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Design and Simulation of Hexagonal Shape Antenna with 'S' and 'A' shaped slot for Wireless Communication Applications

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Abstract: In this investigation, hexagonal shaped microstrip antenna using Coplanar Waveguide Feed (CPW) for wireless communication applications is presented. The proposed antenna consists of hexagonal shape patch embedded with 'S' and 'A' shaped slots. The parametric study is performed to understand the characteristics of the proposed antenna. The antenna exhibits higher frequency band and impedance bandwidth is 2.99 GHz ranging from 4.89 GHz to 8.48 GHz covering higher frequency bands of wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX). The various antenna parameters like S-parameters, current distribution and radiation pattern are studied.

Keywords: Microstrip Antenna, WLAN, WiMAX, CPW feed.

I. INTRODUCTION

The rapid development of wireless communication systems has increased the demand for compact microstrip antennas with high gain and wideband operating frequencies. Microstrip antennas due to their many attractive features have drawn attention of industries for an ultimate solution for wireless communication [1]. Microstrip patch antenna has advantages such as low profile, conformal, light weight, simple realization process and low manufacturing cost [2-3]. However, the general microstrip patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to cover the demanding bandwidth is necessary. There are numerous and well-known methods to increase the bandwidth of antennas, including increase of the substrate thickness, the use of a low dielectric substrate, the use of various impedance matching and feeding techniques [4]. Wireless communications have also been developed widely and rapidly in the modern world especially during the last decade. WLAN (Wireless Local Area Networks) and WiMAX (Worldwide interoperability for microwave access) are technologies mainly used for wireless communication. These operating bands for WLAN are 2.4/5.2/5.8 GHz and for WiMAX are 2.5/5.5/5.8 GHz [5-10].

In this paper, proposed antenna consists of hexagonal shape patch with 'S' and 'A' shaped slot and suitable to operate in WLAN band (5.15-5.35, and 5.75-5.85GHz) and WiMAX band (5.15-5.35, 5.47-5.725, and 5.725-5.825GHz). The details of the proposed antenna design results are presented and discussed in next section.

II. ANTENNA GEOMETRY

The geometry of the proposed monopole antenna is shown in Figure 1. The total size of the proposed antenna is 28.025 mm x 22 mm. As shown in the Figure, the antenna consists of hexagonal patch containing 'S' and 'A' shape slots. The antenna is constructed with the above described patch and fed by Coplanar Waveguide Feed (CPW) feeding. The ground size of the proposed antenna is 11.025 mm x 8 mm. The ground plane is symmetrical at the base line of the feeding strip line. To obtain the optimal parameters of the proposed antenna for WLAN/WiMAX application, IE3D, 14.10 version of Zeland 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 parameters of proposed antenna are shown in Table 1. The distance between patch and ground is 2 mm and between feed and ground is 1 mm. The rectangular strip feed line has dimensions of 13.025 mm × 4 mm.

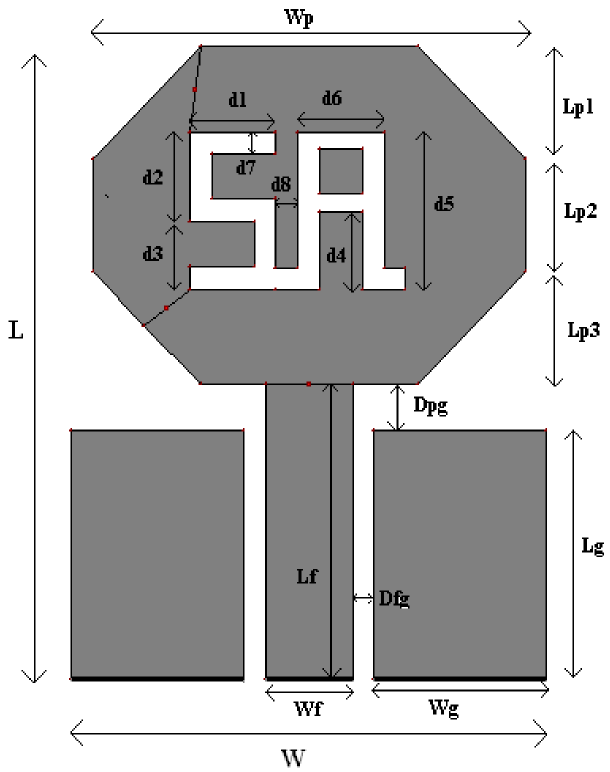

Figure 1: Geometry of proposed Antenna

Table 1: Parameters of the proposed antenna

Parameter	**Size (in mm)**	**Parameter**	**Size (in mm)**	**Parameter**	**Size (in mm)**
L	28.025	D_{pg}	2	d_1, d_2	4
W	22	D_{fg}	1	d_3	3
L_g	11.025	L_{p1}	5	d_4	3.5
W_g	8	L_{p2}	5	d_5	6
L_f	13.025	L_{p3}	5	d_6	4
W_f	4	W_p	20	d_7, d_8	1

III. SIMULATED RESULTS AND DISCUSSIONS

The simulated return losses and other parameter results are obtained. The return losses of the proposed antenna are shown in Figure 2. The result shows that the antenna exhibits higher frequency bands and impedance bandwidth of this frequency band is 2.99 GHz from 4.89 GHz to 8.48 GHz. This implies that it covers WLAN band from 5.15-5.35/ 5.75-5.85 GHz, WiMAX band from 5.15-5.35/5.47-5.725/5.725-5.825 GHz.

The parametric study of the proposed antenna is also studied. Figure 3 shows the effect of slots addition on antenna performance. After adding slots, the peak of return losses and bandwidth is increased and the optimum results are obtained.

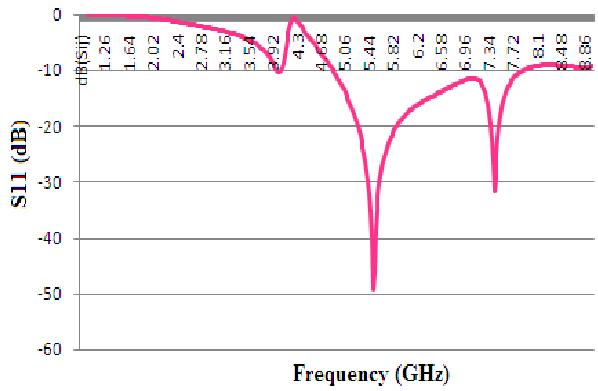

Figure 2: Return losses of proposed antenna

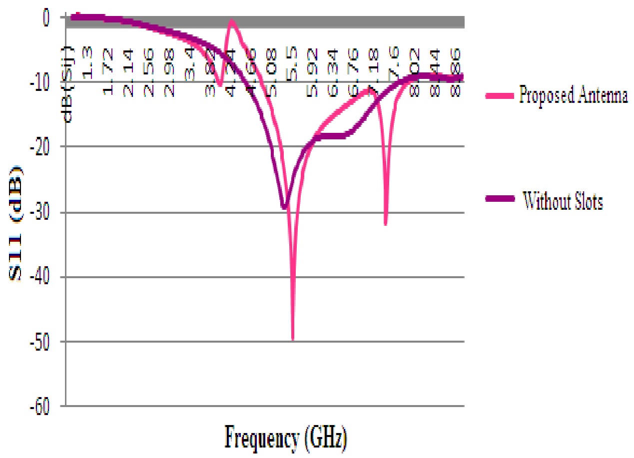

Figure 3: Effect of Slot Addition on Antenna Performance

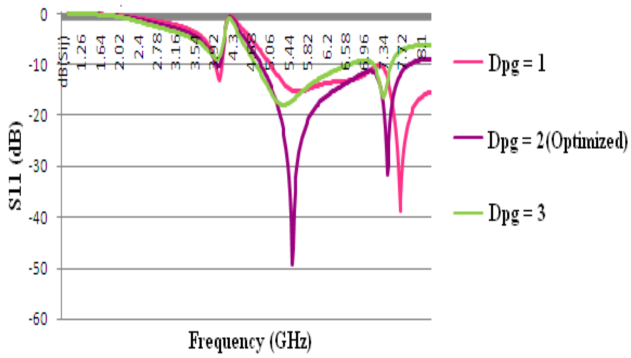

Figure 4: Effect of variation of D_{pg} on Antenna Performance

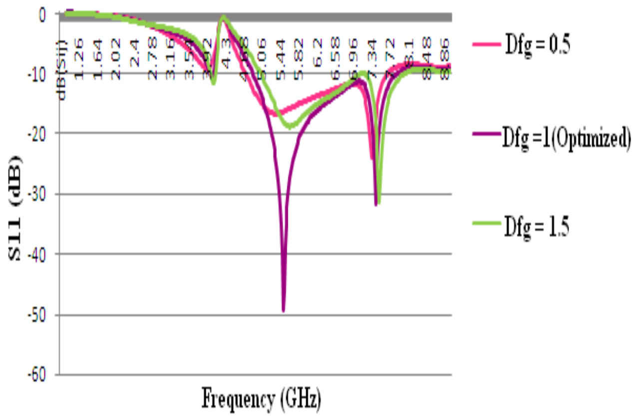

Figure 5: Effect of variation of D_{fg} on Antenna Performance

Figure 4 and Figure 5 shows the effect of distance variation between patch and ground, feed line and ground respectively. It can easily be observed from figures that on varying these distances, there are effects on the return losses of the proposed antenna. Optimized values are also shown in figures.

The proposed antenna has two resonant frequencies: 5.52, 7.44 GHz. In Figure 6, simulated 2D radiation patterns for elevation and azimuthal plane near to resonant frequencies 5.52 GHz are shown. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. Figure 7 shows three dimensional radiation pattern of proposed antenna at 5.52 GHz.

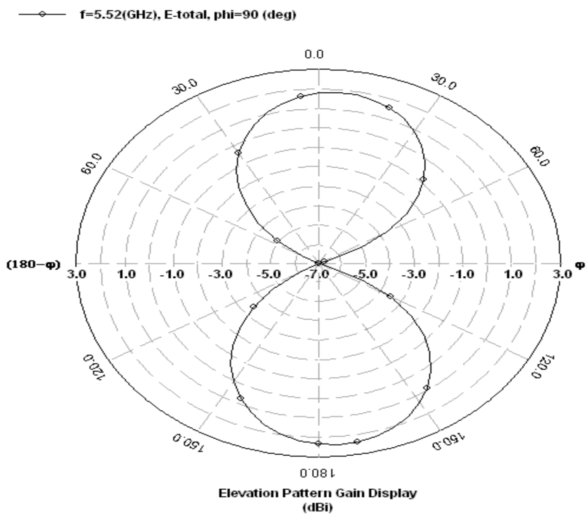

Figure 6(a): Elevation pattern at 5.52 GHz

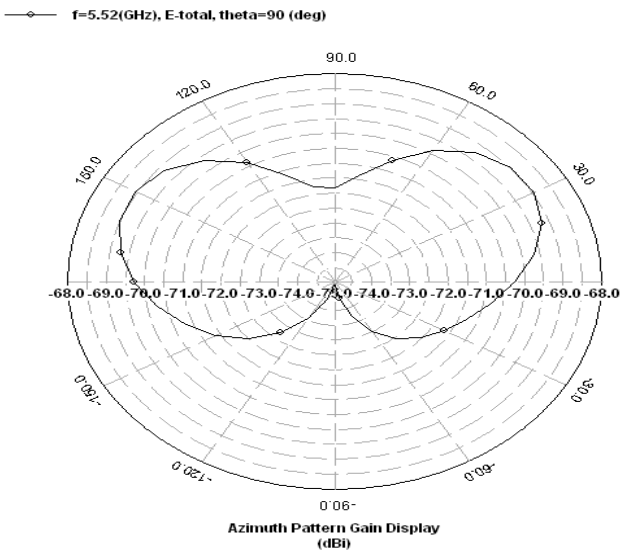

Figure 6(b): Azimuth pattern at 5.52 GHz

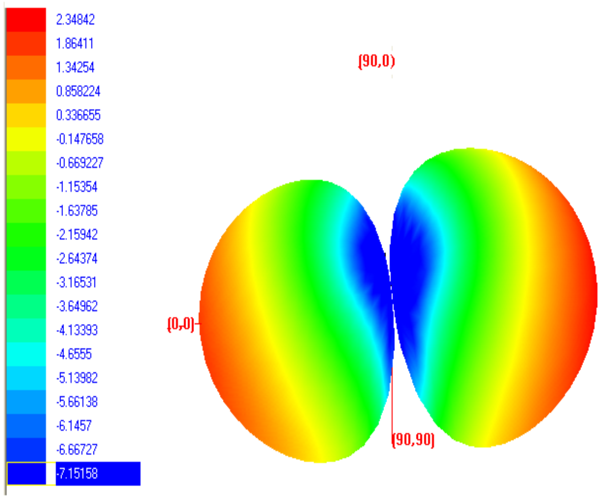

Figure 7: 3-Dimensional Pattern of Proposed Antenna at 5.52 GHz

The formation of the lower and upper frequency resonances can be explained by observing the surface currents on the conductors of the antenna at 5.52 GHz as shown in Figure 8. Current distribution is changed by changing the length and dimensions of patch. The maximum E-current at 5.52 GHz is 12.287 A/m.

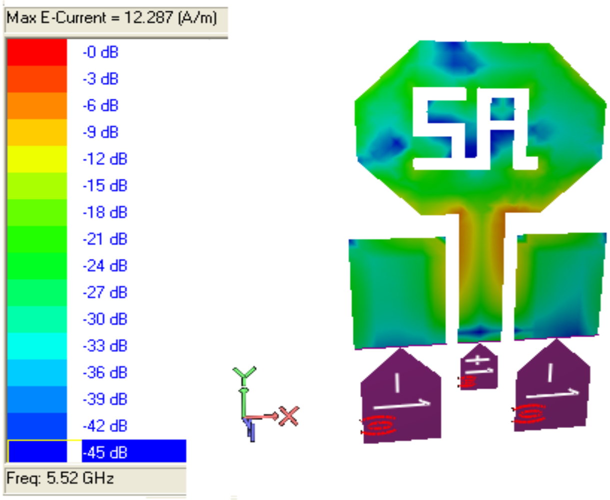

Figure 8: Current distribution of proposed Antenna at 5.52 GHz

Figure 9 shows the variation of VSWR (Voltage Standing Wave Ratio) with respect to frequency.

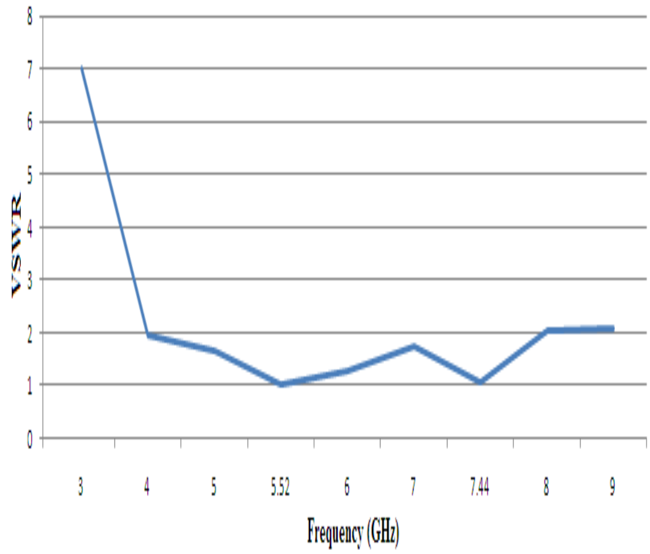

Figure 9: VSWR versus Frequency

IV. CONCLUSION

A hexagonal shape patch with ‘S’ and ‘A’ shaped slots has been presented in this paper. The proposed antenna achieves higher frequency band and impedance bandwidth is 2.99 GHz from 4.89 GHz to 8.48 GHz covering wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) bands. It can be concluded from the results that the designed antenna has satisfactory performance and hence can be used for wireless communication applications.

V. REFERENCES

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