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Novel Ultra Wideband Circularly Polarized Rectangular Patch Antenna

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Abstract: In this paper a very simple micro-strip rectangular patch antenna is proposed with circular polarization and enhanced bandwidth for mobile Ad Hoc network. By using the orthogonal feed orthogonal linear components has been produced having phase difference of odd multiple of 90˚. For enhancing the bandwidth the rectangular patch has been truncated. The bandwidth of antenna is 12%. The proposed antenna gives the axial ratio 0.25dB at resonate frequency of 7.15GHz.

Index Terms: Circularly Polarized Antenna, Mobile Ad Hoc Network, Wideband Antenna.

I. Introduction

In mobile or vehicular communication systems the electromagnetic wave comes from various directions with variety of polarization. Therefore there is need of polarization independent antennas with low cost and good design. Circularly polarized and wideband antennas are suitable in wireless system embedded in complex environment as an effective way to mitigate the multipath propagation. Micro-strip antenna with circular polarization and wideband is a good choice due to low profile. Different techniques has been developed to achieve circular polarization as single point feed [1], artificial ground structure [2], DNA strands [3] and wideband as Ψ-shaped micro-strip antenna [4], M-patch antenna [5]. In this paper dual feed technique has been used to achieve the circular polarization and rectangular slots are used to enhance the bandwidth.

II. Principle Of Operation

To achieve the circular polarization the field must have two orthogonal equal magnitude components and with phase difference of odd multiple of 90˚. By using the dual orthogonal feed two orthogonal components have been generated with the phase difference of odd multiple of 90˚ which results in circular polarization. Circular polarization can also be achieved through diagonally single feed and by corner truncation of rectangular patches. Assuming wave is propagating in Z-direction the condition for circular polarization can be given as:

1. The field must have two orthogonal linear components.
2. The two components must have same magnitude.
3. The two components must have a time-phase difference of odd multiple of 90˚.

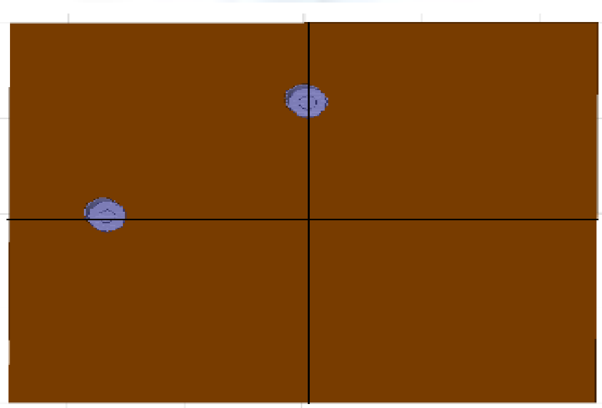


Fig. 1: Orthogonal Co-axial feed

Dual feed technique is the most direct way to generate circularly polarized radiation from a square patch. For designing the patch is first matched to the feed line. When a pair of slots is incorporated the rectangular patch acts like a parallel RLC circuit shown in Fig.3. The resonate frequency is determined by the L1C1 and L2C2.

$$Zin = j\,\frac{\left(\omega L1-\frac{1}{wC1}\right)\left(\omega L2-\frac{1}{\omega C2}\right)}{\omega(L1+L2)-\left(\frac{1}{\omega C1}+\frac{1}{\omega C2}\right)}$$

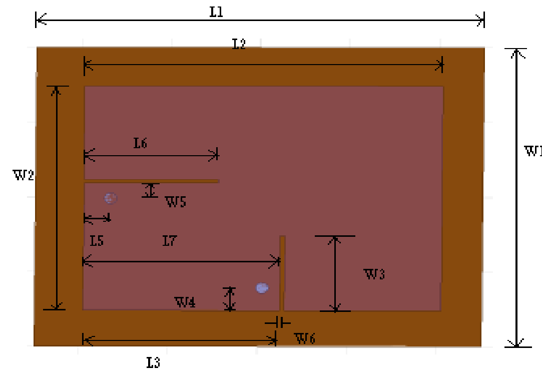


Fig.2. Antenna Geometry (W1=60mm, L1=50mm, W2=30mm, L2=40mm, L3=17mm, L5=3mm L6=15mm, W3=10mm, W4=3mm, W5=2mm, W6=0.5mm)

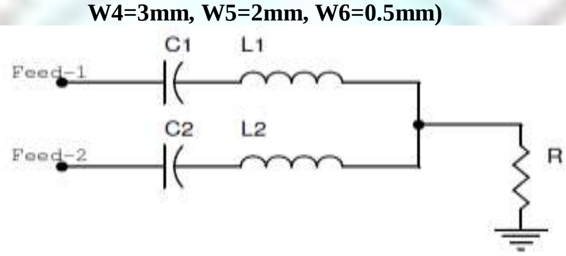


Fig.3. Equivalent Circuit of proposed antenna

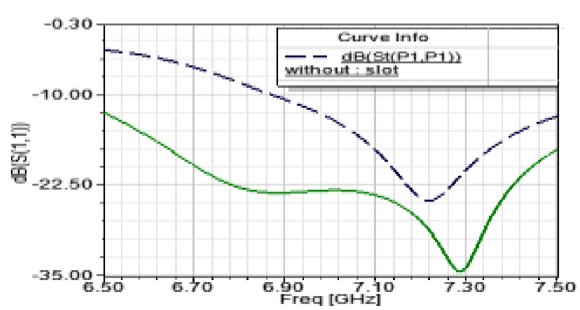
The equivalent circuit represent the parallel resonate mode between two series resonate modes. If the two series resonate mode are too far apart the reactance of the antenna will be very high and reflection coefficient of the antenna will be unsatisfactory. If two resonant circuit is too near the parallel resonate mode will affect the overall frequency response.

II. Antenna Configuration

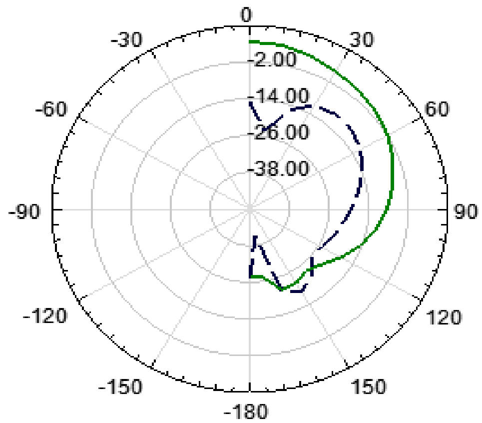
The dimensions of proposed antenna are illustrated in Fig. 2. It composed of 50Ω transition, two 50Ω probe feeds, and two rectangular slots. The rectangular slots are also orthogonal to each other and separated by some distance. Two orthogonal feeds are provided near to the slot. The patch is etched on a Rogers RT/duroid 5880(tm) substrate with dielectric constant 2.2 and thickness 3.2mm. To achieve the impedance matching the feed point is placed at (0, 12, 0) mm and (17, 0, 0) with respect to origin of the patches. The above feeding point gives the best impedance matching.

III. Results

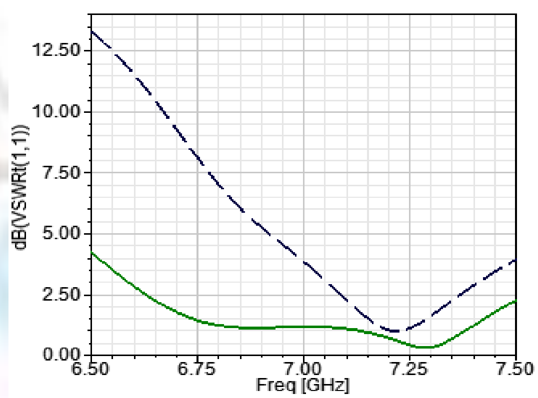
The simulated results of proposed antenna are illustrated in Fig. 4.



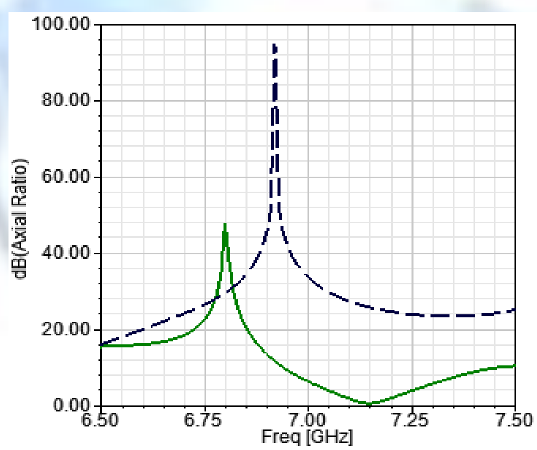
(a)



(b)



(c)



(d)

Fig.4: Simulation results of proposed antenna (a) Return Loss (S11) (b) Radiation Pattern (c) VSWR and (d) Axial Ratio.

Proposed antenna exhibits the wideband operation from 6.7GHz to 7.46GHz at return loss of -20dB. The results of with and without rectangular slots are compared in the graphs. The results show that as the rectangular slots are incorporated the performance of the antenna has been improved. The impedance matching is better and hence the reflection at feeding points is reduced from -8dB to -20dB. The bandwidth of the antenna is improved by 8%. The polarization and VSWR of the antenna is also improved. Axial ratio is reduced to 0.25dB from 20dB at resonate frequency 7.15GHz. The proposed antenna is simulated using the HFSS-13.

III. Conclusion

The introduction of rectangular slots improves the antenna performance significantly. Proposed antenna exhibits the wideband and circular polarization property and very low reflection. Antenna performances are optimum and can be used for the mobile devices in mobile Ad Hoc network.

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