Microstrip Patch Antenna Design for WiMAX

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Abstract— **Microstrip patch antennas are strong entrants in many WIMAX applications. This paper proposes the use of a patch antenna with double U-shaped slots to achieve dual band operation. An impenetrable substrate helps expand the individual bandwidths. A widespread analysis and performance of the designed antenna is simulated using the HFSS software. Due its compact size the antenna is favorable to be entrenched within different portable devices employing WiMAX applications.**
Keywords— Microstrip antenna, Wireless antenna, Broadband antenna, U-slot patch, WiMAX

I. INTRODUCTION

The rapid growth and development of wireless technology has drawn novel demands for integrated components including antennas. Antenna is one of the key modules in an integrated low-profile WiMAX application therefore, antenna miniaturization is essential to attain an optimal design. Microstrip patch antenna due to its advantage such as low profile planner configuration, low weight, low fabrication cost and capability to integrate with microwave integrated circuit technology, the Microstrip patch antenna is very well suited for the applications such as wireless communication system, cellular phone, radar system and satellite communication system [1],[2].One of the potential applications of WiMAX is to provide backhaul support for mobile WiFi hotspots.

The IEEE 802.16 working group has established a new standard known as WiMAX (Worldwide Interoperability for Microwave Access) which can reach a theoretical up to 30- mile radius coverage. Moreover, in the case of WiMAX, the highest theoretically achievable transmission rates are possible at 70 Mbps.Also, several designs of broadband slots antenna have been reported. A monopole antenna for WiMAX applications was proposed in. In this project, two slots and one bridge elements have been applied to generate the three frequencies bands to be used in WiMAX technology. Basically WiMAX has three allocated frequency bands called low band, middle band and high band. The low band has frequency from 2.4 GHz to 2.8 GHz, the middle band has frequency from 3.2 GHz to microstrip line. The analysis is performed numerically using HFSS software.

Mobile WiMAX has offered the industry a very capable platform by which to deliver the demanding service requirements for wireless access today and tomorrow. With the added support for a variety of advanced multi-antenna implementations, Mobile WiMAX offers the wireless operator considerable relief in meeting their growing network demands with higher performance, fewer sites, less spectrum, and reduced cost.

II. ANTENNA DESIGN AND STRUCTURE

Operation Principle: To design a rectangular patch microstrip antenna operating at wideband the patch length L and width W should be selected appropriately. In order to overcome the narrow bandwidth the u slot enclosure on the patch surface is introduced. It has the advantage of radiating in wideband with better efficiency.

Antenna Geometry:The proposed antenna geometry consist of coaxial fed rectangular microstrip patch which is printed over a FR4 substrate which is having the thickness of 1.6mm and permittivity $\varepsilon r=4.4$. A U slot is cut on the patch surface which is mounted over the substrate. The other side of the substrate is coated with metal, which describes the ground plane of the antenna. The reference antenna is given in fig 1

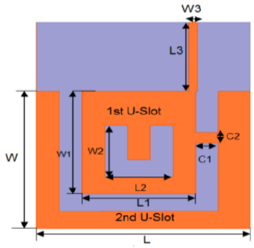

Fig 1 Reference antenna

DESIGN SPECIFICATION:

DESIGN PARAMETER OF MICROSTIP PATCH ANTENNA

1. Effective dielectric constant (Ɛre) : It is a necessary parameter to account for the fringing effect and the wave propagation in the antenna. The value of effective dielectric constant (Ɛre) is slightly less than the dielectric constant (Ɛr) because the fringing fields acting around the boundary sides of the patch are not limited in the dielectric substrate but also spreads in the air[2] .

$$\epsilon \mathrm{eff} = \frac{\epsilon \mathrm{r}+1}{2} + \frac{\epsilon \mathrm{r}-1}{2}\left(1+\frac{10h}{w}\right)^{-0.555}$$

Where h and w are height of the substrate and width of the patch respectively.

2. Effective path length

$$\Delta \mathrm{L} = 0.412\mathrm{h}\,\frac{(\epsilon \mathrm{ref}+0.3)(\frac{w}{h}+0.264)}{(\epsilon \mathrm{ref}+0.3)(\frac{w}{h}+0.8)}$$

Then the effective length will be given as,

$$Leff = \frac{c}{2fo\sqrt{\epsilon \mathrm{ref}}}$$

Where, f0 stands for Operating Frequency. Now, the Actual Length of the patch can be calculated,

$$L = Leff - \Delta L$$

3. The width of the patch

$$W = \frac{c}{2fo\sqrt{\frac{\epsilon \mathrm{r}+1}{2}}}$$

The dimensions of the antenna are given in table 1

Antenna Dimensions		
Description	***W(mm)***	***L(mm)***
Main Patch	*40*	*47*
First U slot	*15*	*15*
Second U slot	*30*	*25*
Feed Line	*2*	*20*
Bridge	*5*	*3*

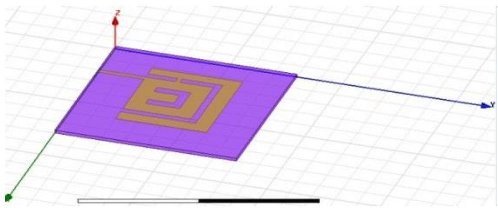

Fig 2Reference Antenna as designed in HFSS Software

The Reference Antenna is designed in HFSS Software, at 2.48 GHz mid frequency, as shown in Fig 2). The antenna is evaluated and the Return loss graph is plotted against the frequency range, as shown below Fig. The Return loss value obtained is -21.22 dB, and the bandwidth obtained is 59.2MHz. at 2.39GHz frequency and at 3.23GHz return loss is -23dB which has 81.3MHz bandwidth, as shown in Fig 3).

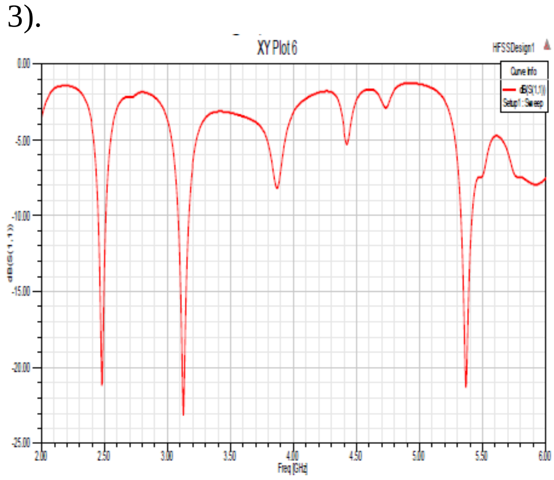

Fig 3 Return loss plot in hfss

The VSWR of the proposed antenna is also plotted in hfss

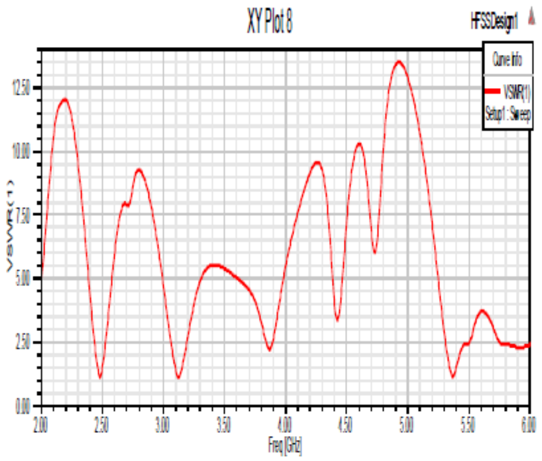

Fig 4 VSWR v/s Frequency plot in hfss

PROPOSED WORK

In this paper following modifications are proposed

□Position and dimensions of the bridge are modified.□

□□Transmission feed line location is changed.

The simulation of the antenna is done in ANSOFT HFSS Software, with the critical frequency of the antenna taken as 2.45 GHz.

SIMULATION RESULTS

Proposed modifications have resulted in better performance of the antenna

Bandwidth and Return loss:

In fig 5 the return loss v/s frequency is plotted. From the graph a Bandwidth value of 149.5 MHz is obtained and a return loss at first peak is -22db and second peak is -31db, and it is found that the performance the proposed Antenna is much better than the performance of the Reference Antenna, where its Bandwidth value is 139.5 MHz and Return loss of -21 dB as first peak and -23 dB as second peak. The proposed antenna is has return loss less than the reference antenna. Hence is comparatively much better.

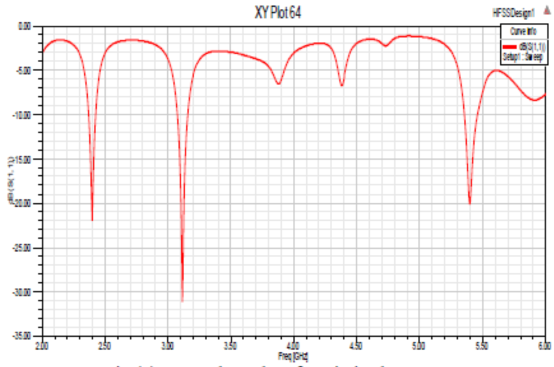

Fig 5 Return loss v/s frequency plot

CONCLUSION

Having certain limitations like low gain and bandwidth the proposed antenna performs much better when compared with the reference antenna.

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