

CPW Fed Micro Strip Patch Antenna for Wireless Communication

Akhilesh Kumar Pandey, Rajeev Singh

Abstract-A novel broadband design of a coplanar waveguide fed micro-strip patch antenna for broadband operations is proposed and are simulated by means of AWR(Microwave Wave Office) and results are experimentally verified. The impedance bandwidth is 71.85% and the resonating frequency is 3.52GHz. The bandwidth is suggestive of ultra wide band operation. The structure can be utilized for GPS, Wi-Fi, WiMAX, GPRS and other wireless communication system.

Keywords: Microstrip patch antenna; GPS; Wide band antenna; CPW fed.

I. INTRODUCTION

Demand of various communication systems with electronic devices that can be used in various applications such as Global Positioning System (GPS), Wireless Fidelity (Wi-Fi), Wireless local Area Network (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), General Packet Radio Switching (GPRS), Long Term Evolution (LTE), Global System for Mobile Communication (GSM), and Wideband Coded Division Multiple Access (WCDMA) etc [1-5] has increased manifolds. Wider bandwidth of antenna enables the user to integrate as a single device for various applications as enunciated above. As microstrip antennas are compact in shape and size, therefore, are commonly used these days. One of the major limitations of microstrip antenna is its low bandwidth (around 2 to 5%), which poses serious problems in certain applications. One of the major objectives is to improve the bandwidth of microstrip antenna and researchers have proposed various techniques to improve the bandwidth. These techniques can be generally categorized as (i) feeding techniques including proximity fed[6] aperture fed[7] L-strip feed[8] coplanar waveguide (CPW) etc., (ii) reactive loading techniques such as inserting slots, notch, loading diodes, shorting pin, wall etc., and (iii) multi-resonator antenna which comprises of stacking, coplanar structures etc.[6-12]. Amongst all these reported techniques CPW fed is one of the simplest techniques to achieve wide bandwidth. A CPW fed antenna first of all was reported in 1990 [13-16]. Several other configurations like tapered slot antennas with coplanar waveguide [16] CPW-fed strip-loaded square slot [17] continuous transverse stub (CPW-CTS) antenna [18] monopole antenna for 5 GHz wireless application.

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[19] rectangular slot and partial circular patch [20] coplanar waveguide-fed circularly polarized antenna [21] dielectric resonator antenna with dual polarization [22] compact tapered-slot antenna for various applications [23], CPW microstrip antenna [24] CPW fed T-Shaped Patch Antenna for WLAN applications [25] are reported. All these proposed radiating structures are very complicated to implement and the bandwidths that have been obtained are reported to be insufficient and as well as have limited applications. To design a CPW fed antenna with wider bandwidth having simple radiating structure with good efficiency and radiation pattern is a challenging task. We propose a CPW fed microstrip patch antenna for wireless application with simple structure. Detailed analysis of antenna structure, discussion of results along with conclusions is presented.

II. ANTENNA DESCRIPTION

Figure 1 show the designed geometry of CPW fed microstrip bounded by square shape track patch. It consists of a radiating microstrip line of dimension $L_m \times W_m$. This microstrip line is inserted into a rectangular track which acts as a ground plane. Schematic diagram of square tracks is shown in figure 1 and specifications are provides in Table 1. Further, antenna is excited by 50 Ω SMA connector thorough microstrip line. Also, a gap 'g_m' is introduced between both sides of square track and microstrip line. The proposed antenna is fabricated on the glass epoxy FR4 ($\epsilon_r=4.4$) having height 1.6 mm. Photograph of the fabricated antenna is shown in figure 2. The current distribution of the proposed antenna at center frequency 3.52GHz is shown in figure 3. A mutual coupling is developed between rectangular track and microstrip line and consequently a current is generated on the rectangular track. It is observed from figure 3 that such arrangement of structure generates only one resonating mode (there is no random change in the moment of current).

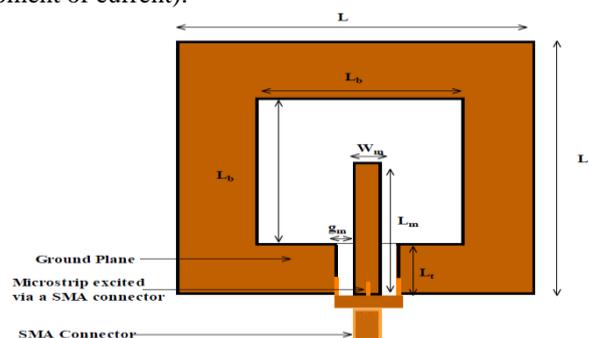


Fig.1. Geometry of proposed CPW fed antenna.



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Table-1 Design specifications of the proposed antenna.

L	L _b	L _m	W _m	g _m	L _t	h	ε _r
(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(Dielectric constant)
70	40	29.5	6	2	15	1.6	4.4

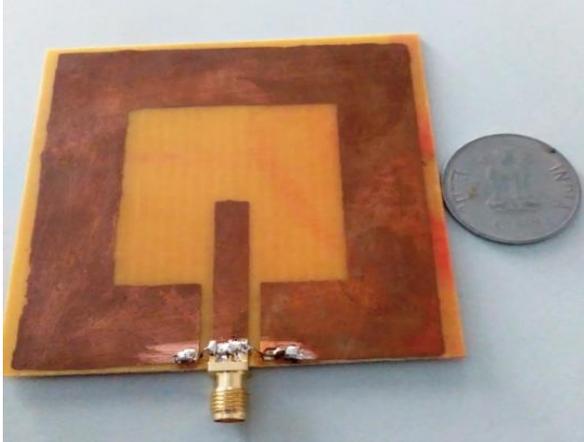


Fig.2. Fabricated photograph of proposed antenna.

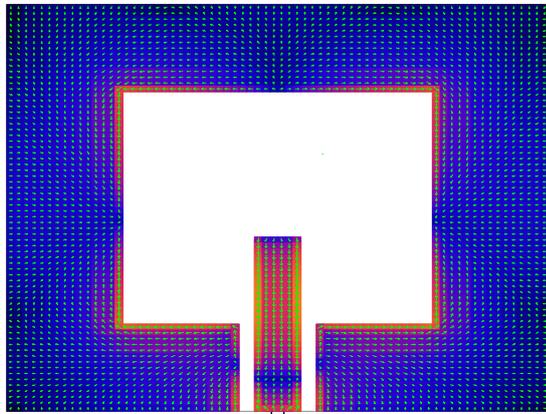


Fig.3. Current distribution of proposed CPW fed antenna at center frequency of 3.5 GHz.

III. RESULTS AND DISCUSSION

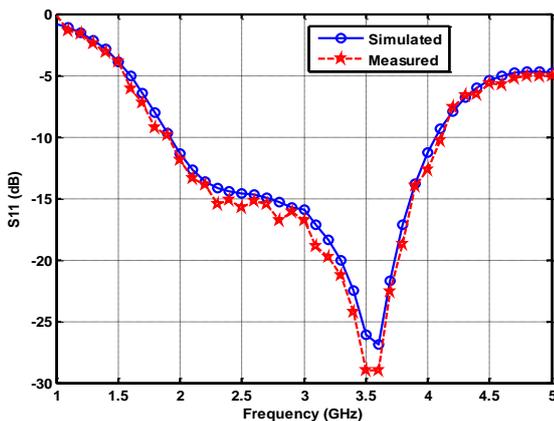


Fig.4. Measured and simulated plots of reflection coefficient.

A perusal of measured and simulated reflection coefficient [cf.figure.4] shows that both are in close agreement. The minute difference in the simulated and measured results can be attributed due the fact that Microwave Office uses method of moments (MOM) and the mathematical instabilities involved in calculating antenna parameters account for these differences.

The bands at -10 dB are observed at 1917 MHz (f_L) and 4067MHz (f_H). The bandwidth obtained is 2150 MHz and percentage bandwidth (BW) is calculated using the formula

$$[(f_H - f_L) / \{(f_H + f_L)/2\}] \times 100 = BW\%$$

Which gives a bandwidth of 71.85%. Thus, this wideband bandwidth can be utilized for various wireless applications.

Figure 5 shows the radiation pattern of proposed antenna at the center frequency. Radiation pattern is plotted for E plane and H plane. It is concluded from the polar plot that antenna is linearly polarized and the E-plane radiation confirms its unidirectional behavior.

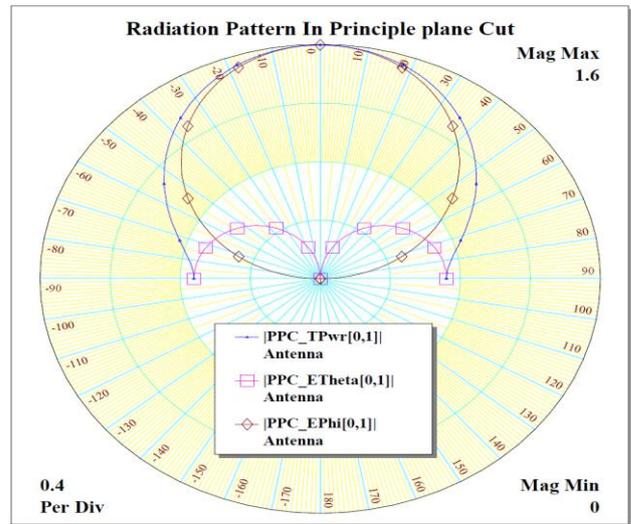


Fig. 5(a)

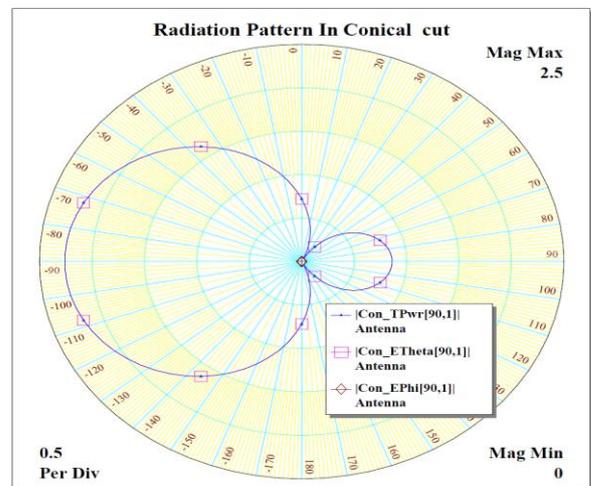


Fig. 5(b)



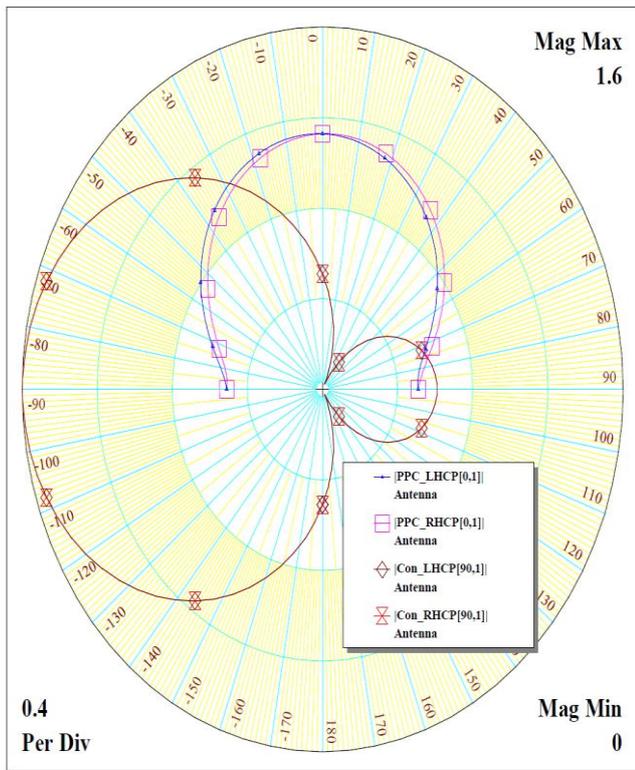


Fig. 5(c)

Fig.5. Radiation pattern of proposed antenna at center frequency i.e. 3.5 GHz. (a) principle plane cut E_θ and E_ϕ (b) conical plane cut H_θ and H_ϕ (c) polarization in principle plane cut and conical plane cut

It is clear that in principle plane cut when θ is fixed at 0 degree and Φ is varying a gain of 2.544 dBi is obtained. Half power bandwidth is calculated as 88° from figure 5(a). When conical plane cut $\Phi=90^\circ$ and θ is varying a gain of 5.062 dBi in azimuth plane is observed.

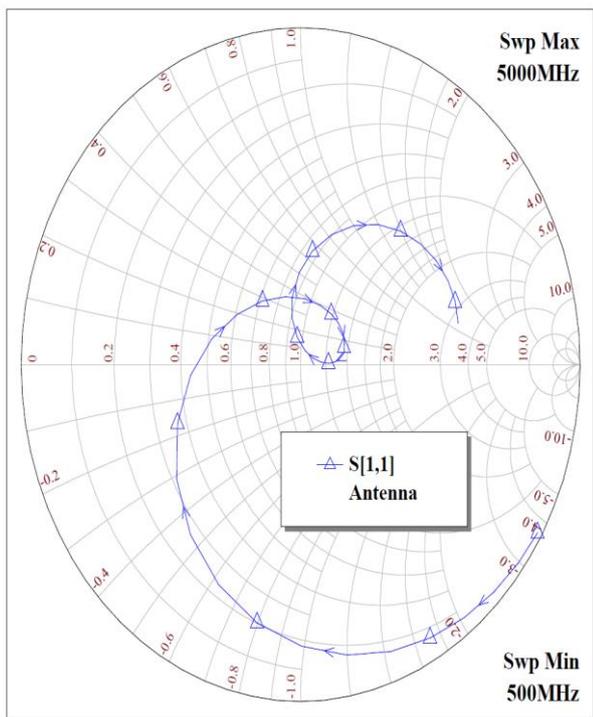


Fig. 6 (a)

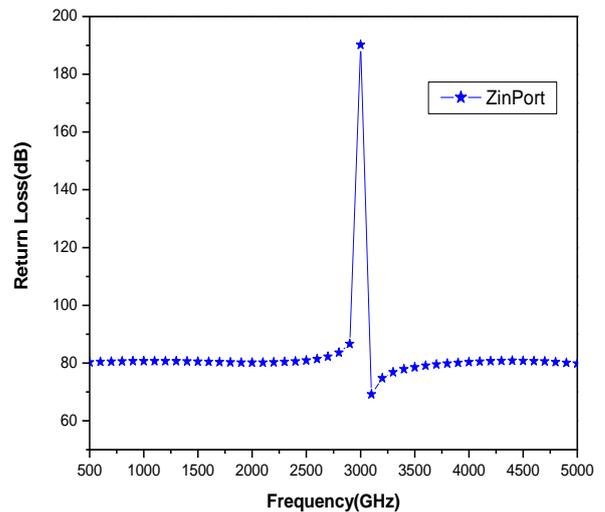


Fig. 6 (b)

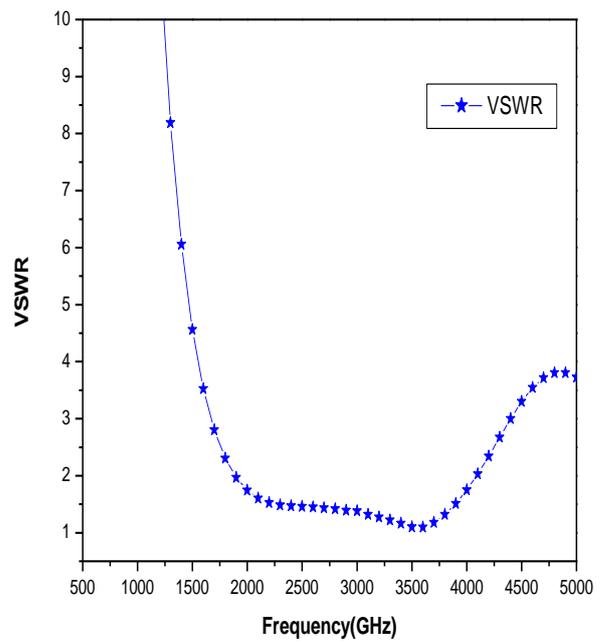


Fig. 6 (c)

Fig.6. (a) Smith Chart of the proposed antenna (b) Input impedance of the proposed antenna(c) VSWR of the proposed antenna.

Figure 6(a) shows that The smith chart provides clear view of complex impedance. As evident from figure 6(b) maximum input impedance of the proposed radiating structure is 60Ω at 3.5GHz which confirms that the structure is good for impedance matching. Figure 6(c) shows that the radiating structure has VSWR of 1.5:1 for the bandwidth range mentioned above. The result of VSWR and return loss are in close agreement for the bandwidth range of 1917 MHz to 4067 MHz

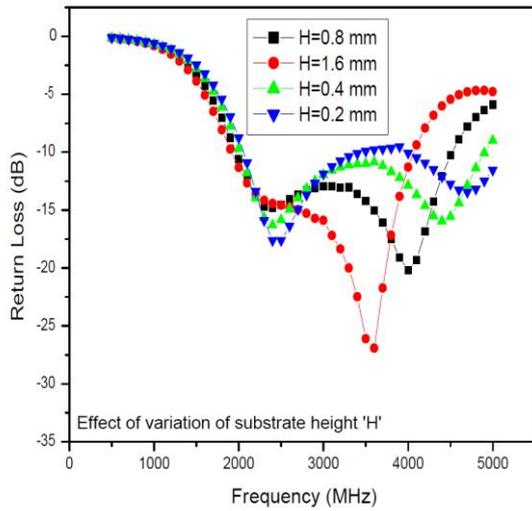


Fig.7. Simulated return loss vs frequency plot showing effect of variation of substrate height.

From figure 7 it is clear that on increasing the height of substrate, resonance frequency is shifted towards higher frequency side and impedance bandwidth of proposed radiating structure also increases.

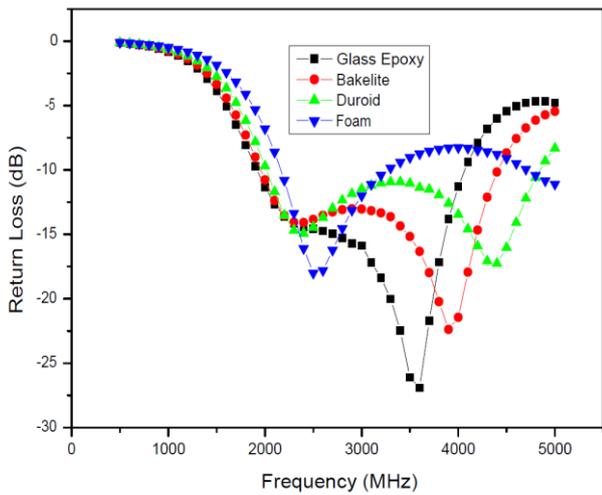


Fig.8. Simulated return loss vs frequency plot for various substrates for fixed height 'H'=1.6mm.

From figure 8 it is clear that as the dielectric constant of the material is increased, the impedance bandwidth also increases.

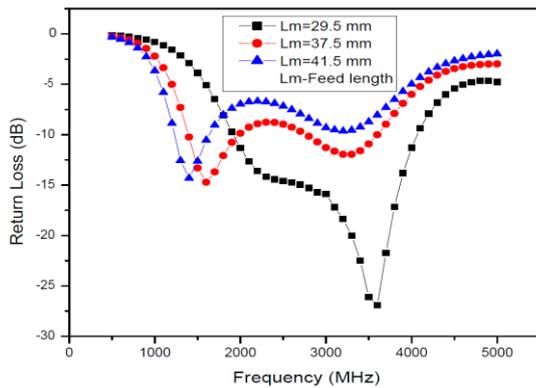


Fig.9. Simulated plots of reflection coefficient with variation of feed length of CPW.

Figure 9 depicts the variation of feed length L_m in terms of reflection coefficient. As the feed length is increased the impedance bandwidth is enhanced and the resonating frequency is shifted towards the higher frequency range.

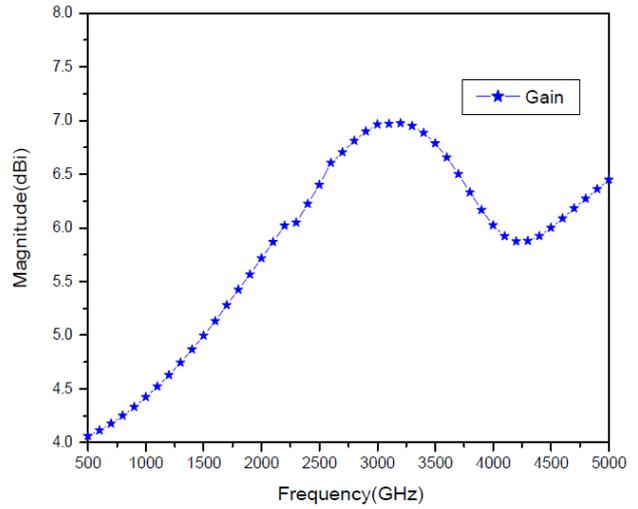


Fig.10. Gain vs frequency variation of proposed antenna.

Gain of the proposed antenna is plotted and shown in fig. 10. It is observed from the figure that antenna provides a good gain of 6.5dBi at the resonating frequency.

IV. CONCLUSIONS

A CPW fed microstrip patch antenna is designed and fabricated, simulated return loss result are verified by the experimental results. A 71.85% bandwidth is obtained and this wider bandwidth can be utilized in various wireless applications which lies in this band of frequencies. An Omni directional characteristic for the proposed antenna structure. The wide band of this antenna makes it suitable for various wireless applications and can be easily integrated in MMICs.

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