Planar Inverted F-Antenna for Handheld Devices Working at Wi-MAX Frequency Range (5.2 GHz)

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Abstract: **In this paper, a design of Planar Inverted F-Antenna to work on the Wi-MAX frequency range (5.2 Ghz, as central frequency) is proposed. The input impedance of the antenna is 50Ω. The international standards according to IEEE 802.16 for Wi-MAX are 2.3 GHz, 3.7 GHz and 5.2 GHZ. The proposed antenna resonates at the frequency of 5.2 GHz with a bandwidth of 120 MHz The substrate used has relative permittivity of 4.4. The antenna is fed by a coaxial probe feed and has a circular ground in order to enhance the bandwidth. The results are simulated by using Ansoft HFSS software. Also gain, directivity and bandwidth of the proposed antenna are studied.**

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Keywords: **PIFA, HFSS, co-axial feed, gain, directivity, return loss.**

1. INTRODUCTION

In today's cellular communication system, there is a need for compact size antenna with more efficiency, gain and a greater bandwidth. Generally, the patch and microstrip antennas used have size in the range of λ/2. However the increasing demand of compact size devices has led us towards PIFA having dimensions in the range of λ/4.

The main problem faced during antenna designing is to improve the efficiency and performance. Nowadays, the researches in antenna mainly focus on enhancing the bandwidth and improving efficiency and at the same time ensuring a compact size that is the demand of today's communication era. This led to the increasing use of PIFA for handheld devices

A PIFA have two parallel conducting plates which are connected to the ground and make the antenna resonate at λ/4. This is due to the introduction of shorting pin. Nowadays PIFA is widely used in mobile and radio applications because of its attributes such as compact size, light weight, low profile, low cost, omnidirectional and simple in design.

The distance between the shorting wall and the feed pin is the controlling factor for the impedance. Impedance is directly proportional to the distance between the feed and the shorting wall, i.e., lesser the distance less will be the impedance.

2. ANTENNA DESIGN

The dimensions of the proposed PIFA are 19.4mm×28mm. In the proposed antenna design, the ground plate is taken to be circular of radius 16mm. The thickness of the substrate is taken to be 1.52mm above the ground. The patch lies 1.52mm above the ground and a shorting plate and a coaxial feed pin is inserted between the ground and the top plate. The dimensions of the shorting wall are 19.4mm×0.5mm×1.52mm. The feed pin has a radius of 0.08mm and has a height equivalent to the thickness of the substrate i.e., 1.52mm. Fig 1. Shows the design of the proposed antenna.

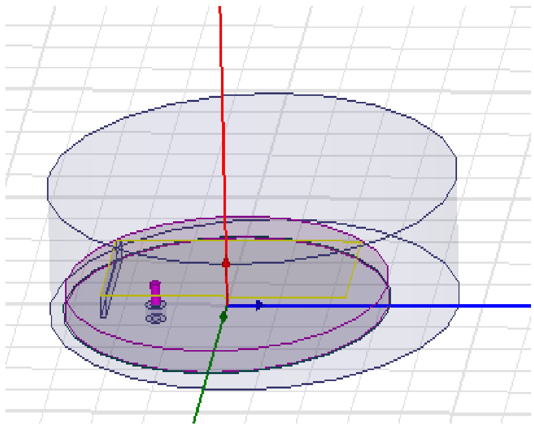

Figure 1. Proposed Antenna Design

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The ground plate is shorted through the shorting wall and the antenna is fed through the feed pin connected to a 50Ω transmission line at the back of the ground plate.

The substrate used has relative permittivity of 4.4 (FR4 Epoxy), the shorting wall and the feeding wall is of same material i.e., PEC.

3. DESIGN PARAMETERS AND SPECIFICATIONS

Design Frequency= 5.2 GHz
Relative Permittivity of Substrate=4.4

Table 1. Various Design Parameters

Parameters	**Dimensions**
Ground	Radius= 16mm
Substrate	Radius=16mm, height=1.52mm
Patch	19.4 mm × 28mm
Feed Pin	Radius=0.08mm, Height=1.52mm
Shorting Wall	19.4mm × 0.5mm × 1.52mm

4. SIMULATED RESULTS

The results for the designed antenna are calculated and studied in HFSS. The S11 parameter versus frequency graph is plotted and the central frequency is observed to be at 5.2 GHz.

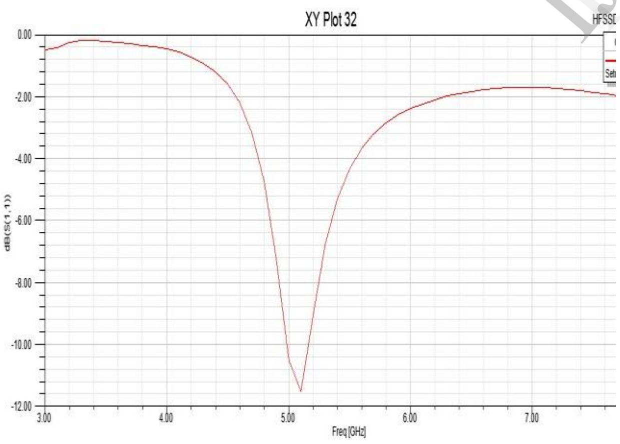

Figure 2. Return Loss versus Frequency

Figure 3 and figure 4 shows the plot of gain and directivity in dB respectively.

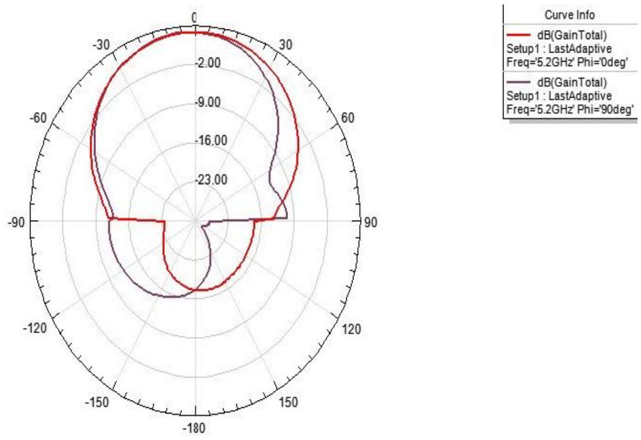

Figure 3 Plot for gain

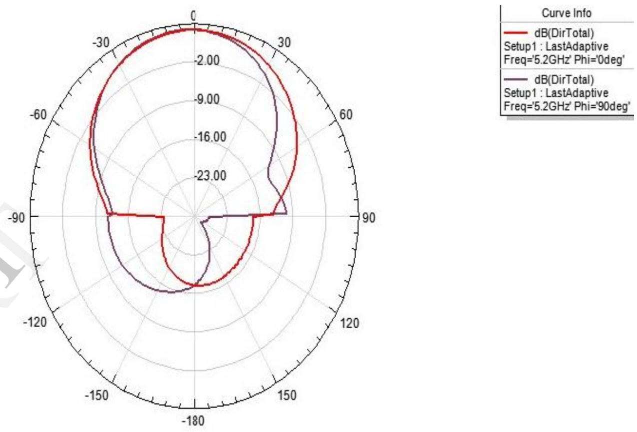

Figure 4 Plot for directivity

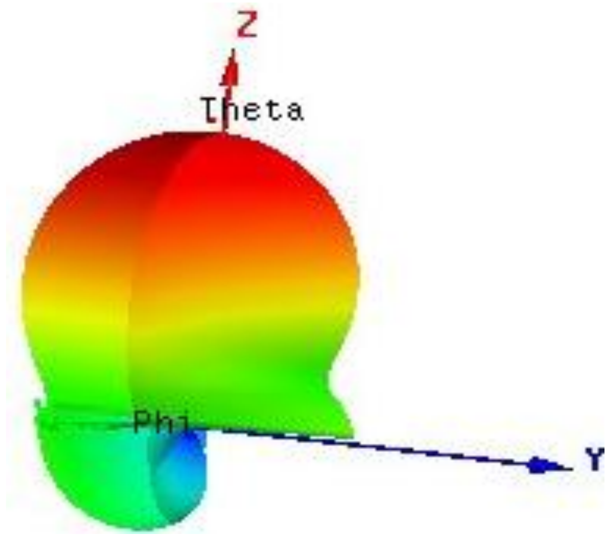

Figure 5. 3-D Radiation Pattern

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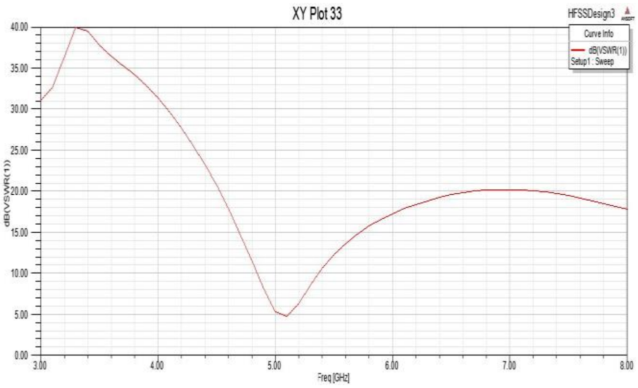

Figure 6. Plot for VSWR

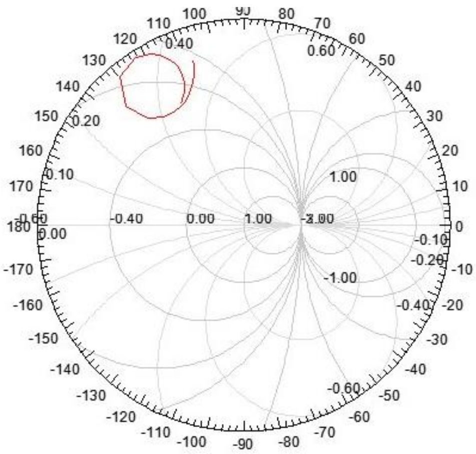

Figure 7. Smith Chart (log)

5. CALCULATED RESULTS

Return loss at 5.2 GHz = -11.59 dB

Bandwidth of the antenna as calculated at -10 dB Return Loss= 120 MHz

Maximum value of Gain= 3.9570 dB, Phi = ‘0’ deg and 4.0057 dB, Phi= ‘90’ deg.

Maximum value of Directivity= 4.0286 dB, Phi= ‘0’ deg and 4.0774 dB, Phi = ‘90’ deg.

Frequency Sweep = 5.2 GHZ.

6. CONCLUSION

The designed antenna is supporting Wi-MAX frequency ranges with the central frequency of 5.2GHz and a bandwidth of 120 MHz. Thus an antenna with a compact size, greater efficiency and more bandwidth is successfully designed.

However, further changes and modifications in the design can make the antenna resonate at dual or more frequency range. We can introduce slots to make the antenna resonate at more than one frequency.

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