Small Size Planar Inverted-F Antenna For WiMAX applications

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ABSTRACT- This work presents a small size planner inverted-F antenna (PIFA), with a single feed which covers WiMAX (3.2-3.6 GHz) and (5-5.8 GHz) range. The proposed antenna has many advantages like compact size and wide operation bandwidth. The antenna portion of 20mm* 15mm and the overall dimension25mm *40mm can be easily applied in the USB dongle. The proposed antenna is designed and optimized by using Ansoft HFSS13.0.

Keywords- PIFA, USB dongle, WiMAX, Antennas, HFSS.

1. INTRODUCTION

Wireless communications have progressed very rapidly in recent years. The future technologies requires a small antenna which is also multiband so that different types of data can be transmitted avoiding multiple antenna. Also to meet the miniaturization requirement, the antennas employed in devices must have their dimensions reduced accordingly[1]. For optimum system performance, the antenna must have small SAR and high radiation efficiency. PIFA has the attractive feature of low profile, small size and are very promising candidates for satisfying the design consideration. PIFA in general consist of a ground plane, a top plate, a shorting wire or strip and a feed wire attached between the ground plane and the top plate[2].

. WiMAX has three licensed spectrum profiles i.e low band, middle band and high band. Low band has frequency ranging from 2.5 to 2.8 GHz, the middle band has frequency ranging from 3.2 to 3.8 GHz and high band has 5.2 to 5.8 GHz. Many studies have been done on different techniques and structures to increase the bandwidth to have a multiband in single antenna. The criterion of this work is to design a multiband antenna for a USB dongle which is efficient, compact and low profile[3]. In this paper, two slots, one on the ground plane and the other on the plate have been introduced to accomplish a compact antenna to be used for WiMax application covering middle band and the higher band.

2. ANTENNA STRUCTURE

The proposed antenna consist of ground plane, shorting pin, top plate, one slot on the ground plane and one slot on the top plate. Since the objective of the study is to design a Planner inverted-F antenna for WiMax USB dongle applications, the overall size of the antenna including the ground plane is chosen to be 25 mm* 40 mm and the available space of antenna design is limited to 20 mm * 15 mm. Fig. (a) Shows the front view and Fig (b). Shows the side view of the proposed PIFA.

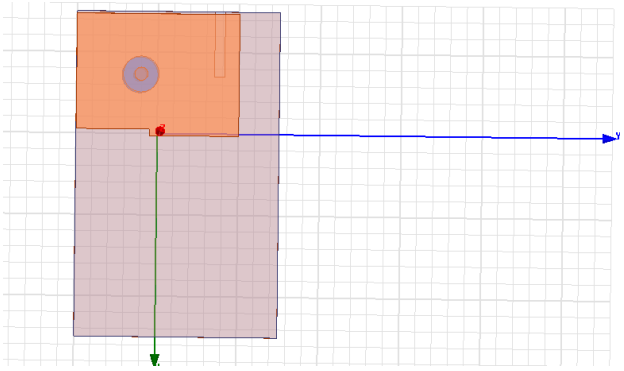

Fig. (a) Front view of proposed PIFA

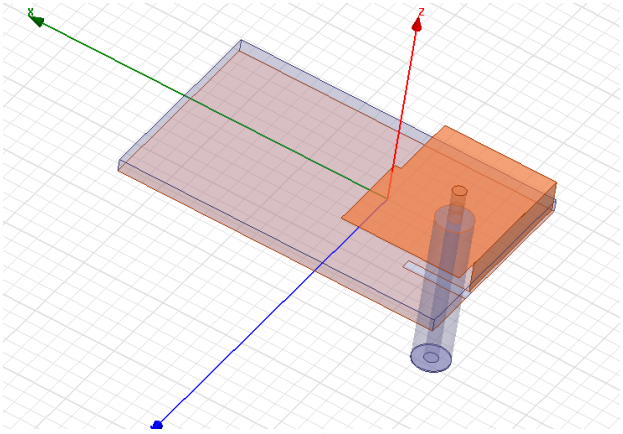

Fig. (b) Side view of proposed antenna

This antenna is designed on FR4 which has dielectric constant of Er=4.4 and height of dielectric substrate is (h) =1.6 mm. The radiating patch is matched to the ground plane via a rectangular shorting plate. the width of the shorting plate is 4 mm. The volume between radiating plate and ground plane is filled by air.

3. THE CHOICE OF SIMULATOR

The high frequency structure simulator (HFSS) is a software package which is used for calculating the electromagnetic behavior of a structure. HFSS is a full-wave finite electromagnetic simulator which enables to design three dimensional (3D) high frequency structures. It integrates simulation, visualization, modeling and automation where solution to 3D EM problems is quickly and accurately obtained[8]. Ansoft HFSS can be used to calculate parameters such as S-Parameters, Re- sonant Frequency and Fields. Typical uses include Package Modeling, PCB Board Modeling, Mobile Com-munications (Patches, Dipoles, Horns, Conformal Cell

Phone Antennas), Specific Absorption Rate (SAR). Ansoft HFSS is the tool of choice for High productivity research and development.

4. RESULTS AND VALIDATION

The simulation software, HFSS, produced all the simulation results presented in this chapter. All the antenna designs were simulated and optimized several times until satisfactory results are obtained. In this chapter, the accomplished results such as return loss (S11), 3-D Gain plots, VSWR plots and radiation patterns are discussed. The main purpose of this paper is designing and simulating a multiband planner inverted-F antenna (PIFA). Proposed antenna covers multiband and this is achieved by using a modified ground plane and top plate. A rectangular slot has been etched in ground plane as well as on the top plate which helps in achieving multiband operation.

4.1 RETURN LOSS - The following plot Fig. (C) shows the return loss of the multiband antenna design.

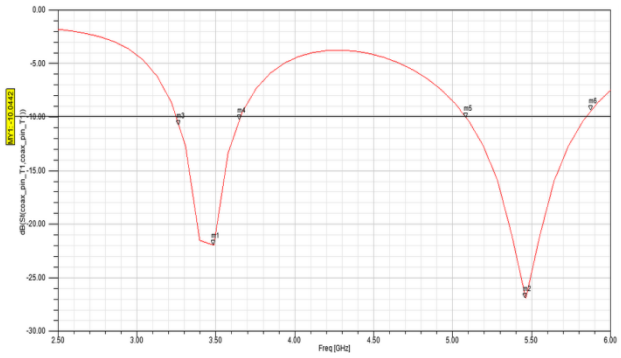

Fig. (c) Simulated return loss

From the plot shown in Fig. (c) it can be seen that the resonant frequencies achieved are 3.4 GHz and 5.4 GHz with return loss of -21.9 dB and -26.9dB respectively. Therefore, the proposed antenna covers the middle frequency band range and high frequency band range of WiMAX that is , the middle band has frequency ranging from 3.2 to 3.8 GHz and high band has 5.2 to 5.8 GHz.

4.2 3D RADIATION PATTERN - The simulated 3D pattern resonance obtained from the simulation result is shown in Fig (d). It is seen from the plot that antenna is a good radiator and almost omnidirectional radiation can be used.

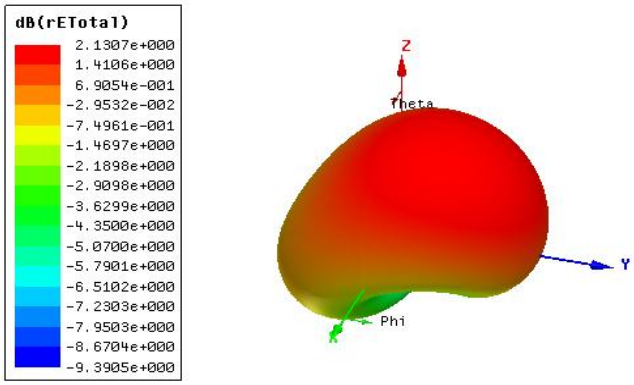

Fig. (d) Simulated 3D radiation pattern

4.3 3D GAIN - The gain and efficiency are two important figure of merit of the antenna. The overall gain of the antenna is obtained after simulation is shown in Fig (e). A peak gain of 3.6 dB is observed at resonance.

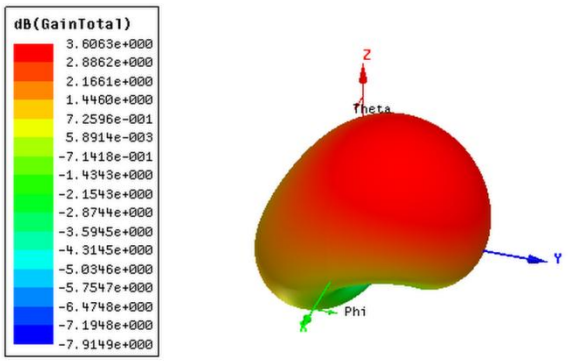

Fig. (e) Simulated 3D gain plot

4.4 VSWR PLOT - The simulation result for VSWR for the frequency range from 3.2 GHz to 5.8 GHz is shown in Fig (f). The value of VSWR can be seen in the plot and has to be less than 3 dB at both the resonant frequencies whisch is desirable for most of the wireless applications.

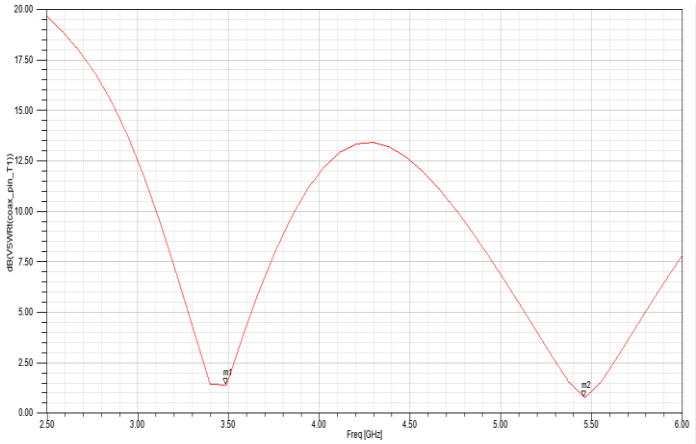

Fig. (f) Simulated VSWR plot

4.5 VALIDATION - This paper has focused on development of multiband planner inverted-F antenna for the use in the WiMax application. Due to the development of new communication standards , designer have to incorporate them without increasing size and complexity.The designed multiband antenna, built on PIFA design is small in size and have omnidirectional radiation pattern[6]. Compared with the traditional multiband PIFA, the proposed PIFA covers the WiMax range with a smaller size. Table 1 shows the comparison of PIFA design for WiMax which has already been proposed and the PIFA design proposed above. Early introduced PIFA antenna covering WiMax range has a ground plane of 50mm*50 mm and also the size of the top plate is 29mm *38 mm. But this proposed antenna discussed above has an advantage of small size having ground plane of 25mm*40 mm and available space for antenna is 20mm*15 mm. The result and the comparison below shows that there is a total percentage of size reduction of about 73.3 %.

TABLE 1. Comparison of already proposed design to the design proposed in this paper.

ANTENNA DESIGN PARAMETERS	VOLUME (MM)	RESONANT FRQUENCIES	FREQUENCY BANDS COVERED
Design already proposed	15000	2.3 GHz 3.6 GHz 5.6 GHz	2.3 GHz 3.6 GHz 5.6 GHz
Design proposed above	4000	3.8 GHZ 5.4 GHz	3.2 GHz to 3.6 GHz 5 GHz to 5.8 GHz (complete middle and high frequency bands of WiMax)

% SIZE REDUCTION= 100 – 4000/ 15000 *100= 73.3 %

5. CONCLUSION

This paper has focused on development of multiband planner inverted-F antenna for the use in the WiMax application. The designed multiband antenna, built on PIFA design is small in size and have omnidirectional radiation pattern. The result show that the antenna structure is suitable for its use in USB dongle.

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