Compact double U-Slots Patch Antenna for Mobile WiMAX Applications

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Abstract

A small triple-band 2.7 GHz, 3.2 GHz and 5.3 GHz compact microstrip patch antenna with two U-shaped slots and a small ground plane is presented. It has been developed to be used in future WiMAX technology. The required bandwidths are fulfilled the WiMAX technology 4.8 %, 3 % and 2.5 % respectively. The return loss for the triple band are -18.5 dB, -14.5 dB and -19 respectively.

1-Introduction

The IEEE 802.16 Working Group has established a new standard known as WiMAX (Worldwide Interoperability for Microwave Access) this WiMAX can reach a theoretical up to 30-mile radius coverage, Moreover the data rate concerned for the WiMAX bands is 70 Mbps. Nowadays researches focusing on how to design an antenna for WiMAX technology. Basically WiMAX has three allocated frequency bands called low band, middle band and high band. The low band has frequency from 2.5 GHz to 2.8 GHz, the middle band has frequency from 3.2 GHz to 3.8 GHz and the high band has 5.2GHz to 5.8 GHz.
Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight , low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, cellular phones, pagers, radar systems, and satellite communications systems[1,2]. The main advantage of using Transmission Line feeding is very easy to fabricate and Simple to match by controlling the inset position and relatively simple to model. Narrow bandwidth in microstrip patch antenna is a disadvantage. The broadband characteristic of a microstrip patch antenna with a U-shaped slot has been confirmed by many published results and several design of broadband slots antenna has been reported [3-6]. A multi U-slot Patch antenna has been reported recently for 5 GHz WLAN [7], and also a monopole antenna for WiMAX applications was proposed in [8].

In this paper, a double U-slot microstrip patch antenna is designed and simulated for WiMAX bands with over all dimensions 50 mm x 40 mm and height of 1.5 mm. A parametric study on the structure is made in-order to obtain the best possible size and position of the connectors. Simulation results based on a commercially available Finite Element package, HFSS, on the return loss, and E, H plane radiation pattern are provided and discussed.

2- Antenna design

In this paper several parameters have been investigated using Ansoft HFSS software. The design specifications for the Patch Antenna are:
The dielectric material selected for the design is FR4 which has dielectric constant of (ε_r =4.4) and thickness of dielectric substrate (h) = 1.5 mm.The antenna is fed by 50 Ω microstrip line, through a quarter wavelength transformer for impedance matching.

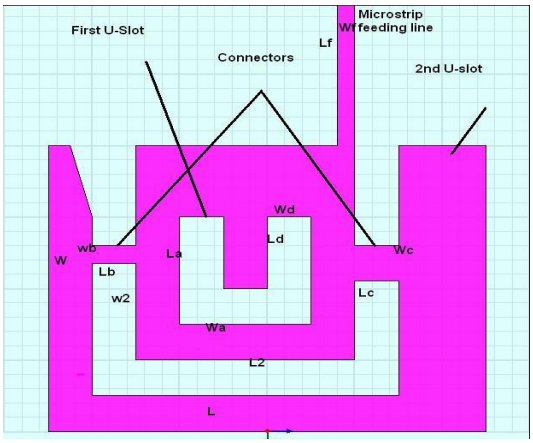

Figure 1 configuration of the double U-slots Patch antenna on a dielectric substrate.

The overall dimensions of the Double U-slot patch are:

L	40 mm
W	50 mm
L2	30 mm
W2	25 mm
La	15 mm
Wa	5 mm
Lb	5 mm
Wb	2.5 mm
Lc	5 mm
Wc	5 mm
Ld	10 mm
Wd	5 mm
Lf	19.59 mm
Wf	2 mm

Table 1: the dimensions of the Antenna

WiMAX technology has a data rate up to 70 Mbps. Through simulations return loss losses were calculated with different widths of the connector (As shown in Fig. 1) and the E-Plane and H-Plane radiation patterns were also simulated as shown in Fig. 2 and Fig. 3.

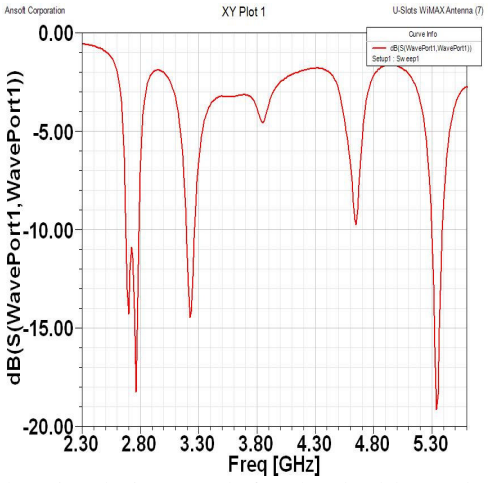

Figure 2: the Simulation result for the double U-slot Antenna.

Fig. 2 shows response for the double U-Slot antenna at three bands which they are 2.7 GHz, 3.2 GHz and 5.3 GHz. The three bands satisfied the bandwidth of the WiMAX technology. The impedance bandwidth for the low band is 4.8 % which satisfy the required bandwidth for WiMAX. Also for the middle band the impedance bandwidth is 3 % whereas in the higher band the bandwidth is 2.5 %. The return losses for the three bands are -18.5 dB, -14.5 dB and -19 respectively.

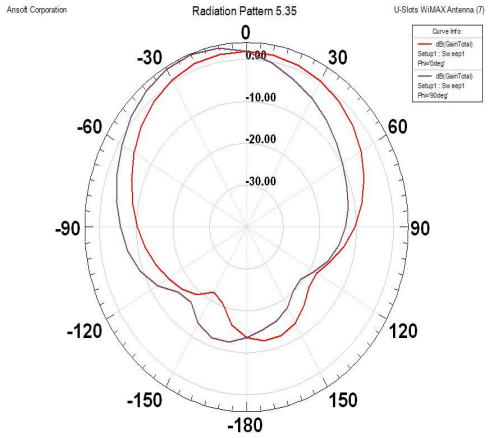

Figure 3a

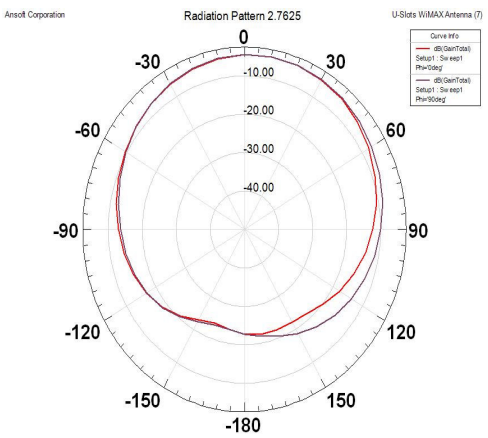

Figure 3b

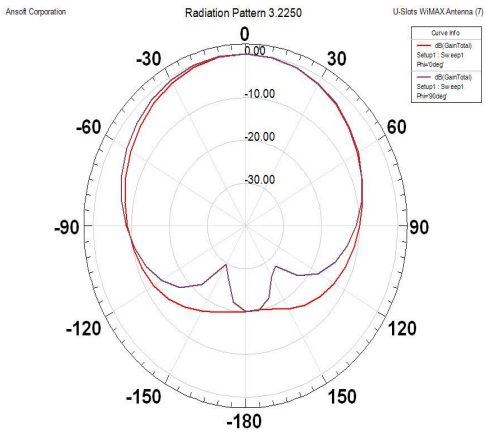

Figure 3c

Figure 3: (a) E and H Plane Radiation Pattern at 2.7 GHz. (b) at 3.2 GHz. (c) at 5.3 GHz.

3- Conclusion

The triple-band behaviour at 2.7, 3.2 and 5.3 GHZ has been achieved as well as the bandwidth requirements for WiMAX standards 4.8 %, 3 % and 2.5 % respectively. The return loss for the triple band is -18.5 dB, -14.5 dB and -19 dB respectively. Very broad radiation patterns have been obtained which seems to be adequate for the envisaged applications

Acknowledgement

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