Microstrip Patch Antenna Design for WiMAX

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Abstract: In this paper, a small size wideband single-layer single-patch microstrip antenna is analyzed. By placing a symmetric inverted U-slot on the rectangular patch and using coaxial probe-fed the impedance bandwidth is improved to 33.31%. One of the main characteristics of this antenna is that the bandwidth of 33.31% has been achieved without using thick foam or air substrate. This can also serve as a single feed compact rectangular microstrip antenna for dual band applications. Different slits are introduced at the right edge of the patch to reduce the resonant frequency. For the proposed antenna two resonant frequencies are obtained at 3.75 GHz and 5 GHz with bandwidth of 28.74 MHz, return loss –14.35 dB and bandwidth of 113.89 MHz, return loss -39.88 dB respectively. The antenna size has been reduced by 57.14 % when compared to a conventional microstrip patch. The characteristics of the designed structure are investigated by using MoM based electromagnetic solver, IE3D. An widespread analysis of the return loss, radiation pattern, gain and efficiency of the proposed antenna is presented. The simple configuration and low profile nature of the proposed antenna leads to easy fabrication making it suitable for the use in Wireless Communication System.

Keywords: Dual U-shape, Patch antenna, WiMAX antenna

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 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]. 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 radius coverage of up to 30-mile(theoretical). 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,

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 that it is very simple to fabricate and easy 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 shown 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

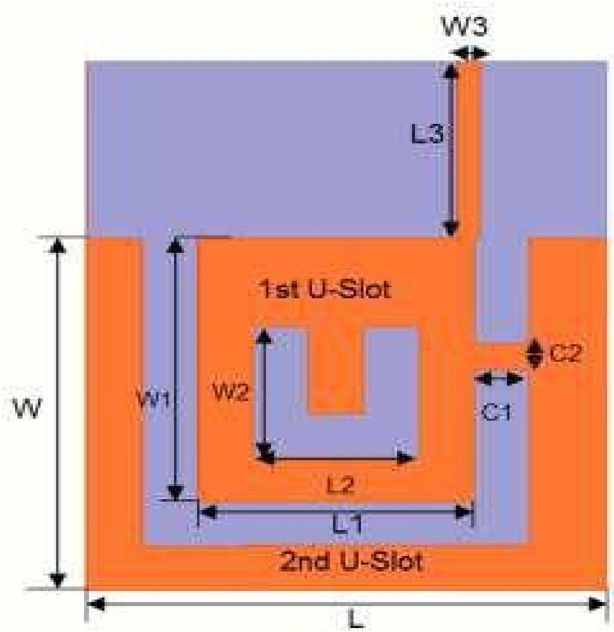

Fig. The structure and detail diminution of the proposed patch antenna.

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.

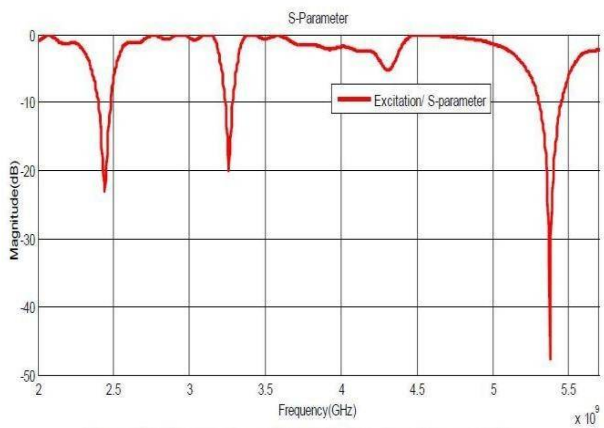

Fig.2 The return loss simulation result with dual U-slots.

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 bandwidths of the dual band are 4.22%, 1.87% and 3.51% respectively.

III. PARAMETRIC STUDY

There are some parameters 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.

The effect of changing width of W:

In Fig., 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.

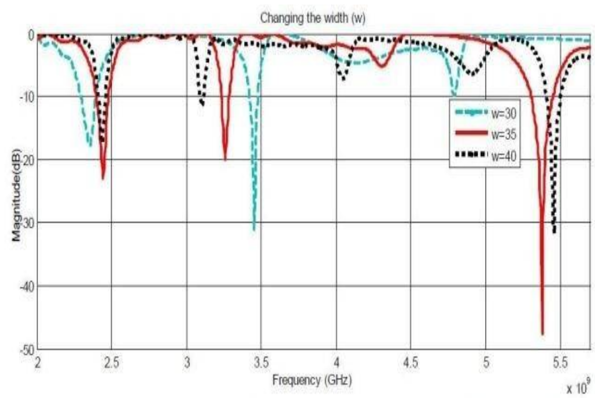

Fig. The effect of increasing the width of W

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 is also decreasing. Finally, when 35 mm width is used then three band return loss and bandwidth increasing. The good characteristic of the return loss and bandwidth is obtained (W) 35 mm.

The effect of changing width of bridge C2:

In Fig., 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

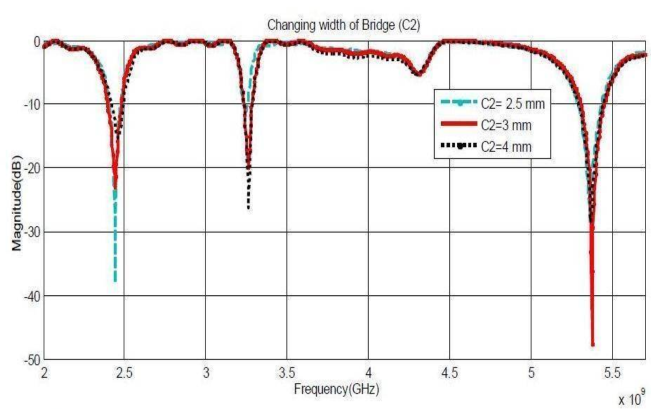

Fig. The effect of increasing the width of bridge (C2).

Antenna arrays offer improved directivity compared to a single-radiator antenna. The directivity of an array is due to interference effects between the individual elements of the array, which means that the spatial distribution of the elements as well as phases and magnitudes at each element need to be tuned for optimal performance.

Both the radiation pattern and S-parameters of the array is decided by several factors: the design of the **individual patch element**, the arrangement and spacing of the **array**, and the layout of the **feed network**. Each of these can be considered separately by dividing the process of designing the array into separate stages. By creating the array in steps, the task of optimizing the design is made less challenging, and the most appropriate tools can be used at each stage.

One common application of printed arrays is in wireless local area networks (WLAN). This piece of writing explains the design process for a planar microstrip patch array for WLAN frequencies using the circuit and full-wave 3D solvers and optimization tools in CST STUDIO SUITE®. The goal in this case is to design an array with high directivity, low cost and low side lobes, exhibiting a good impedance matching in the frequency range 5.18 – 5.85 GHz. The same approach can also be used to design other types of array by using a different radiator or array layout.

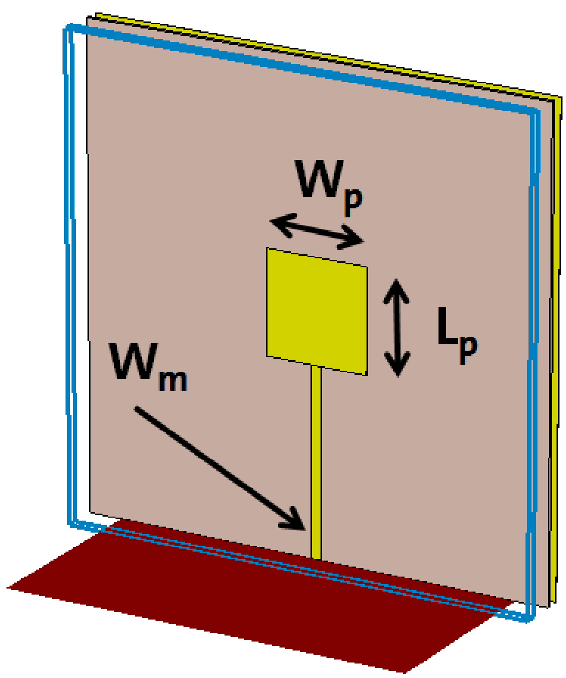

Figure: The patch antenna model

When the bridge width used is 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, for a bridge width 3 mm the return loss and bandwidth also increased. The good characteristic of the return loss and bandwidth is obtained (C2) 3 mm.

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. (a)-(c).

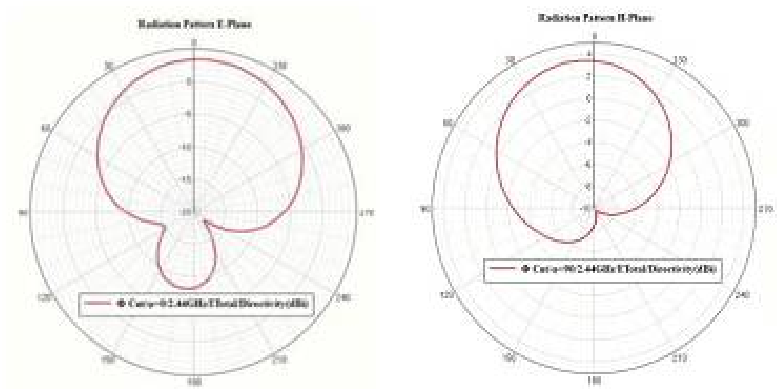

Fig.(a) Radiation pattern E & H plane at 2.44 GHz

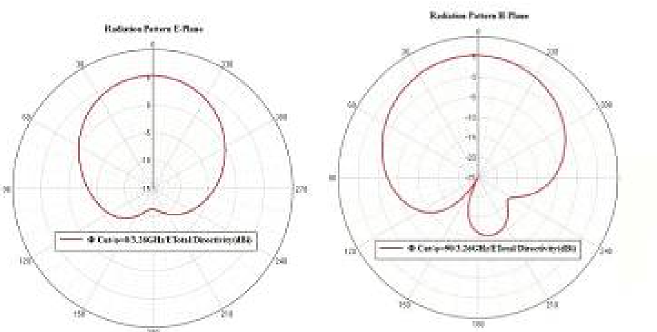

Fig. (b) Radiation pattern E & H plane at 3.26 GHz

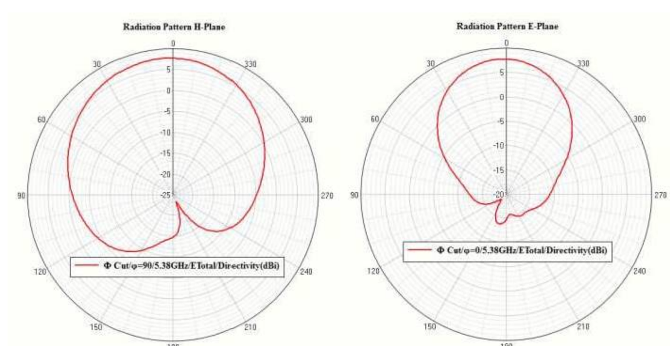

Fig. (c) Radiation pattern E & H plane at 5.38 GHz

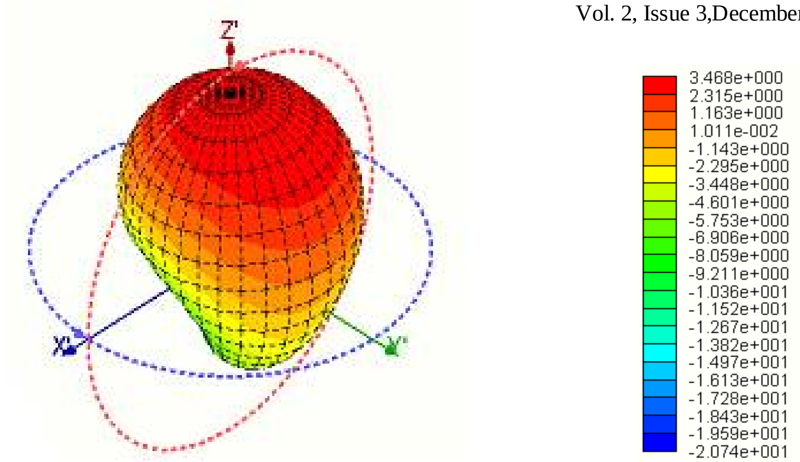

Fig.6 (a) 3D radiation pattern at 2.44 GHz

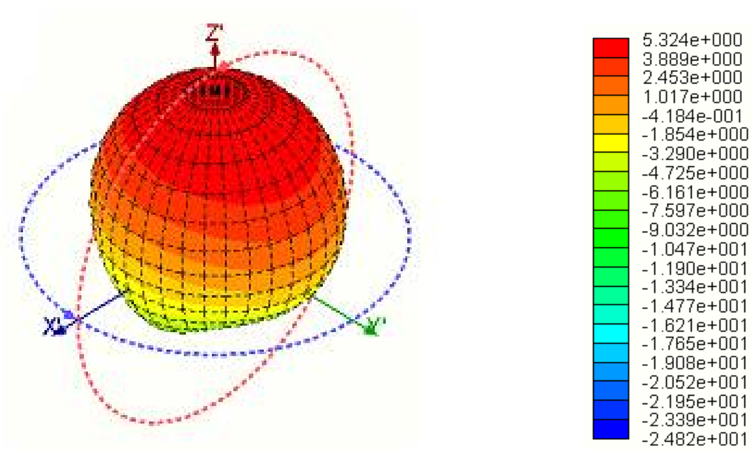

Fig.6 (b) 3D radiation pattern at 3.26 GHz

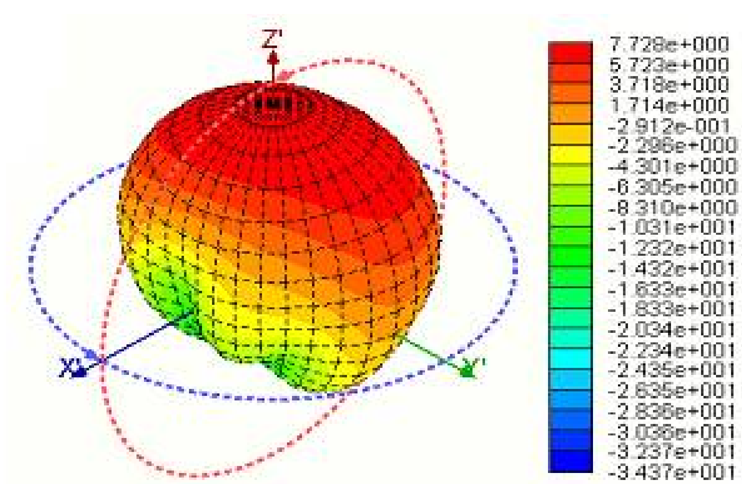

Fig. 6 (c) 3D radiation pattern at 5.38 GHz

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.

VI. REFERENCES

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