# Broadband Circularly Polarized Planar Slot Antenna for Bluetooth/WiMAX Application


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**Abstract** A wideband circular polarized slot antenna using coplanar waveguide feed (CPW) technique is presented in this work. A rectangular slot is created in the ground plane and an asymmetric patch residing in the rectangular slot is fed by central signal strip. The rectangular slot is perturbed by a conducting stub embedded in the ground. Ground is further modified by etching a few rectangular slots in it aiming at broadband circular polarized behavior. A grounded metallic arm of L-shape is incorporated in the structure which improves the axial ratio bandwidth of the proposed antenna. The proposed antenna provides an overlap band, i.e., $S_{11}$ <−10 dB and axial ratio<3 dB from 1.83 to 3.37 GHz which provides a large axial ratio bandwidth of greater than 1.5 GHz for which antenna exhibits circularly polarized behavior thereby covering Bluetooth and WiMAX usable bands.

**Keywords** Coplanar waveguide · Wideband · Circular polarized

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## 1 Introduction

The increasing demand for wireless and high-speed communication has triggered the requirement of wideband circular polarized planar antennas with low profile, easy integration with microwave-integrated circuits and reduced losses. Circular polarized antennas are less affected by polarization mismatch loss, multipath fading, adverse weather conditions, Faraday rotation, and reflections. In [1], circular polarized behavior is studied by introducing multiple feeds, in [2] circular polarization is achieved by using notch slots and ground feed, in [3] rectangular slot contains a parasitic element which is energized by an L-shaped feed line in order to produce wideband circular polarization. In [4], instead of a wide rectangular slot, step-shaped slot has been used for obtaining wideband circular polarization by controlling the impedance of slot. In [5] rectangular slot with grounded metallic ring is implemented to increase the 3 dB axial ratio bandwidth. Lightning-shaped feed line proposes a new option for gradual variation in slot impedance, resulting in wide impedance bandwidth.

## 2 Antenna Configuration

Figure 1 shows the top view of proposed coplanar waveguide antenna along with its geometrical dimensions (mm) illustrated in Table 1. An asymmetric slot is incorporated in the ground plane in place of conventional rectangular slot and is energized by a 50 Ω feed line having width of 3.2 mm and a distance of 0.4 mm from the ground plane. FR4 epoxy is used as a substrate of height = 1.6 mm, $\varepsilon_r = 4.4$, having loss tangent = 0.02 is used to model the antenna. Grounded stubs are protruded into the slot for obtaining broadband circular polarization performance.

**Table 1** Antennal dimensions (mm)

| a | b | c | d | e | f | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|
| 4.4 | 1.2 | 6.4 | 8.7 | 9.2 | 3.2 | 1.6 | 9.2 | 14.6 | 7.6 |
| l | m | n | o | p | q | r | s | t | u |
| 35 | 2.1 | 6.6 | 1.43 | 2 | 2 | 15 | 5.7 | 3.7 | 2.7 |
| v | w | | | | | | | | |
| 3.1 | 35 | | | | | | | | |


**Fig. 1** Schematic view of antenna

## 3 CP Mechanism

Magnetic current vector distribution for circular polarized frequency band at 3.3 GHz is depicted in Fig. 5. Path of rotation traced by current vector in azimuthal plane with advancing time is studied. Considering +z axis as direction of propagation, the dominant current vector follows anti-clockwise sense of rotation. Hence conforming right-handed circular polarized behavior. Sense of rotation followed by dominant current vector along with axial ratio less than 3 dB confirms the circular polarized nature of antenna. Surface current density is illustrated in Fig. 6 depicting the regions responsible for dominant CP radiation. So direction of rotation of current vector along with axial ratio less than 3 dB confirms circular polarized behavior of antenna for a frequency range of 1.83–3.37 GHz (Fig. 2).

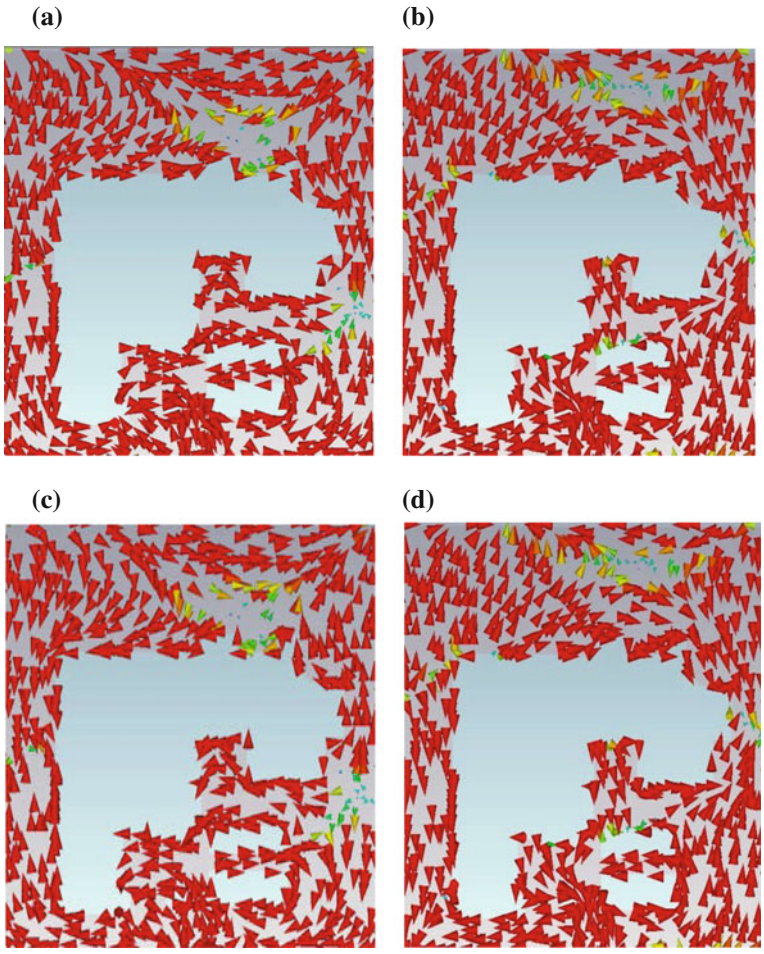


**Fig. 2** Magnetic current vector distribution at 3.1 GHz **a** t = 0 **b** t = T/4 **c** t = T/2 **d** t = 3T/4

## 4 Result and Discussion

$S_{11}$ for the antenna is depicted in Fig. 3 which confirms that the antenna resonates for a frequency range extending from 1.70 to 4.46 GHz. A positive gain is observed for the resonating band as Fig. 4 illustrates an average gain of 3 dBi for the antenna. Circular polarization (CP) performance for the antenna is depicted in Fig. 5 by axial ratio. Figure 5 confirms the wideband circular polarized nature as the axial ratio is less than 3 dB along with return loss less than −10 dB for frequency range extending from 1.83 to 3.37 GHz. Normalized radiation pattern is plotted in Fig. 6 which confirms RHCP nature of antenna.

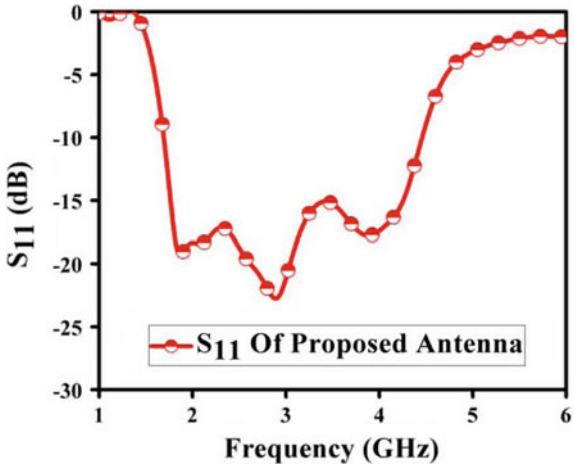


**Fig. 3** Return loss for antenna

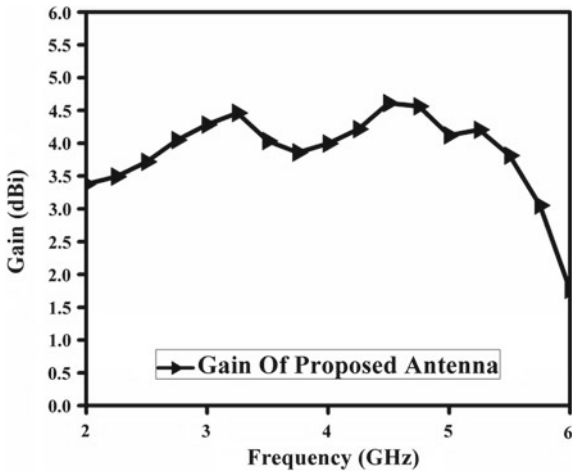


**Fig. 4** Gain for antenna

## 5 Conclusion

A broadband band circular polarized coplanar waveguide antenna has been presented in this letter. Use of asymmetric patch and grounded L-shaped arm for generation of circular polarization is studied in this work. Antenna miniaturization is achieved by incorporating asymmetric slot which replaces the conventional rectangular slot. CP performance for the antenna is precisely controlled by grounded arm which is protruded into the slot. Circular polarization is achieved for a wide range of frequency and the antenna can be applied for Bluetooth and WiMAX applications.

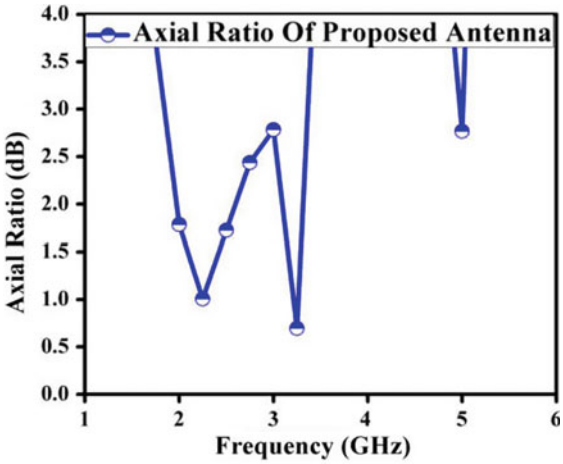


**Fig. 5** CP performance for antenna

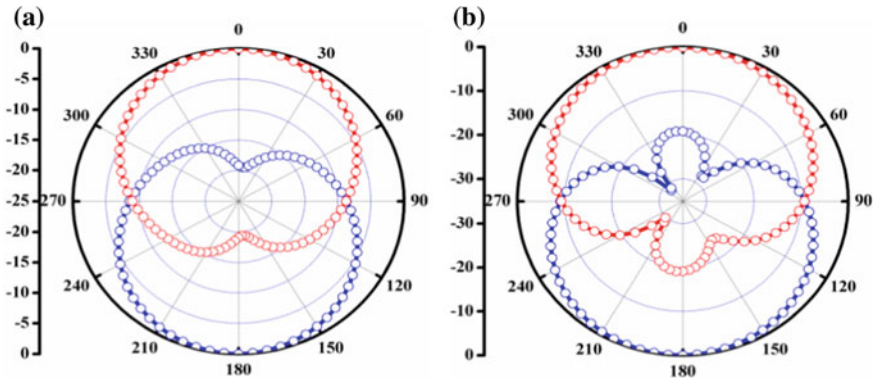


**Fig. 6** Normalized radiation pattern at 3.1 GHz at *xz*-plane and *yz*-plane

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