

Design & Simulation of Double U-Slot Microstrip Patch Antenna for WiMAX Application

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Abstract— This paper presents the numerical simulation of double U-slots microstrip patch antenna for WiMAX application. The proposed antenna is feed by the Transmission line. The total area occupies by the antenna 40mmx47mm. In this design two slots and one bridge elements have been applied to generate the three frequencies bands 2.44GHz, 3.26GHz and 5.38GHz respectively. In addition, the antenna has achievable return loss, radiation pattern and also bandwidths within the -8dB return loss bandwidth. The bandwidths of the three frequencies band are 4.22%, 1.87% and 3.51% respectively. The return loss S_{11} characteristic for the three band are -24dB, -20dB and -47dB respectively. Due to the compact area occupied, the proposed antenna is promising to be embedded within the different portable devices employing WiMAX applications.

Index Terms— Patch antenna, Double U-slot antenna, WiMAX antenna, GEMS software simulink.

1 INTRODUCTION

A microstrip antenna consists of a dielectric substrate, with a ground plane on the other side. The microstrip patch antenna is very well suited for applications such as wireless communication system, cellular phone, radar system and satellite communication system [1], [2]. 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. One of the potential applications of WiMAX is to provide backhaul support for mobile WiFi hotspots. A low profile double U-slots antenna for WiMAX operation has low return loss and bandwidth. Recently, proposed printed antenna for WiMAX operation has the three frequencies bands but the return loss not over -30dB [3]. The broadband characteristic of a microstrip patch antenna with U-shaped slot has been confirmed by many published results [4], [5]. Also, several designs of broadband slots antenna have been reported [6], [7]. A monopole antenna for WiMAX applications was proposed in [8]. In this paper, 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 fre-

quency from 2.4 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. This paper addresses the numerical analysis of the proposed antenna for WiMAX operation with acceptable return loss, gain and bandwidth. For the numerical analysis we consider the substrate permittivity of the antenna is $\epsilon_r = 4.4$ (FR4) with substrate thickness 1.2mm and feed by a 50 Ω microstrip line. The analysis is performed numerically using GEMS software.

The paper is divided as follow: Section 2 discusses the antenna design and structure; Section 3 presents the parameter study; Section 4 explains the simulation process for the antenna and Section 5 conclusions.

2 ANTENNA DESIGN AND STRUCTURE

In this paper several parameter have been investigate using GEMS software. The design specifications for the patch antenna are:

- The dielectric material selected for the design is FR4.
- Dielectric constant 4.4
- Height of substrate (h) = 1.2 mm.

The antenna is fed by 50 Ω microstrip line, 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 [3]. The proposed antenna has two U-slot shaped and one bridge to connect both shapes together as shown in Fig.1, the detailed dimensions are given in Table-1.

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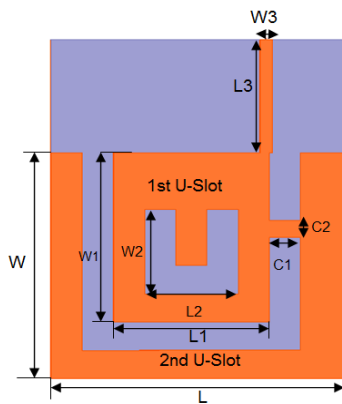


Fig.1 The geometric view of the proposed patch antenna

The proposed antenna generates three bands at 2.44, 3.23 and 5.38 GHz with simulated impedance bandwidth of 4.22%,

TABLE 1

THE DIMENSION OF THE U-SLOTS ANTENNA (UNIT=MM)

W	L	W1	L1	W2
40	47	30	25	15
L2	W3	L3	C1	C2
15	2	20	5	3

1.87% and 3.51% respectively. Thus the three bands satisfied the required bandwidth for the WiMAX compliant transmitters.

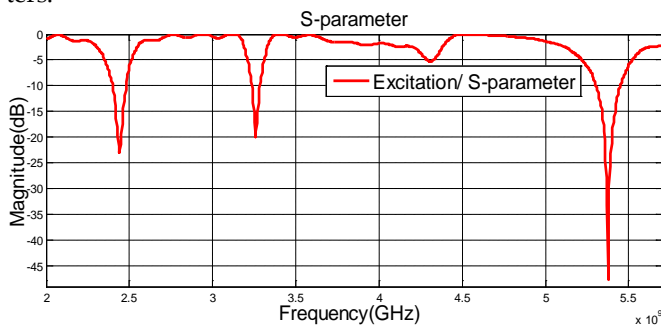


Fig.2 The return loss simulation result with two U-slots

As show in Fib.2 the simulation indicates a response at 2.44 GHz with return loss = - 24 dB, 3.26GHz with return loss = -20 dB and 5.38 GHz with return loss = -47 dB. The bandwidths of the dual band are 4.22 %, 1.87% and 3.51 % respectively.

3 PARAMETRIC STUDY

There are some parameter that effect the antenna performance, two of them have a very noticeable effect in the determining the performance of the antenna. The two parameters that show the most effect are width of the W and width of the bridge. The return losses are different according to parameter changes. These effects will be explained and summarized in this section.

3.1 The effect of changing width of W

In Fig.3, it shows the return loss based on variation in the width of the second U-slot (W) from 30 mm to 35 mm and to 40 mm. The first and second bands are not affected by the width of the second U-slot.

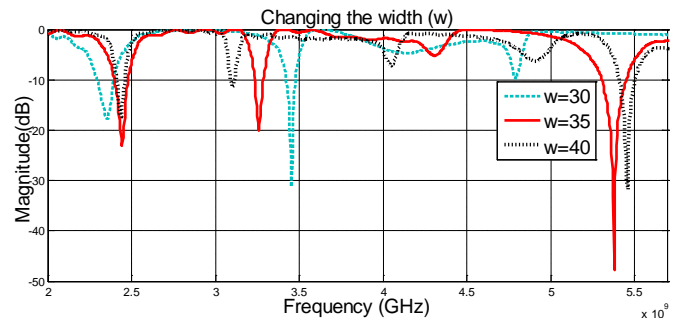


Fig.3 The effect of the increasing the width of W

When 30mm width is used then first band and second band return loss increasing but third band decreasing. Again when we are used 40mm width then first band and third band return loss increasing but second band decreased and bandwidth also decreasing. Finally, when we are sued 35mm width then three band return loss and bandwidth increasing. The good characteristic of the return loss and the bandwidth is obtained (W) 35 mm.

3.2 The of changing width of bridge C2

In Fig.4, it is describes the return loss based on increasing and decreasing the width (C2) of the first U-slot. Bridge width affects the bandwidth of the resonance frequency and return loss. When bridge width is sued 2.5mm then return loss is increased but bandwidth is decreased. When bridge width is sued 4mm then bandwidth is increased but return loss is decreased. Again, when we are used bridge width 3mm then return loss and bandwidth also increased. The good characteristic of the return loss and the bandwidth is obtained (C2) 3 mm.

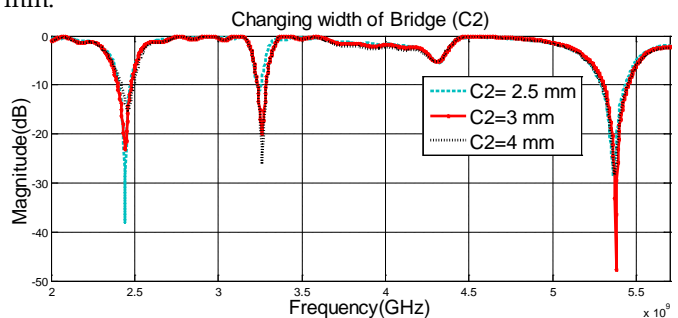


Fig.4 The effect of increasing the width of bridge (C2)

4 SIMULING RESULT

The radiation patterns at the centre frequencies 2.44GHz, 3.26GHz and 5.38GHz of WiMAX application are plotted as shown in Fig.5 (a)-(c). The 3D radiation pattern at the center frequencies 2.44GHz, 3.26GHz and 5.38GHz are plotted as shown in Fig.6 (a)-(c).

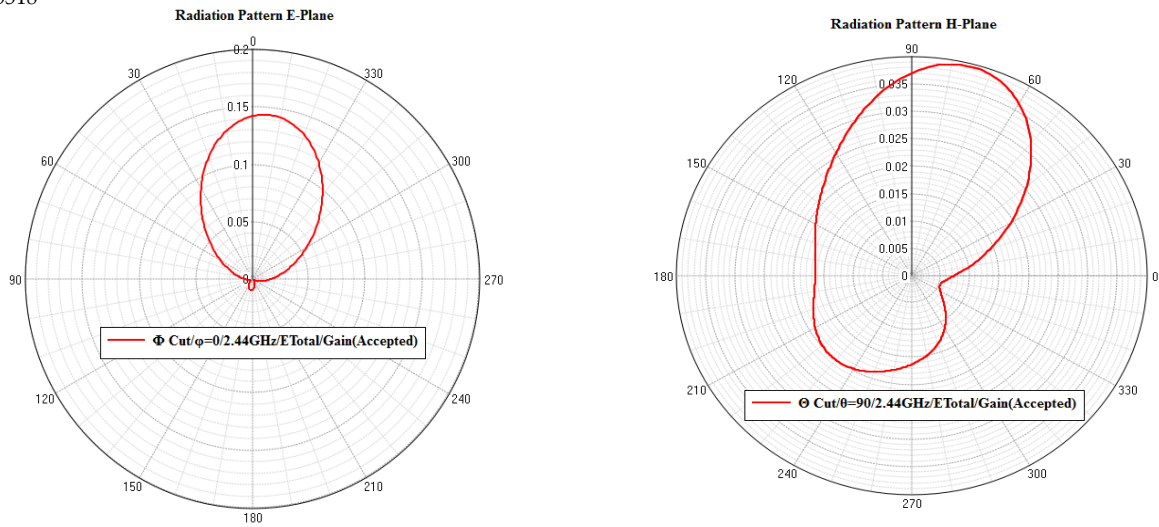


Fig.5 (a) Radiation pattern E-plane and H-plane at 2.44GHz

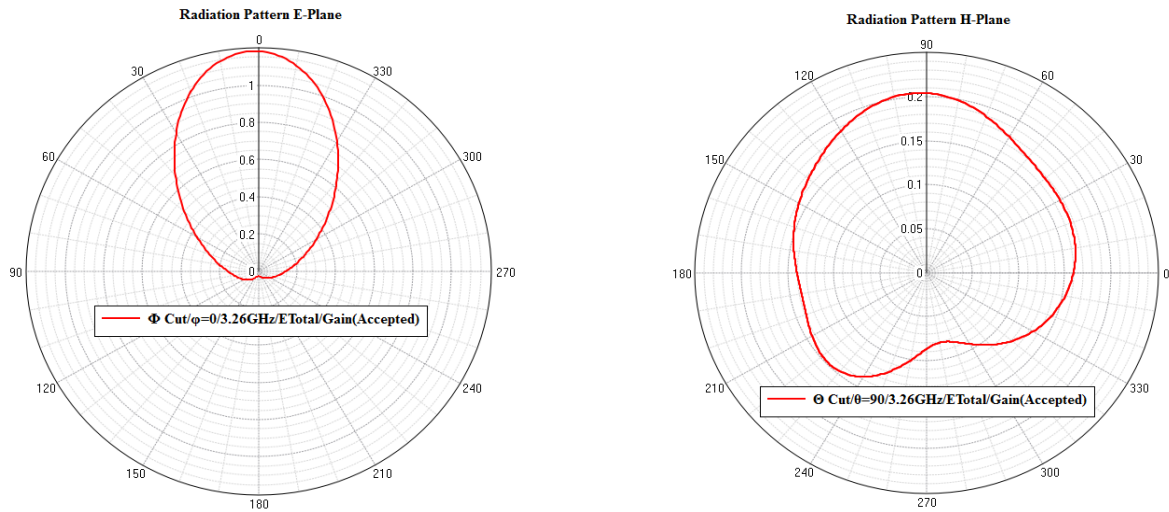


Fig.5 (b) Radiation pattern E-plane and H-plane at 3.26 GHz

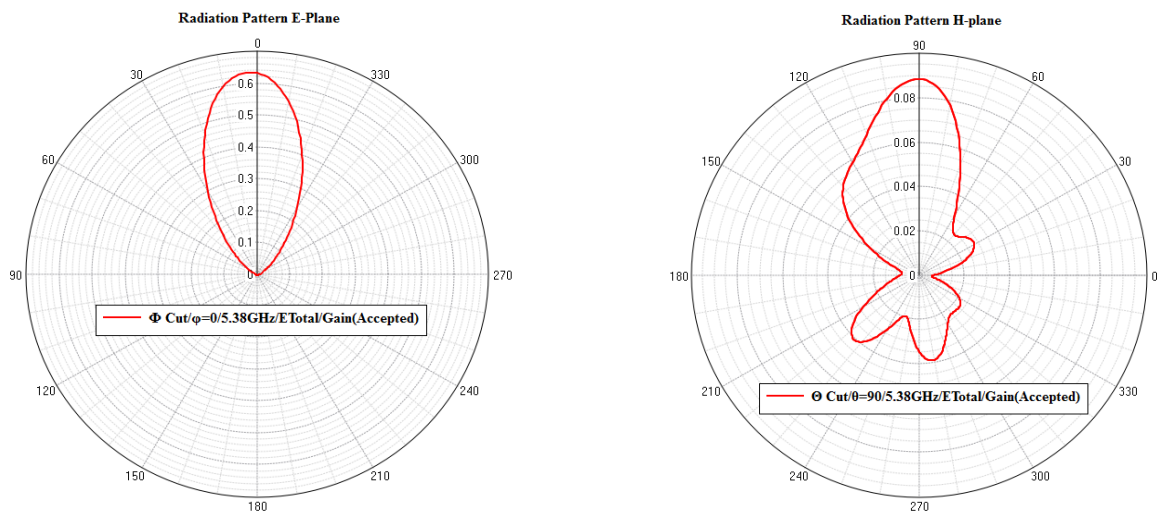


Fig.5 (c) Radiation pattern E-plane and H-plane at 5.38 GHz

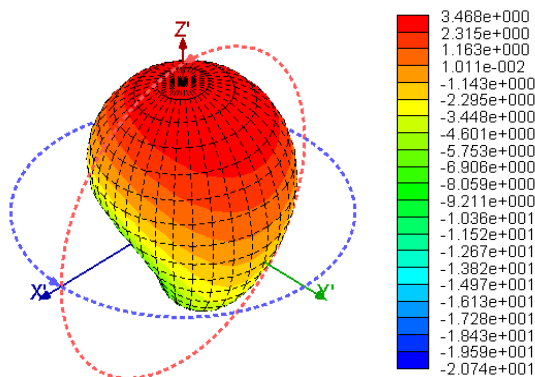


Fig.6 (a) 3D Radiation pattern at 2.44GHz

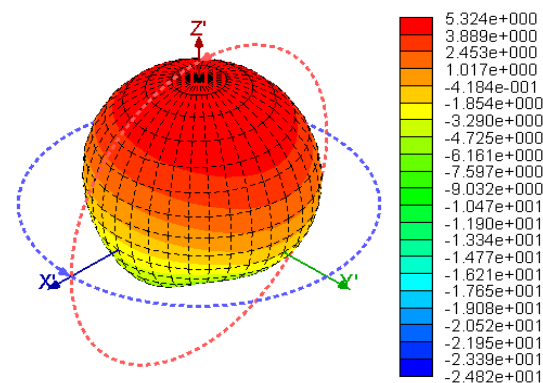


Fig.6 (b) 3D Radiation pattern at 3.26 GHz

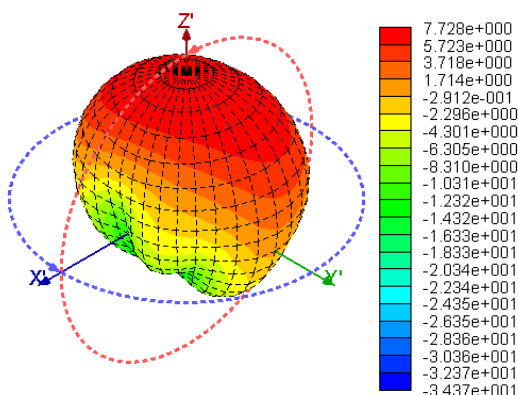


Fig.6 (c) 3D Radiation pattern at 5.38 GHz

4 CONCLUSION

This paper presented the simulation of the microstrip patch antenna with double U-slots. From two U-slots shape on the patch, the three bands can be generated and by adding one bridge the exact frequencies band for WiMAX can be achieved. The three frequency band 2.44GHz, 3.26GHz and 5.38GHz has been achieved as well as the bandwidth requirements for WiMAX standards 4.22%, 1.87% and 3.51% respectively. The return loss for the triple band are -24dB, -20dB and -47dB respec-

tively. The U-slot patch antenna is designed for increasing the bandwidth and return loss but gain cannot increase. If array of the U-slot patch antenna is used then the gain can be improved. Therefore, the antenna will be better work in the WiMAX applications and wireless communications system.

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