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Dual U-Shape Microstrip Patch Antenna Design for WiMAX Applications

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***Abstract*— This paper presents the dual U-shape microstrip patch antenna feed by the transmission line. The proposed antenna is designed by FR4 substrate and ground plane with an area 40mm×47mm. This antenna is designed for WiMAX applications and wireless communication system. The two slots and one bridge elements have been applied to generate the three frequencies bands 2.44GHz, 3.26 GHz and 5.38 GHz to be used in WiMAX technology. Basically WiMAX has three allocated frequency bands called low band, middle band and high band. One bridge element has been used to shift the frequencies in proper way. The bandwidths (-8dB) 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 -24 dB, -20 dB and -45 dB respectively. E-plane and H-plane for the three frequencies is satisfactory within the bandwidth. E-plane and H-plane radiation pattern are provided.**

***Index Terms*— Dual U-shape, Patch antenna, WiMAX antenna, GEMS software simulink.**

I. Introduction

A microstrip antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantage such as low profile planner configuration, low weight, low fabrication cost and capability to integrated with microwave integrated circuit technology, 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]. WiMAX is wireless communication system.

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. In order to satisfy the integration of WiFi, WiBro and WiMAX for WMAN applications, multiband compact antennas are the preferred front end for mobile terminals [3]. The

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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 multi U-slot patch antenna has been reported recently for 5GHz WLAN [8], and a monopole antenna for WiMAX applications was proposed in [9]. A rectangular microstrip antenna with two U-shaped slots on the patch using foam layer has been reported in [10]. Recently, some designs have been reported to achieve multiband antenna for Wireless LAN application [11],[12]. A bandwidth enhancement for conical radiation using a shorting wall has been studied recently and reported in [13]. The main goals of the previous research work and literature related to the patch antenna are focusing on achieving multi-width bands, improving the impedance bandwidth performance.

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 frequency 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 5.2 GHz to 5.8 GHz [3]. The total size of the ground plane is 40mm×47mm and height of 1.2 mm and the size of the radiated patch is 40mm×47mm, fed by a 50 Ω microstrip line. A comprehensive parametric study on the structure is made in order to understand the effect of various dimensions of the main parameters. The proposed antenna is simulated with commercially available package GEMS software, on the return loss, and E, H plane radiation pattern are provided and discussed.

II. 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 mode [3]. The proposed antenna has two U-slot shaped and one bridge to connect both shapes together as shoen Fig.1, the detail dimensions are given in table-1.

Table 1 (The dimension of the U-slot antenna , unit = mm)

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

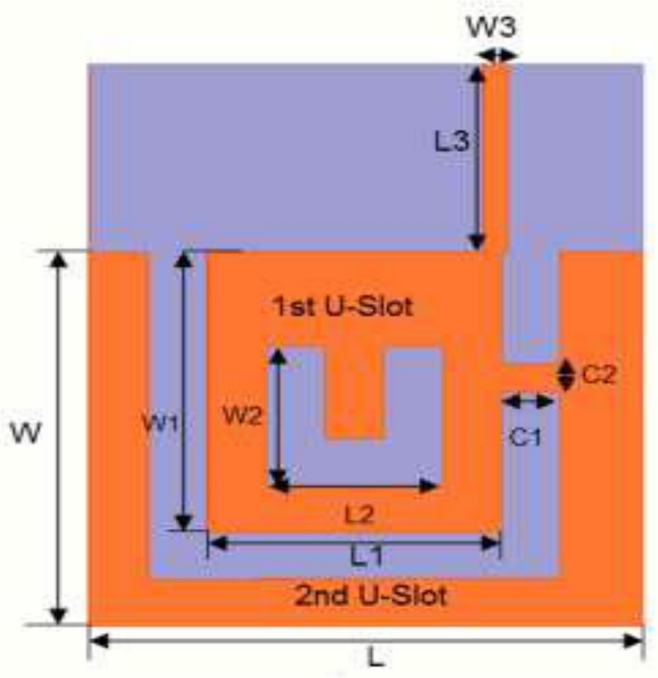

Fig.1 The structure and detail diminution of the proposed patch antenna.

The proposed antenna generates three bands at 2.44, 3.23 and 5.38 GHz with simulated impedance bandwidth of 4.22%, 1.87% and 3.51% respectively. Thus the WiMAX compliant transmitters.

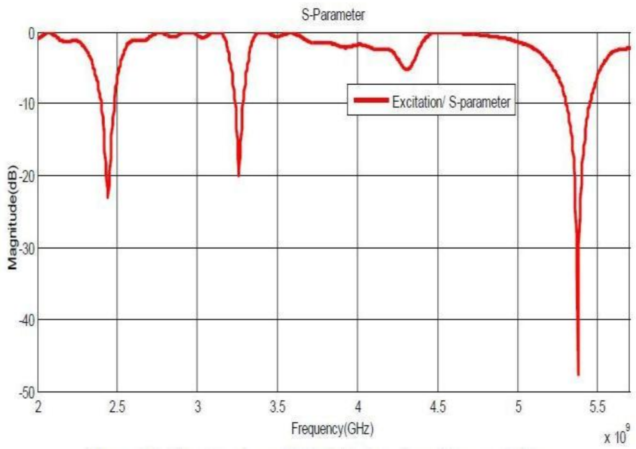

Fig.2 The return loss simulation result with dual U-slots.

As shown in Fig.2 the simulation indicates a response at 2.44 GHz with return loss = -24 dB, 3.26 GHz with return loss = -20 dB and 5.38 GHz with return loss = -45 dB. The bandwidth of the dual band are 4.22%, 1.87% and 3.51% respectively.

III. 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.

A. 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.

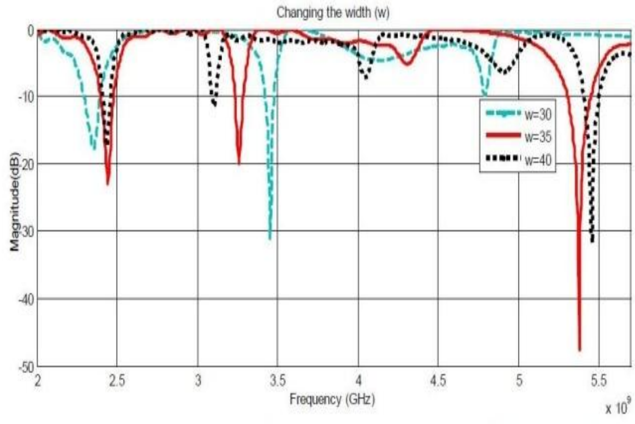

Fig.3 The effect of increasing the width of W

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

B. The effect 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

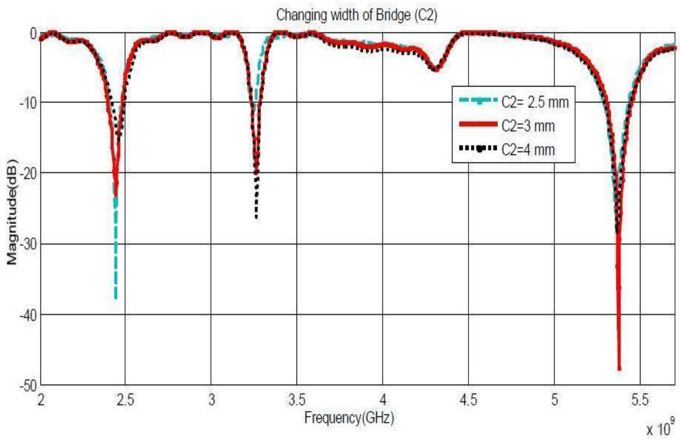

Fig.4 The effect of increasing the width of bridge (C2).

bridge width is used 2.5 mm then return loss is increased but bandwidth is decreased. When bridge width is used 4 mm then bandwidth is increased but return loss is decreased. Again, when we are used bridge width 3 mm then return loss and bandwidth also increased. The good characteristic of the return loss and bandwidth is obtained (C2) 3 mm.

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IV. RESULT

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

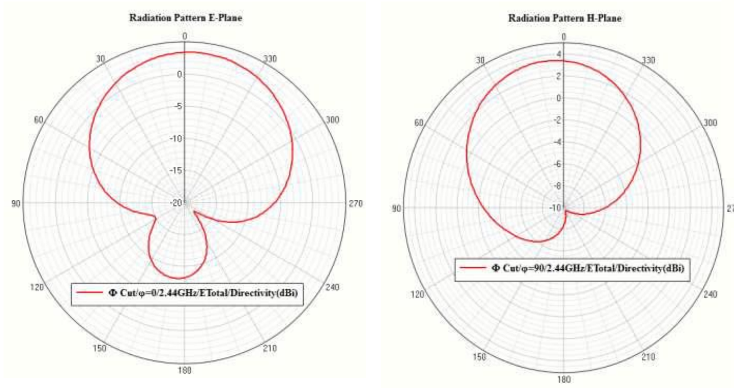

Fig.5(a) Radiation pattern E & H plane at 2.44 GHz

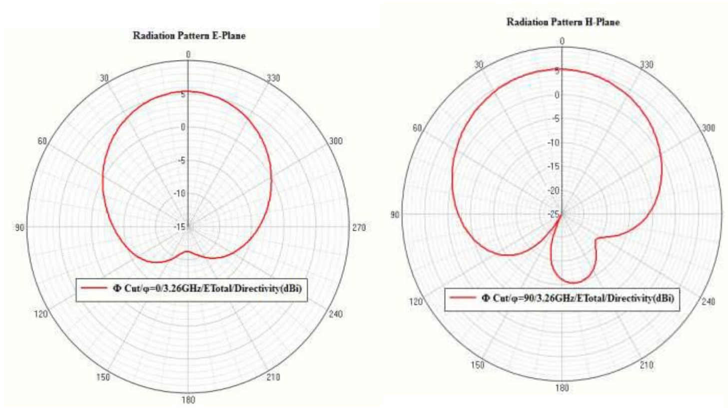

Fig.5(b) Radiation pattern E & H plane at 3.26 GHz

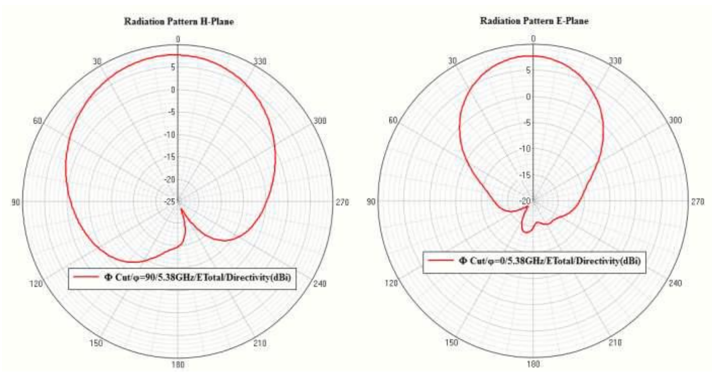

Fig.5 (c) Radiation pattern E & H plane at 5.38 GHz

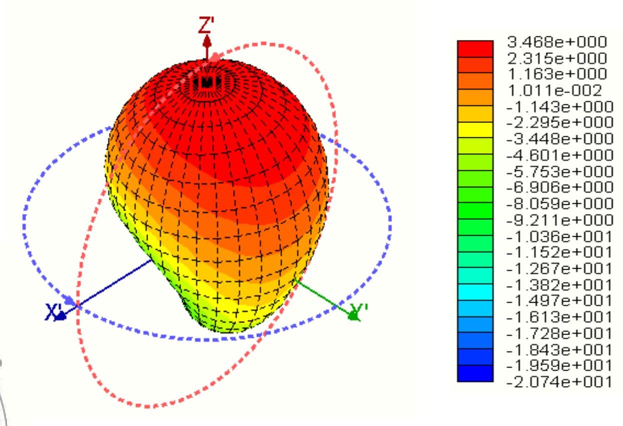

Fig.6 (a) 3D radiation pattern at 2.44 GHz

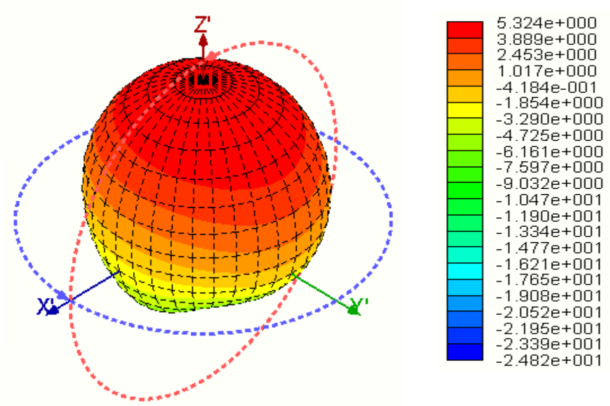

Fig.6 (b) 3D radiation pattern at 3.26 GHz

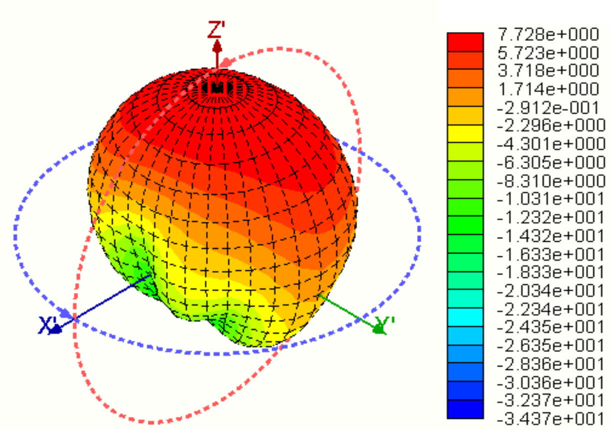

Fig. 6 (c) 3D radiation pattern at 5.38 GHz

V. CONCLUSION

This paper presented the simulation of the microstrip patch antenna with dual U-slots. From two U-slots shape on the patch. Three bands can be generated and by adding one bridge the exact frequencies band for WiMAX can be achieved. The three frequency band 2.44 GHz, 3.26 GHz and 5.38 GHz has been achieved as well as the bandwidth requirements for WiMAX standard 4.22%, 1.87% and 3.51% respectively. The return loss for the triple bands are -24 dB, -20 dB and -456 dB respectively. The U-slot patch antenna is used then the gain can be improved. Therefore, the antenna will work better in the WiMAX applications and wireless communication system.

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