Abstract—In this paper, a novel design of a multiband patch antenna with CPW-Fed is proposed. First, the CPW-fed conventional slot antenna is designed and then the rectangular shape is modified to achieve higher bandwidth. It covers the two bands of WLAN/WiMAX applications i.e. lower band. 2.4-3.12 GHz and higher band of 5.2-5.84 GHz. The overall size of the design is 33 mm x 23 mm x 1.6 mm with a volumetric size of 1.2 cm³. The parametric study is performed to understand the characteristics of the proposed antenna. Also, good antenna performances such as radiation patterns and antenna gains over the operating bands have been observed. The maximum gain of the proposed antenna is 5.7 dBi at 7.9 GHz band.

Index Terms—WiMAX, WLAN, Microstrip Antenna, CPW Feeding.

I. INTRODUCTION

Information is indeed the lifeblood of modern economies and antennas provide mother earth a solution to a wireless communication system. An antenna is a device that provides a means for radiating or receiving radio waves. In other words, it provides a transition from guided waves on a transmission line to a “free space” wave (and vice versa in the receiving case). Thus information can be transferred between different locations without any intervening structure[8] Some of the antennas are Parabolic Reflectors, Patch Antennas, Slot Antennas, and Folded Dipole Antennas[1-4]. Each type of antenna is good in their own properties and usage. We can say antennas are the backbone and almost everything in the wireless communication without which the world could have not reached at this age of technology [12]. Patch antennas play a very significant role in today’s world of wireless communication systems.[11] A Micro strip patch antenna is very simple in the construction using a conventional Micro strip fabrication technique.[7] A Micro strip device in its simplest form is a sandwich of two parallel conducting layers separated by a single thin dielectric substrate. The upper conductor is a thin metallic patch (usually Copper or Gold), which is a small fraction of a wavelength. The lower conductor is a ground plane which should be infinite theoretically. The patch and ground-plane are separated by a dielectric substrate which is usually non-magnetic. The dielectric constant of the substrate ranges from 1.17 to about 25, with the loss tangent ranging from 0.0001 to 0.004[6]

In this paper, a novel approach to achieve a multiband antenna is introduced. The geometry of the proposed antenna is composed of the rectangular patch with two cross slot, T-cut shape slots and a small rectangle strip placed on the radiating sides of the antenna. The addition of the increases the upper edge frequency significantly resulting in a bandwidth of 1.6. The paper is organized as follows. The section 2 presents the printed slot antenna for multiband operation and its radiation performances. After that, design and parameter study of the printed slot antennas with a cross-slotted structure and T-shape slot structure are described in Section 3. Finally paper summarized in Section 4.

II. ANTENNA DESIGN

The antenna was designed on a low-cost FR4 substrate with height of h_sub=1.6 mm dielectrics constant ε_r=4.4 and tangent loss tanδ=.002. A rectangular patch was chosen as the monopole radiation element. The antenna is fed by a CPW
transmission-line, which can be easily integrated with other CPW-based microwave printed circuits on the same substrate. The CPW feed was connected to the coaxial cable through a standard 50 SMA connector. The designed structure was simulated using IE3D simulation software. The geometry of the proposed structure is given in Figure 1.

![Fig. 1 Structure of CPW-Fed microstrip patch antenna](image)

The designed parameters of this antenna can be stated as that length of the rectangular patch $L=29$ mm, width of the rectangular patch $W=16.5$ mm, length of the ground plane $L_g=19$ mm, width of the ground plane $W_g=7.5$ mm, length of the added slot $L_1=3.5$ mm, length of another slot $L_2=7$ mm, width of the both slits is $W_1=12$ mm, $W_2=5.6$ mm $L_3=9.5$ mm, $W_3=2.3$ mm. To give feeding to this geometry a feed line of having length $L_f=22$ mm and width $W_f=3$ mm is used. The distance between the ground plane and the rectangular patch is denoted by $s$ that this is equal to $2$ mm and the distance between the feed line and ground plane is denoted by $d$ is equal to $0.7$ mm. The designed antenna covers the frequency band from $2.4$ to $3.12$ GHz and from $5.2$ to $5.84$ GHz such that total bandwidth of the proposed antenna is $1.4$ GHz. Total gain of the proposed antenna $5.3$ dBi at frequency $7.9$ GHz.

### III. RESULTS & DISCUSSION

For the proposed antenna design, IE3D simulation software is used, which is full wave electromagnetic simulation software for the microwave and millimeter wave integrated circuits. The results of the designed antenna shows that this antenna is covering the WLAN frequency bands $2.4$ GHz and $3.1$ GHz and WiMAX frequency band of $5.5$ GHz. We can say that the designed antenna will be useful for both WLAN and WiMAX applications. The following graph shows the return loss of the proposed antenna.

![Fig. 2 Return loss of microstrip antenna](image)

This graph shows that the designed antenna is providing the frequency from $2.4$ to $3.12$ GHz and from $5.2$ to $5.84$ GHz which shows that the designed antenna is suitable for both WiMAX and WLAN applications. In the $1^{st}$ band the return loss is $-24$ dBi at $2.81$ GHz frequency, in the $2^{nd}$ band return loss is $-28.3$ dBi at $5.5$ GHz frequency. The azimuth plane and elevation plane of the designed antenna are as:
The gain of the proposed antenna is shown in figure 5.

This graph shows the gain of the designed antenna is 5.3 dBi at 7.9 GHz frequency. Now the 3D pattern of the antenna is shown in figure 6.

**Current Distribution Pattern:** This pattern showing that how much of the current is flowing in the proposed structure. Maximum current flowing in the proposed structure is 10.47 A/m. The average current density is shown in different colors. We can see the average current distribution on the surface of the antenna. As we can observe the current is almost maximum at the centre and it is minimum at the edge of the feed line. The current distribution pattern is shown below.
Fig. 7 Current distribution in proposed antenna

**Parametric study:** In this Paper the proposed antenna is having three cuts on the radiating side of patch i.e. two cross-slot, T shape cut and a single horizontal strip cut. In this part the effect of each and every cut is analyzed. First we start with a single cross slot. which gives the total bandwidth of 2.6 GHz. with return loss of 2 nd band is -29.1 dBi. Then the another cross slot is introduced resulting in to the increase in bandwidth to 2.72 GHz. The return loss dip reaches to -47 dBi. For further increment we added a horizontal strip cut. The bandwidth remain almost constant but return loss dip decrease to -45 dBi. Then only T –cut and two cross slots are examined. which is useful and antenna covering the actual band of WLAN/WiMAX application. But this cost bandwidth. Bandwidth reduces to 13.4 GHz. To further increase the bandwidth horizontal strip cut is again added but it only enhance the bandwidth to 14.8 GHz. The parametric study is shown in fig 8.

Fig 8: Parametric study of the proposed antenna

**IV. CONCLUSIONS**

A new multiband printed microstrip antenna with CPW-fed is proposed for the WLAN/WiMAX applications. The radiation pattern is bidirectional pattern for all of operation bandwidth, The antenna has small size, the prototype antenna shows high gain. It can be observed that the peak gain is 5.3 dBi at 7.9 GHz. There is every possibility that the overall performance of the proposed antenna can be improved in terms of size, shape, power loss, bandwidth, etc. Specially Bandwidth of the antenna. The parametric study shows that how the antenna bandwidth changes with the cut slots. The small size cost the bandwidth.

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