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# Coplanar Waveguide Fed Microstrip Patch Antenna

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**Abstract:** In this study, a new Compact Coplanar Waveguide (CPW) fed antenna is presented. The impedance matching and the radiation characteristics of this proposed structure is studied using method of moment techniques. The proposed antenna is based on CPW feed configuration with C shaped patch and two notches. The achievable bandwidth of the proposed antenna obtained about 400 MHz (5.02-5.42 GHz) at -10 dB return loss which corresponds to WLAN 5.2 GHz frequency band and the achievable gain is 8.5 dBi. Stable radiation characteristics are obtained across the operating band.

**Key words:** CPW-fed antenna, printed antenna, WLAN antenna

## INTRODUCTION

The explosive growth of wireless system and booming demand for a variety of new wireless application such as WLAN (Wireless Local Area Network), it is important to design broadband and high gain antennas to cover a wide frequency range. The design of an efficient wide band small size antenna, for recent wireless applications, is a major challenge. Microstrip patch antennas have found extensive application in wireless communication system owing to their advantages such as low-profile, conformability, low-cost fabrication and ease of integration with feed-networks (He *et al*., 2008). Recently, a great interest in coplanar waveguide (CPW)-fed antennas has been found due to their many attractive features such as wider bandwidth, better impedance matching, simplest structure of a single metallic layer and easy integration with active devices or monolithic microwave integrated circuits. Many efforts have been made to design CPW-fed antennas capable of single-band operation (Miao *et al*., 2000), or capable of dual or multiband operation but with more complex geometrical structure (Laheurte, 2001; Chen, 2002). More recently, several slot geometries like square, rectangular, triangular, trapezoidal, circular, elliptical etc., in combination with either a rectangular, fork like or circular tuning stub is optimized for achieving wide-band operation (Chiou *et al*., 2003; Chen, 2003; Jan and Hsiang, 2006; Wang and Lee, 2006; Qu *et al*., 2006). However, the achievable maximum gains of these antennas are below 7 dBi. Recently, another (CPW)-fed double folded slot antenna which is matched to the feed line without external matching circuitry is presented by Omar *et al*. (2009). The gain exhibits only 3.2 dBi. By reducing slot coupling another CPW-fed printed slot-loop antenna (Shynu and Amman, 2009) with narrowband and gain of 2.1 dBi is offered. In this paper, a new design of a CPW-fed antenna including C shape patch and notches for 5.2 GHz wireless local-area network (WLAN: 5.15-5.35 GHz) application is presented. A better gain of 8.5 dBi is achieved compare to the design reported by Miao *et al*. (2000), Laheurte (2001), Chen (2002), Chiou *et al*. (2003), Chen (2003), Jan and Hsiang (2006), Wang and Lee (2006), Qu *et al*. (2006), Omar *et al*. (2009) and Shynu and Amman (2009). Details of the proposed design performance are presented and discussed.

## ANTENNA DESIGN

Figure 1 shows the geometry and parameters of the proposed CPW-fed antenna. The antenna is printed on Roger RT5880 Printed Circuit Board (PCB) where the patch width and length is 37 mm by 37mm. The substrate has a dielectric constant of 2.2 and thickness of 1.5748 mm. The CPW feed line, which has a single strip with a width of 2 mm, height of 13 mm and gap of distance of 0.2 mm, is designed for a 50 ohm characteristic impedance. As shown in figure, the proposed antenna consists of CPW feed alone with C-shaped patch and two notches. The length of the C-shaped antenna excites the frequency on the upper portion of the patch (PQR). The C-shaped patch with introducing extended ground plane is used to ensure the patch length produces good frequency resonance at 5.2 GHz band. The extended ground plane with trapezoid shape cut is used at the top end for achieving good bandwidth. This extended ground

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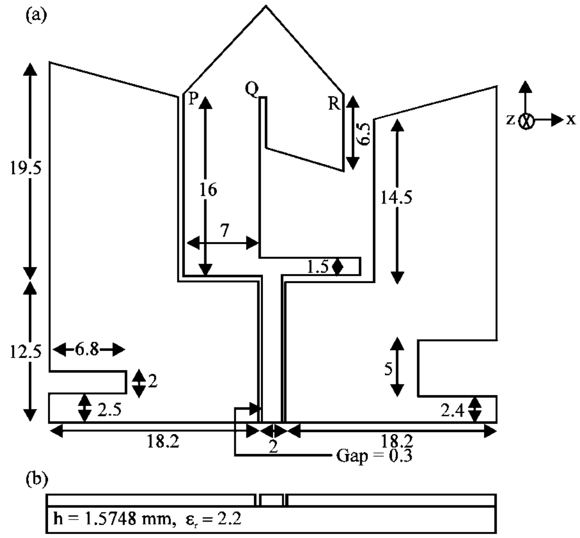


Fig. 1: Geometry of the proposed patch antenna (a) Top view and (b) Side view

plane dimensions also affect the antenna input impedance and it is found that the ground plane must be optimized for good impedance matching. These techniques plays govern role to improve the gain of this antenna. In addition, the two rectangular cutting edges (notches) on the bottom of the ground plane helps to restrict the current flow and further enhance the impedance bandwidth.

## RESULT ANALYSIS

The resonant properties of the proposed antenna have been optimized by using commercially available EM simulator software named IE3D v12. Figure 2 shows the simulated result of the return loss of the proposed antenna. The three closely excited resonant frequencies at 5.08, 5.27 and 5.39 GHz as shown in the figure gives the measure of the wideband characteristic of the patch antenna. The simulated impedance bandwidths of 400 MHz from 5.02 GHz to 5.42 GHz is achieved at -10 dB return loss (VSWR≤2).

The simulated radiation patterns at the frequency of 5.15 GHz in the xz-plane and yz-plane are plotted in Fig. 3a and b. As shown in Fig. 4, the designed antenna displays good radiation patterns in the xz-plane and yz-plane at frequency of 5.15 GHz. The normalized crosspolarization level is lower than about -12 dB in xz-plane and -14 dB in yz-plane. Notable, the radiation characteristics of the proposed antenna are better to those of the conventional patch antenna.

The simulated gain of the proposed patch antenna at various frequencies is shown in Fig. 4.

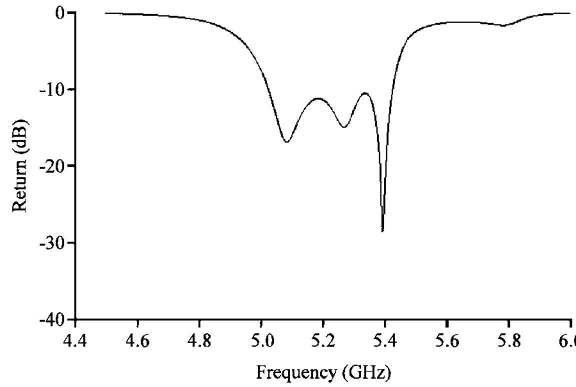


Fig. 2: Simulated return loss of the proposed patch antenna

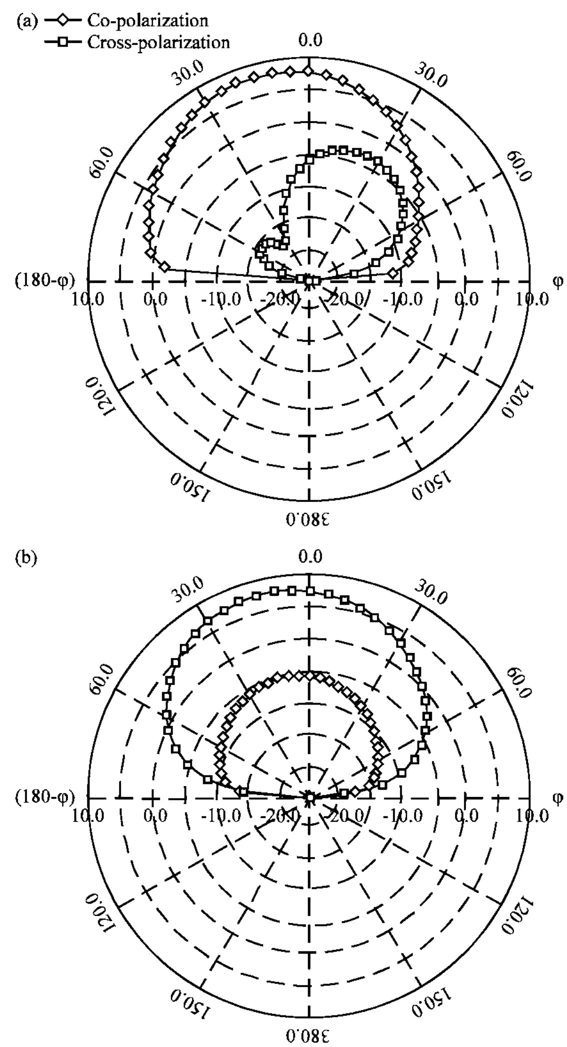


Fig. 3: Radiation pattern of proposed patch antenna at 5.15 GHz for (a) xz-plane and (b) yz-plane

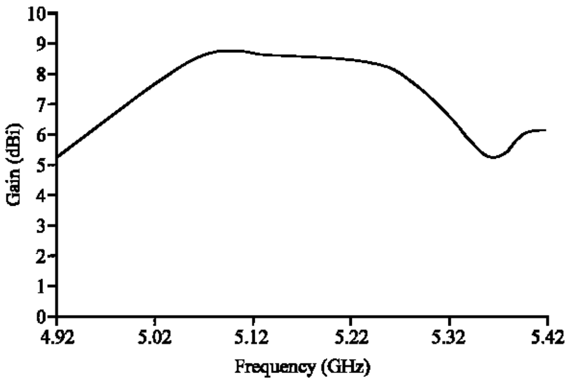


Fig. 4: Simulated gain of proposed patch antennas at different frequencies

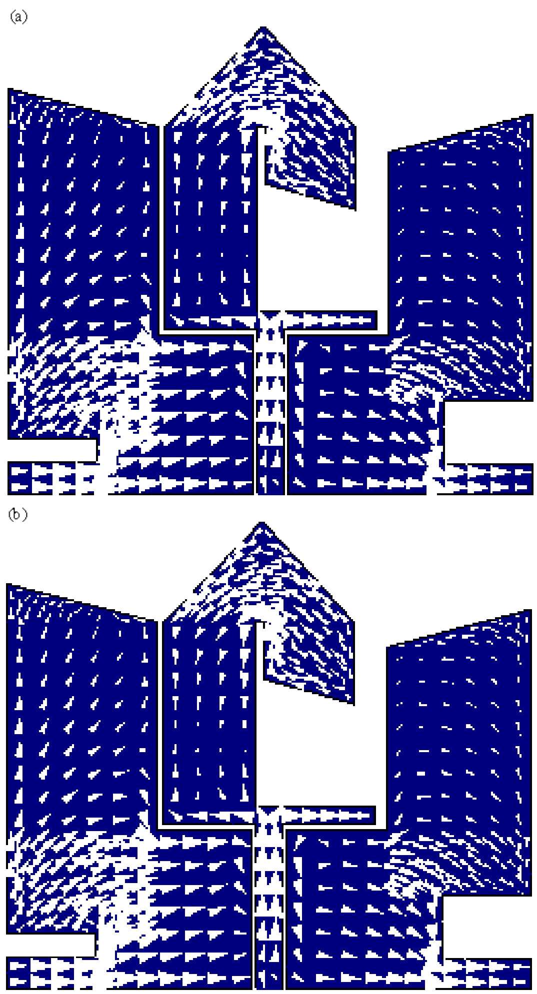


Fig. 5: Simulated current distribution on the patch at a) 5.08 GHz, b) 5.39 GHz

The maximum achievable gain is 8.5 dBi at the frequency of 5.145 GHz (Fig. 4).

Figure 5a and b show the current distribution on the patch at 5.08 GHz and 5.39 GHz Arrows shows the direction of the current. It can be seen that the current intensively flows mainly on the strip and at the cutting edge on the left and right ground (notches).

## DISCUSSION

The proposed antenna is designed to operate at WLAN 5.2 GHz frequency band which is corresponds to IEEE 802.11a (5.15-5.35 GHz) applications. It can be observe that the achievable impedance bandwidth of 400 MHz at 5.2 GHz band is obtained due to proper matching and introducing notches on the design.

It can be noticed that acceptable broadside radiation pattern is obtained at the frequency of 5.15 GHz. However, the xz-plane and yz-plane patterns show relatively large cross-polarization radiation. This behavior is largely due to the strong surface current and electric field observed, which leads to a significant increase of the cross-polarization radiation.

One of the major problems with CPW fed antenna is the ability of achieving high gain antenna. In this proposed design a high gain of 8.5 dBi has investigated which shows better gain compared to design reported earlier. This is obtained due to coupling in between extended ground plane and C shape patch especially on the PQR portion.

From the current distribution display, it is observed that at frequency 5.08 GH, the concentrate current is more on C-shaped patch (PQR portion) while slightly less on the ground cutting edge (notches). At the frequency of 5.38 GH, the more concentrate current flows on the notches produces lowest resonant frequency of -28 dB. It concludes that with the aid of two notches on the ground, the flow of the current distribute more on excited radiating element, leads wider impedance bandwidth.

## CONCLUSION

In this study, a new CPW-fed patch antenna covering the 5.2 GHz WLAN has been demonstrated. With incorporating CPW-fed extended ground plane, C-shaped patch and notches, the proposed antenna exhibits a bandwidth of 400 MHz (5.02 to 5.42 GHz) at 10 dB return loss. The maximum achievable gain of the antenna is 8.5 dBi. In addition, the proposed antenna shows well defined radiation pattern over the band which makes the design suitable for wireless communication applications.

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