COMPACT CPW FED ANTENNA HAVING DUAL 'T' AND INVERTED BEAKER SHAPED FOR WLAN/WIMAX OPERATIONS

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ABSTRACT

In recent years, great interest is focused on microstrip antennas for their small volumes, low profiles, good integration, low costs and good performance. With the continuous growth of wireless and mobile communication service and the constant miniaturization of communication equipment, there are higher demands for the volume of antennas, integration and working band. This paper presents a basic rectangular shaped microstrip patch antenna for wireless communications system which is suitable for 4.54 GHz to 5.632 GHz band operations. These systems may include upper higher bands of WiMAX (Worldwide Interoperability for Microwave Access) and wireless local-area network (WLAN). A rectangular ring slot is cut and double T shape along with one inverted beaker slot is embedded into it. Besides that, in the inverted beaker shape, similar shape slot is cut. This design has several advantages such as compact size, omnidirectional radiation pattern etc. which all are studied. The results confirm good performance of the single and multiband antenna design.

Keywords

Microstrip Antenna, WLAN, WI-MAX, CPW feed.

1. INTRODUCTION

Microstrip antennas have many advantages over conventional antennas such as low profile, ease of integration with active and passive devices, ability of mounting on planar, non-planar and rigid exteriors to form MICs and low manufacturing cost due to use of printed circuit technology. In case of planar antennas designed for wireless communication systems, it is necessary to have a compact size antenna configuration that can be integrated with other devices [1]. Since the physical area of the microstrip antenna is inversely proportional to the frequency, it is difficult to achieve a compact size antenna for modern communication systems for WLAN, WiMAX and Wi-Fi applications, particularly with normal patch geometries having acceptable efficiency and isolation values [3]. There is often a tradeoff in realizing compact antennas while maintaining their performance characteristics. Traditional patch antenna using rectangular, circular or triangular geometries under normal conditions resonate at a single frequency and have inherent low bandwidth and gain values limiting their potential applications. The current upsurge in wireless communication systems has forced antenna engineering to face new challenges, which include the need for small-size, high-performance, low-cost antennas [2]. In recent works, with wide-band property, monopole antennas have drawn much attention in multi-band antenna designs. The currently described antenna design satisfies WLAN/WiMAX standards. Rapid advances of various WLAN protocols have sparked the requirements for miniaturized multiband antennas with suitable frequency bands appropriate for the WiMAX (IEEE 802.16e-2005 standard) applications are highly desirable. Recently, wireless local area network (WLAN) (working at 2.4/5.2/5.8 GHz) and worldwide interoperability for microwave access (WiMAX) (working at 2.5/3.5/5.5 GHz) allowed for convenient portable/mobile wireless access to various digital communication systems have been becoming very attractive. Multi-band antennas with simple structure and superior radiation performance for WLAN/WiMAX applications have been increasingly appealing. In recent works [3-9], with wide-band property, monopole antennas have drawn much attention in multi-band antenna designs. Recently, several broadband antenna designs have been reported, such as wide-slot antennas, open-slot antennas and CPW-fed antennas but their bandwidths are not enough for WLAN and WiMAX applications. CPW-fed antennas in references possess enough bandwidth for WLAN and WiMAX applications, but they have either large sizes or complicated structures.

The currently described antenna design satisfies WLAN/WiMAX standards. In this paper, proposed monopole antenna consists of a rectangular ring in which double T shaped and inverted beaker shape are embedded. In the inverted beaker shape, similar shaped slot is cut suited to operate in both WLAN band and WiMAX band. The details of the proposed antenna design and the experimental results are presented and discussed next.

2. ANTENNA DESIGN

The geometry of the proposed monopole antenna is shown in Figure 1. The total size of the proposed antenna is 23.100 x 19.500 mm^2. As shown in the figure, the antenna consists of a rectangular ring in which double T-shape is embedded into it. Along with this, a inverted beaker shape slot is embedded which is formed by adding rectangular slit to the semicircle. Inside this inverted beaker shape, similar shaped slot is cut. To form the rectangular ring, two rectangles are taken of perceptive decreasing dimensions. The rectangular ring slot has dimension of 0.975 mm. The antenna mainly constructed with the above described patch and fed by CPW (Coplanar Waveguide Feed) feeding. The ground size of the proposed antenna is 9.925 x 7.525mm^2. The ground plane is symmetrical at the base line of the feeding strip line. The rectangular slit is used for the CPW feeding. The size of rectangular slit is adjusted to obtain optimum bandwidth. To obtain the optimal parameters of the proposed antenna for WLAN/WiMAX application, IE3D, full-wave commercial EM software that can simulate a finite substrate and a finite ground structure, is used. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters.

The optimized dimensions of broadband antenna are set as follows:

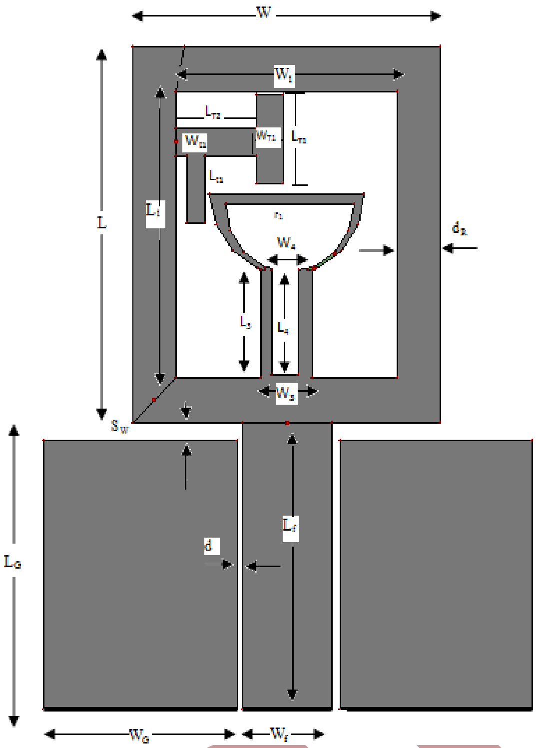

Fig. 1: Configuration of Antenna

Table 1: Parameters of the proposed multiband antenna

Parameter	Dimensions (in mm)	Parameter	Dimensions (in mm)
L	13.975	W	11.975
L_1	10.775	W_1	8.675
L_G	9.925	W_G	7.525
W_f	3.475	L_f	10.575
d	0.325	S_W	0.65
d_r	1.675	L_{T1}	3.325
L_{T2}	3.150	W_{t1}	0.725
Lt1	2.50	W_t	1.025
r	2.98	L_3	4
W_3	2.025	r1	2.525
L_4	3.9	W_4	1.025

The feeding is provided by the rectangular strip of dimensions 10.575 x 3.475 mm^2 in the proposed antenna. The gap (S_W) between the ground plane and radiating patch of antenna is taken to be 0.65 mm. Moreover, the gap between the ground plane and feeding strip of antenna is taken as 0.325 mm. In the radiating patch of antenna, rectangular ring is taken whose slot length is 1.675 mm. Besides it, dual T-shape is embedded on rectangular ring. Dual T-shape has dimensions of 3.325 x 3.150 mm and 2.50 x 0.725mm. The inverted beaker shaped slot (embedded into rectangular ring) is formed by taking a rectangular slit of dimensions 4 x 2.025 mm^2 and a semicircle is placed on its top of radius 2.98 mm. Similar shaped slot is cut inside this inverted beaker shape having dimensions of rectangular slit 3.9 x 1.025 mm^2 and semicircle of radius 2.525mm.

3. RESULTS AND DISCUSSIONS

The design evolution of the proposed antenna and its corresponding simulated return losses are presented in Fig. 2. This figure clearly shows that it has working bands and impedance bandwidth of 1.068 GHz from 4.552 GHz to 5.620 GHz which provides the 5/5.2/5.6 GHz working band of WLAN/ WIMAX.

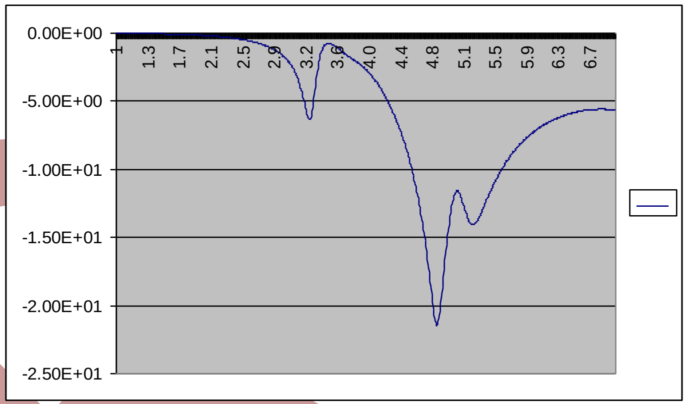

Fig. 2: Return loss of proposed multiband antenna

Figure 3 shows the parametric study of the proposed antenna. It shows the comparison graph of return loss when only patch was there in form of rectangular ring and no slot is embedded and then dual T-shaped slot and one inverted beaker shaped is embedded in patch and then when the inverted beaker shaped slot is cut into the similar shaped slot. As shown in fig. 3, there was no impedance bandwidth in working band in initial stage when there was only rectangular ring patch. After embedding the double T-shape and inverted beaker shaped slot, working band appears with optimum bandwidth. The bandwidth is further improved in final proposed antenna. The proposed antenna covers higher frequency bands of WLAN/WI-MAX. In figure 4.1 and 4.2, simulated 2D radiation pattern for elevation and azimuthal plane near at resonant frequencies 5.31GHz is shown. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. E-plane patterns at 90 degree are shown in figure4, presenting a figure of eight like structure, which satisfies the condition of radiation pattern of a microstrip antenna, which is same as that for a monopole antenna.

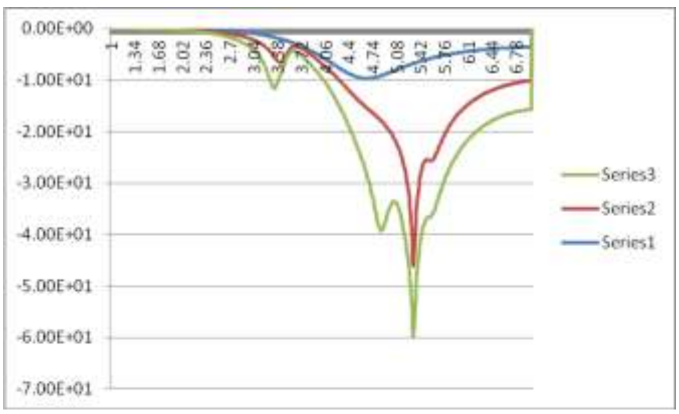

Fig 3: Comparison of return Loss of (a) Antenna having no Slot except rectangular ring (b) Antenna having double T and inverted beaker shape (c) Proposed Antenna

Similarly H-plane patterns for 0 degree forms an omnidirectional pattern as shown in figure 4.2. These patterns are desirable for WLAN/WiMAX applications. Figure 5 shows three dimensional radiation pattern of proposed antenna.

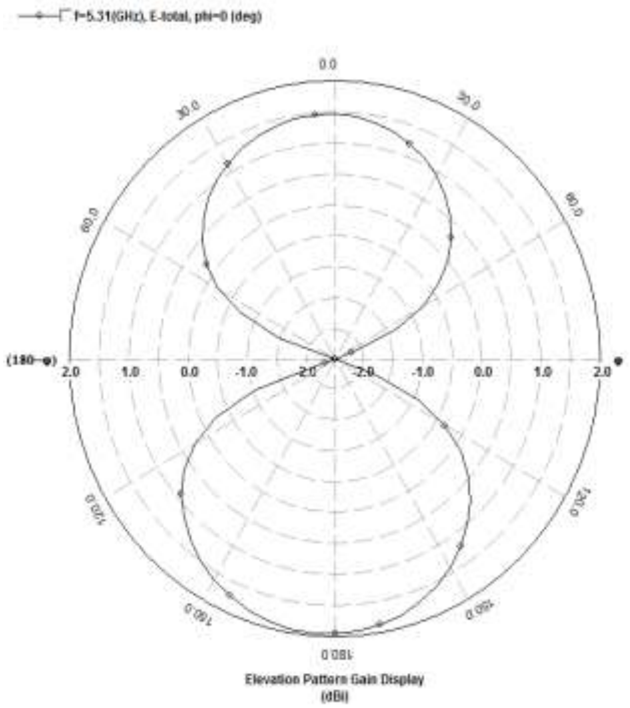

Fig. 4.1: Elevation pattern at 5.31 GHz

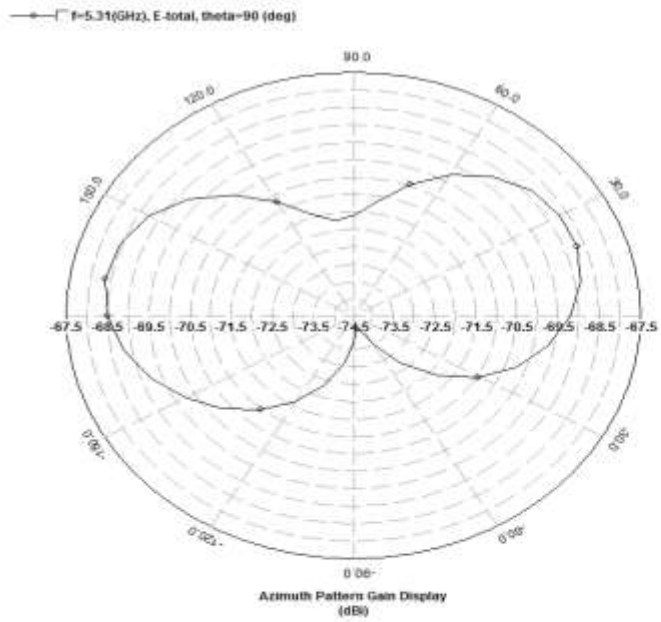

Fig. 4.2: Azimuth pattern at 5.31 GHz

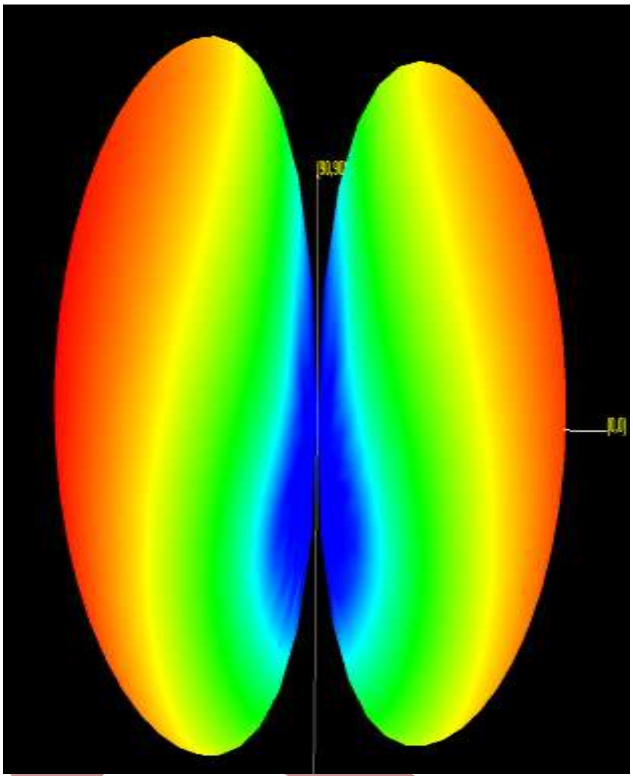

Fig.5: 3-Dimensional Pattern of Proposed Antenna

The formation of the lower and upper frequency resonances can be explained by observing the surface currents on the conductors of the antenna at 5.31 GHz, as shown in Fig.-6. Current distribution is changed by changing the length and dimensions of patch.

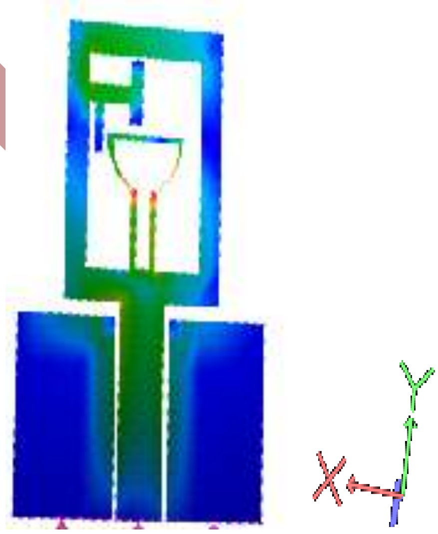

Fig 7: Current distribution of proposed antenna at 5.31 GHz

4. CONCLUSION

A monopole antenna suitable for WLAN/WiMAX applications is proposed. Effects of varying dimensions of key structure parameters on the antenna and various parameters like gain, current distribution, radiation pattern and their performance are also studied. Moreover, the proposed antenna has several advantages, such as small size, excellent radiation patterns, and higher gains and good efficiency. These characteristics are very attractive for some wireless communication systems for a variety of applications.

5. REFERENCES

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