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# Simulation and Design of Broad-Band Slot Antenna for Wireless Applications

Amar Partap Singh Pharwaha & Shweta Rani

*Abstract*——**A broadband slot antenna configured with coplanar waveguide (CPW) fed is presented for wireless communication systems. The antenna is designed with FR4 substrate and characterized by measuring return loss, VSWR, gain and radiation pattern. The proposed antenna has low profile, light weight and has successfully demonstrated broadband and multiband characteristics which covers WIMAX, WLAN, Bluetooth, X-band and other various wireless applications.**

***Index Terms*—Microstrip patch antenna, Return loss, VSWR.**

## I. Introduction

As wireless communication applications require more and more bandwidth, the demand for wideband antennas increases as well. The design of an efficient wideband small size antenna for recent wireless applications is a major challenge. The microstrip patch antenna have found extensive applications in wireless communication systems owing to their advantages such as low profile, conformability, low fabrication cost and ease of integration with feed network [1],[2]. Microstrip patch antennas comes with drawback of narrow bandwidth, which can be overcome by increasing substrate thickness, use of low dielectric substrates and use of various impedance matching feeding techniques [3]-[6]. The CPW fed planar slot antennas posses features like wide impedance bandwidth, omnidirectional radiation pattern, constant gain, low profile, high radiation efficiency with simple structures, low radiation loss, less dispersion and easy integration to monolithic microwave integrated circuits. Therefore CPW fed planar slot antennas are most promising design for wideband wireless applications [7]-[10]. In planar slot antennas slot width and feed structure affects the impedance bandwidth. The wider slot gives more bandwidth and optimum feed structure ensures good impedance matching [11]-[13]. In this paper we presented a new antenna design which is fed by a CPW line so that only a single layer of substrate is required. The antenna is fed from one corner of the radiating patch.

Descriptions of antenna design with both theoretical and experimental details are elaborated in the following sections.

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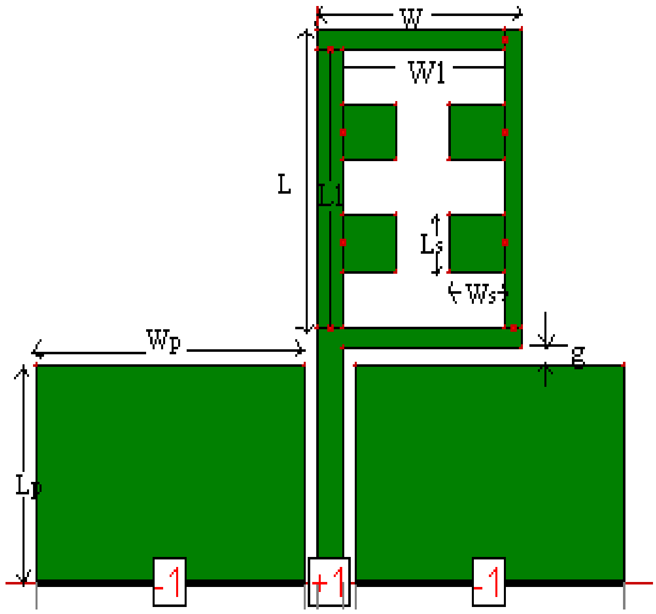


Fig.1 Geometry of proposed CPW fed slot antenna

## II. Antenna Design & Structure

The antenna is designed on a substrate of thickness, h = 1.6 mm with dielectric constant, $\epsilon_r$ = 4.6. A 50Ω CPW fed transmission line which consist of a single strip having width of 3 mm is used to feed the antenna as shown in Fig.1.There is a gap of 1.5 mm between the single strip and the coplanar ground plane. Two finite ground planes with the same size are placed symmetrically at both sides of CPW line. The patch size is characterized by the length L, width W and thickness, h. The slot structure is very much similar to the geometry if an E shape slot joined with another inverted E-shape slot. The slot length, width and positions are the important parameters to control the bandwidth. The length of the current path is increased due to slots which lead to additional inductance in series. Hence, the wide bandwidth is generated as the resonant circuit becomes coupled. For simulation the length of the designed antenna, L = 31.8 mm and width, W = 24 mm, Length of the ground plane, $L_p$ = 21.6 mm and width of the ground plane, $W_p$ = 31.5 mm. The space between patch and ground plane , g = 1.8 mm, the slot length $L_1$ and width $W_1$ are 27.8 mm and 19 mm respectively. The two slots from left and the two slots from right are equally spaced with $L_s$ = 5.56 mm and $W_s$ = 6.3 mm. The shape has provided broad bandwidth which is required for the operation of fourth generation wireless communication systems.

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## III. Results & Discussion

The simulation of the design is carried out by the method of moments technique (IE3D software). The simulated results of the return loss and bandwidth are shown in the Fig.2.

As from the Fig.2 it is clearly visualized that the impedance bandwidth of the multibands are 0.6 GHz from 2.1 GHz to 2.7 GHz, 0.35 GHz from 4.6 GHz to 4.95 GHz, 1.6 GHz from 5.2 GHz to 6.8 GHz, 0.5 from 7.1 GHz to 7.6 GHz and 0.35 from 9.4 GHz to 9.75 GHz, which covers the (2.4 - 2.484 GHz), (5.15 - 5.35 GHz) and (5.725 - 5.825 GHz) frequency ranges of WLAN and 2.5/5.5 GHz frequency ranges of WIMAX.

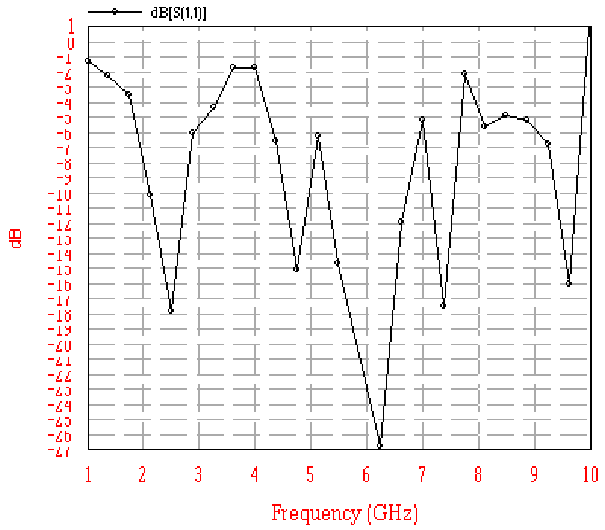

Fig.2 Simulated return loss of proposed antenna

It also covers some frequencies of X-band like (9.4 GHz to 9.75 GHz) which operates in the range of 8-12 GHz and is widely used in satellite communication, radar applications, terrestrial communication networking, motion direction and various other applications.

Fig.2 gives the simulated return loss of the proposed antenna which is -17.85 at 2.5 GHz, -15.21 at 4.75 GHz, -27dB at 6.2 GHz, -17.57 at 7.37 GHz and -16.07 at 9.62 GHz. The radiation patterns of the proposed antenna for different frequencies are simulated at 2.5 GHz, 4.75 GHz, 6.2 GHz, 7.37 GHz and at 9.62 GHz. It is noted that all the five frequencies gives stable patterns. The patterns in x-y plane are in symmetry with antenna axis and patterns in y-z plane are nearly omnidirectional. The Radiation performance of antenna is acceptable at all frequency bands. The radiation patterns in x-y and y-z plane are shown in Fig.3 to Fig.7.

Fig. 8 shows the VSWR of the proposed antenna which is less than 2 for all center frequencies like 2.5 GHz, 4.75 GHz, 6.25 GHz, 7.37 GHz and 9.62 GHz. The simulated gain of the designed antenna is shown in Fig.9 which clearly indicates that maximum 8.423 dBi and 8.232 dBi gain is achievable at 7.37 GHz and 9.62 GHz frequencies respectively. Gain at other frequencies is also considerable and can be observed from the Fig.9.

## IV. Conclusion

A slot antenna with multiband and broad band characteristics has been presented. The antenna has small size and easy to integrate with circuit on the same dielectric, resulting in the reduction of, fabrication cost and required volume of whole system. This paper shows the maximum bandwidth of 1.6 GHz which covers 5.2 GHz to 6.8 GHz frequencies and maximum gain of 8.432 dBi at 7.37 GHz frequency. With nearly omnidirectional radiation patterns, the proposed antenna seems to be a good antenna for wireless applications.

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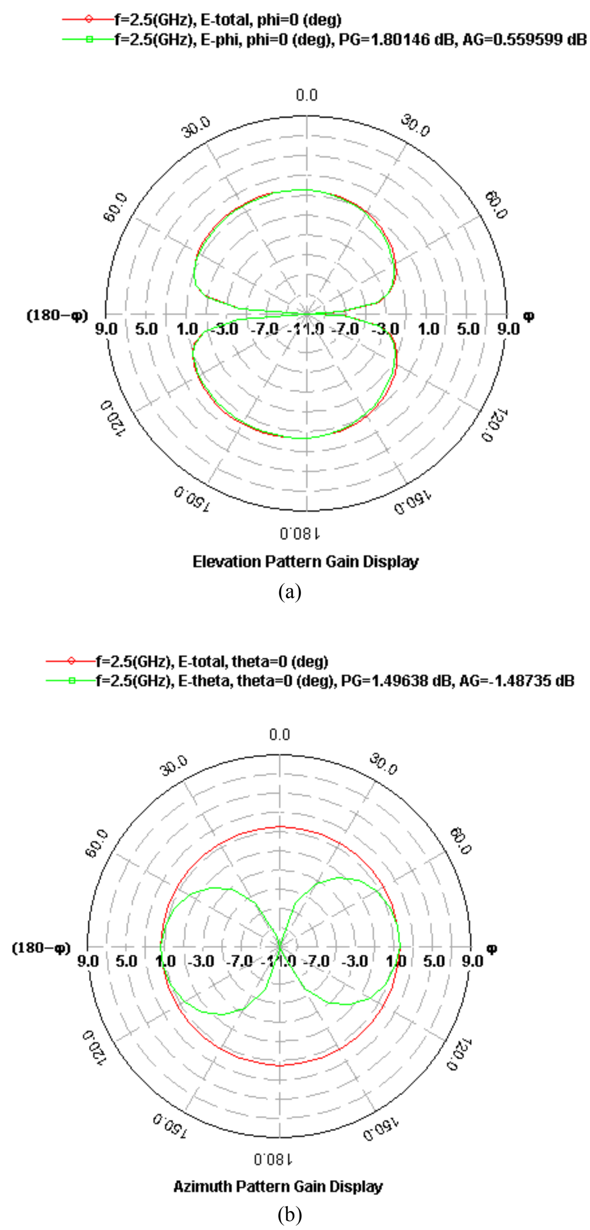

Fig.3 Radiation patterns at 2.5 GHz. (a) xy-plane. (b) yz-plane

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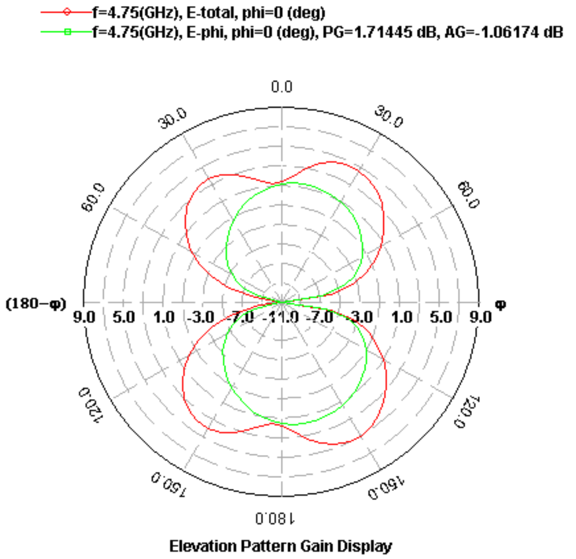
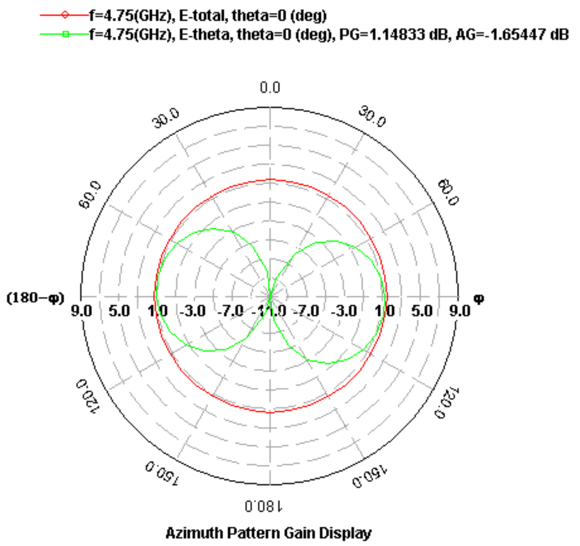
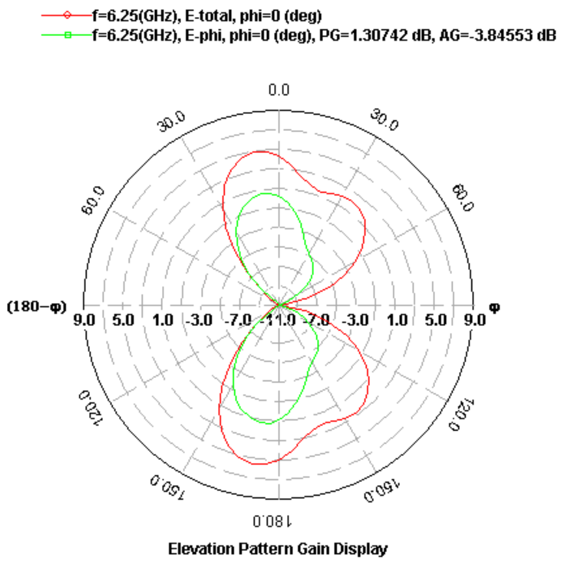



(a)




(b)

Fig.4 Radiation patterns at 4.75 GHz. (a) xy-plane. (b) yz-plane

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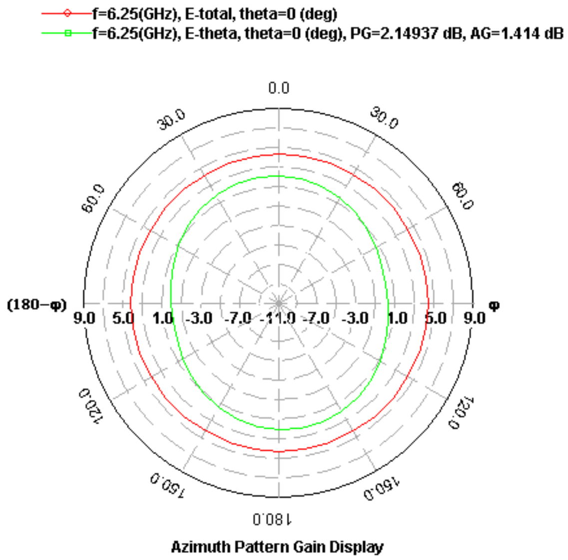
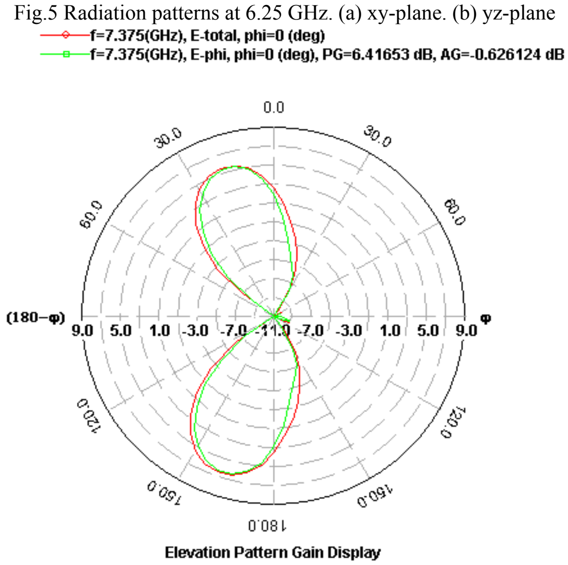
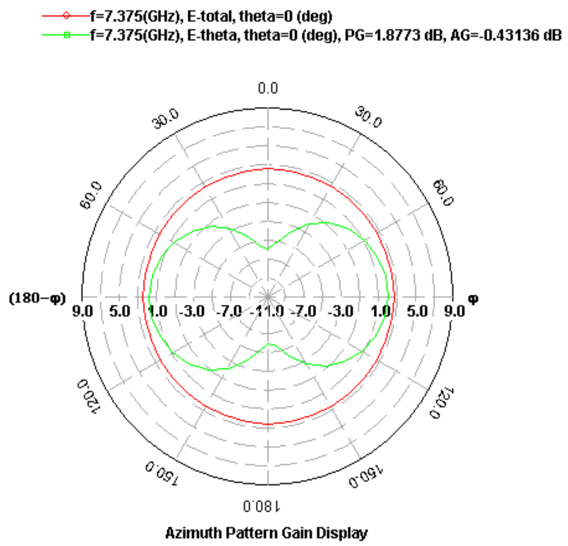



(b)

Fig.5 Radiation patterns at 6.25 GHz. (a) xy-plane. (b) yz-plane

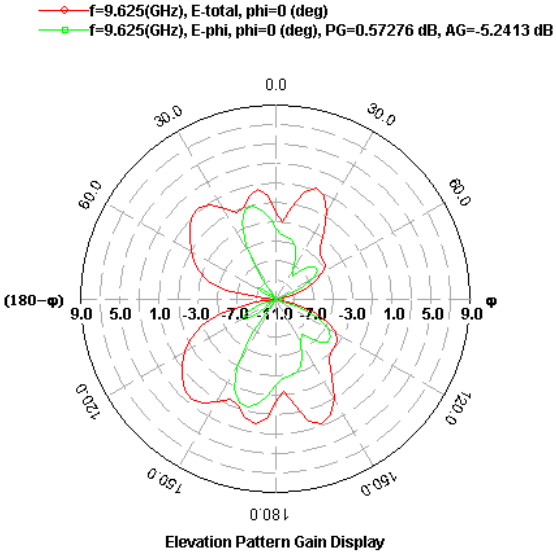



(a)

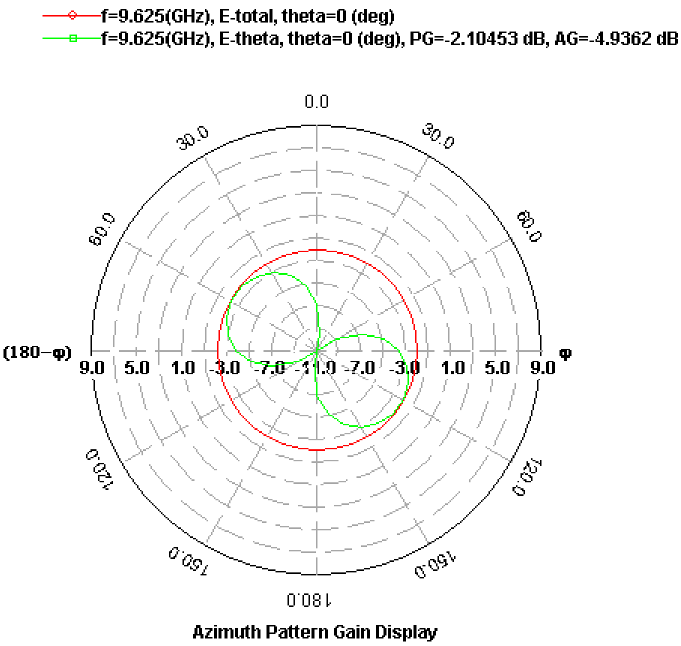



(b)

Fig.6 Radiation patterns at 7.375 GHz. (a) xy-plane. (b) yz-plane




(a)




(b)

Fig.7 Radiation patterns at 9.625 GHz. (a) xy-plane. (b) yz-plane

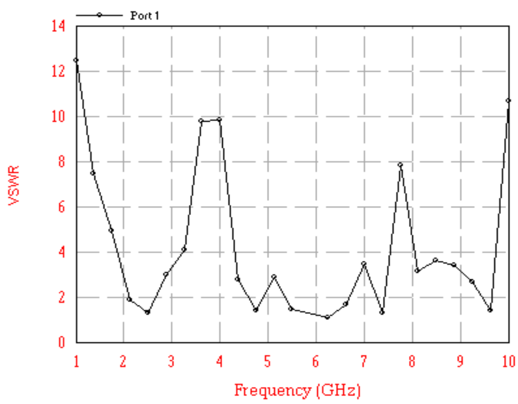



Fig.8 Simulated VSWR of proposed antenna

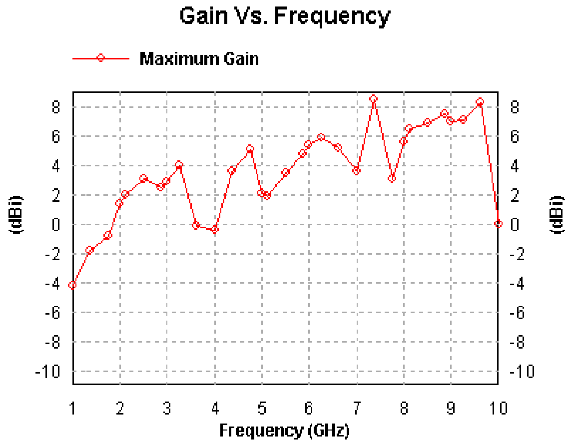



Fig.9 Simulated Gain of proposed antenna

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