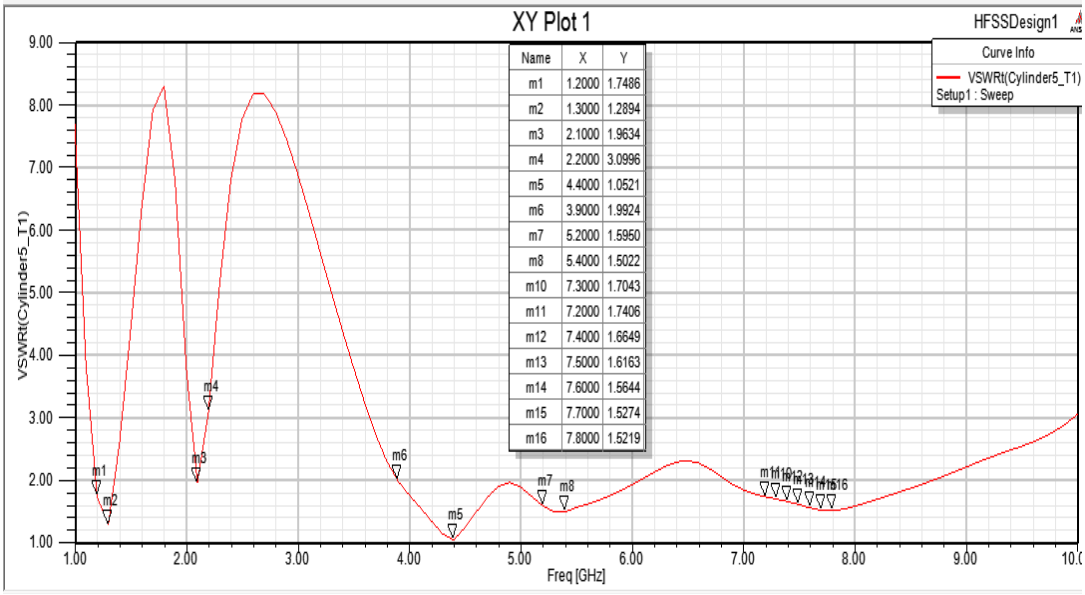

Figure 3.3: Plot of VSWR v/s Frequency of design 2

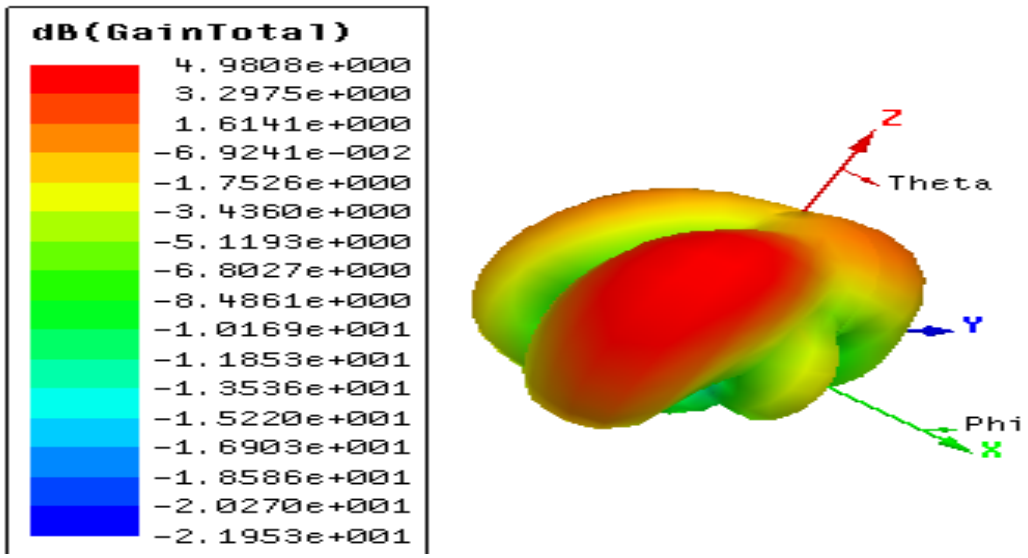

Figure 3.4: 3D plot of gain of design 2

IV. CONCLUSION

In this paper a comparative study on Planar Inverted-F Antenna (PIFA) for mobile applications has been performed. VSWR and gain is analysed by varying the size of T-slot. Hence the final designed antenna is capable of covering various frequency bands, Wi- Fi/Bluetooth 802.11g (2.4 GHz), m-Wi-MAX (2.5 GHz), Wi-MAX (3.5 GHz) and Wi-Fi 802.11a (5.2 GHz) used in mobile communication with VSWR less than 3.

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