Academic Science

International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 5
May 2017

CPW-Fed Circularly PolarizedDual Loop Antenna for UHF Application

Taimoor Khan and Pallab Pran Dutta
Department ofElectronics and Communication Engineering
National Institute of Technology, Silchar, India

ABSTRACT- *A double D-Loop circularly polarizedprinted antenna is proposed forUHF applications. It generatesa uniform and strong magnetic field in a near-field area of the double loop. For UHF application, the overall fabricated size of dimension 80 mm×80 mm×3.2 mm is achieved. It has good impedance matching and uniform magnetic field distribution with circular polarization in the frequency bandwidth of648 MHz to 658 MHz with reflection coefficient of less than -48 dB.*

Index Terms-Circular Polarization, CPW-Fed, UHF, Loop Antenna

I. INTRODUCTION

In recent years, several researchers have contributed in the field of loop antenna forultrahigh frequency (UHF)applications. Loop antenna is a very simple, inexpensive and versatile type of antenna. And they can take many different shapes such as- ellipse,rectangle, triangle, square, circle and many different forms .Among them the most popular one is the circular loop antenna due to its simplicity in construction and analysis.A small circular loop shows the same characteristics of an infinitesimal magnetic dipole whose axis is perpendicular to the plane of the loop [1].Here, our antenna exhibits circular polarization. It is so because in this antenna, the reception of signal is allowed irrespective of the orientation of the receiving antenna along with the capability of suppressing multipath interference [2].

Different techniques [3-13] have been proposed for achieving circular polarization in antennas.A cross-slot on the patch is used for getting circular polarization [3] Again in [4] elliptical patch antenna is used to produce right-handed circular polarized TM_{21} mode. On the other hand in [5], a meandered structure loaded with a 100 Ω resistor chip is used as the feeding mechanism to excite circular polarization radiation. In [6], R. S. Goopta1, Q. D. Hossain and M. A. Hossaina single feeding is used to realize the orthogonal modes of operation. Circular polarization in [7-8] is achieved using single feeding with cross-slot having unequal arm lengths. By using proper length of slot and suitable patch position, equal amplitudes of the two orthogonal resonant modes can be achieved having 90^0 phase difference, by this process circular polarization is achieved. In [9], by using the same procedure and Y shaped slot circular polarization is achieved.Circularpolarization in [10-11]is achieved by putting slit lines at the boundary of the microstrip patch. In [12],W. S. Chen, C. K. Wu, and K. L. Wonghave used in single-feed square microstrip antenna with shortened pair of patch corners to achieve circular polarization. Tang and Wong[13] have designed an equivalent-triangular-ring circularly polarized microstrip antenna.

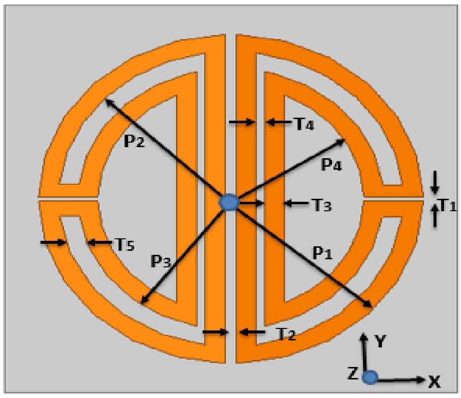
Here, in the proposed work, the authors have used a 45^0 axially inclined double D-loop printed copper to ensure circular polarization. The printed antenna consists of a double D-loop on the top of the substrate and the coplanar feed at the bottom of the substrate. It achieves circular polarization and resonant frequency at around 652 MHz. This paper is organized as follows. The proposed antenna configuration is presented in Section II. Next, in Section III, simulation work and parametric study of the printed antenna is done. The simulation results of the antenna are presented in Section IV. Finally, the conclusion followed by referencesis then discussed in Section V.

Academic Science

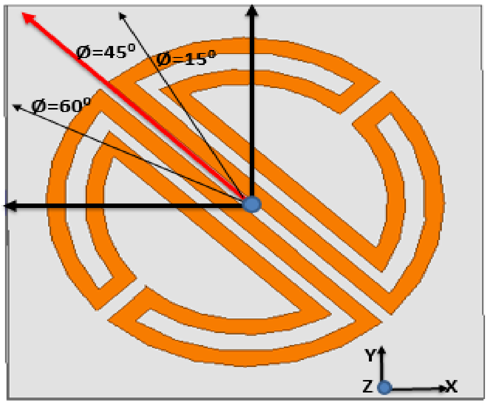
International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 5
May 2017

II. PROPOSED ANTENNA CONFIGURATION

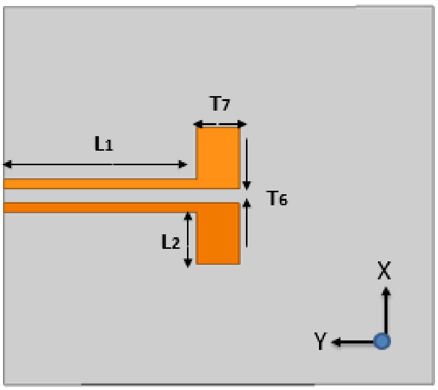
The geometry of the proposed double D-loop printed antenna designed using FR4 substrate (dielectric constant = 4.4 and thickness = 3.2 mm) is shown in Fig. 1. The ground plane size for the proposed antenna geometry is optimized as $D_1 \times D_2$ = 80 mm × 80 mm. The antenna is excited via a coplanar waveguide (CPW) feed printed at bottom of the substrate and exited using 50Ω lumped port. The width of the coplanar feed conducting strips can be varied for adjusting port matching. The 3D-configuration of the proposed antenna is shown in Fig 2. Different geometrical parameters of the proposed antenna are optimized using HFSS v13.0 simulator and their optimal values are mentioned in Table I. The proposed antenna geometry is analyzed by rotating the antenna horizontally by an angle of 'ø' degree from the center ($0 \leq ø \leq 180^0$). The detailed parametric study in this case is described in section III.



(a) Top-viewof antenna

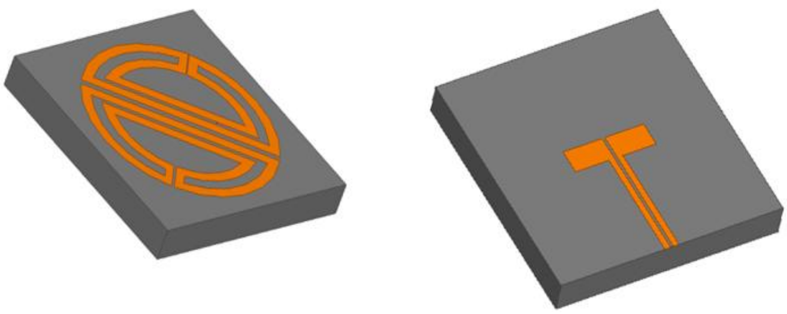


(b) Rotation angle of the loop(ø)



(c) Bottom view of the CPW fed

Fig.1. 2D structure of the proposed antenna



(a) 3D-Top view (b) 3D- Bottom view

Fig.2. 3D-Configuration of Proposed Antenna

Table IOptimal Values of Geometrical Parameters

S. No.	Parameters	Dimension	S. No.	Parameters	Dimension
1	T_1	1 mm	9	D_2	80 mm
2	T_2	2 mm	10	P_1	33 mm
3	T_3	2.5 mm	11	P_2	30.5 mm
4	T_4	2.5 mm	12	P_3	27 mm
5	T_5	3.5 mm	13	P_4	25.5 mm
6	T_6	1 mm	14	L_1	35.85 mm
7	T_7	8 mm	15	L_2	12 mm
8	D_1	80 mm	-	-	-

III. SIMULATION WORK AND PARAMETRIC STUDY

The axial ratio of the proposed antenna for a range of frequencies of antenna operation is shown in Fig.5(b). From the figure it is clear that the minimum axial ratio of 1.08 dB which is closer to the ideal circular polarization value is obtained at a center frequency of 653 MHz. Return loss of – 48 dB is obtained from the simulation which is shown in Fig.5(a). The simulated impendence bandwidth as well as axial ratio bandwidth is about 10 MHz from 648 MHz to 658 MHz, or 1.53% around the center frequency of 653 MHz.

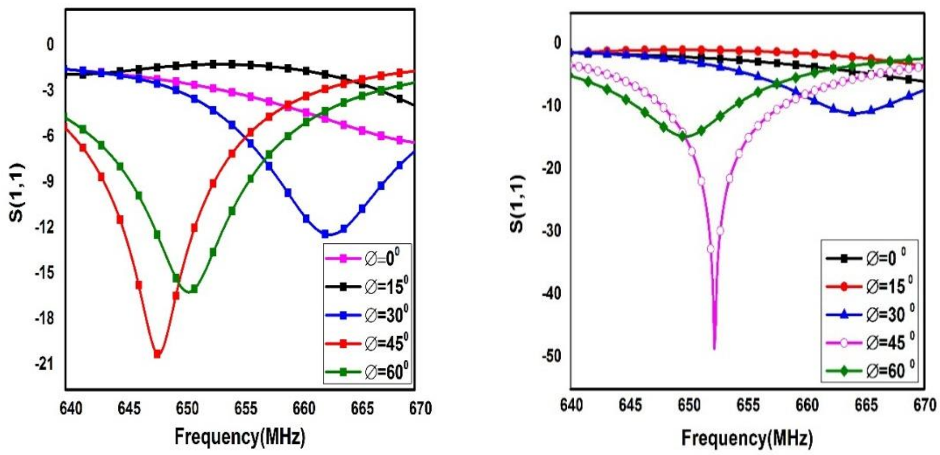
A comparative study of the effect of different width of the double D-loop and the rotation angles (Ø) of the loop on the performance of the antenna is analyzed as shown in figures below. The width of the D-loop and the rotation angle are optimized in terms of return loss and axial ratio responses using HFSS v13.0.

The width (T_3) of the printed double D-loop is varied from 2 mm to 3.5 mm taking a step size of 0.5 mm. Along with it the printed double-loop is also rotated at the center from 0° to 60° taking a step size of 15°. At 0° and 15° in every case the reflection coefficient is below -10dB. But on increasing up to 30°, 45°, 60°, a very good reflection coefficient is observed [Fig.3 (a), (b), (c), (d)]. Finally the best result is obtained at width (T_3) 2.5mm and 45^0 which gives circular polarization and return loss of -48 dB.

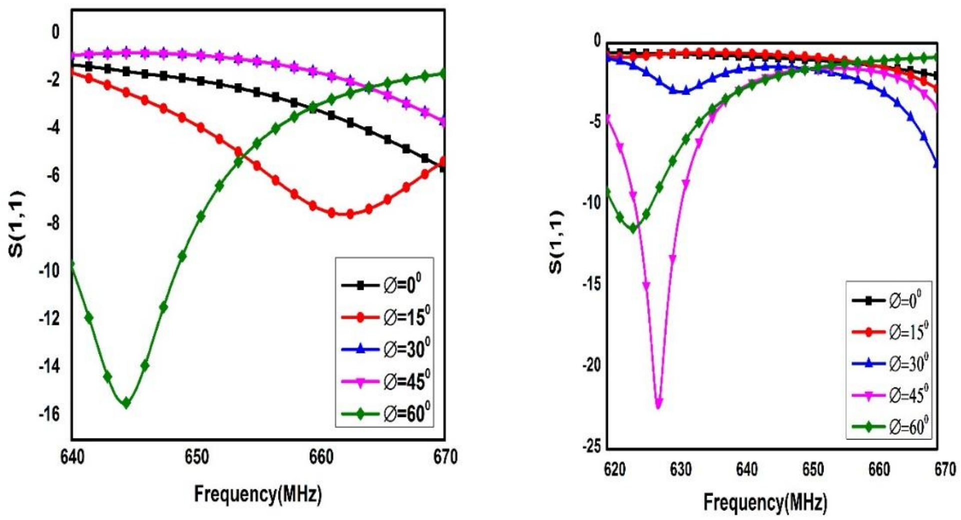
Moreover, at 45° of all the width the axial ratio of less than 3 dB is obtained. As a result it can be seen that circular polarization exists. Axial ratio is the ratio of major axis to the minor axis of the polarization ellipse. Here, Optimization of the structure is done to obtain good return loss and axial ratio.

In Fig.3(a) it is shown how the return loss and resonant frequency changes when the loop width is 2mm and at rotation angle (Ø) 0^0, 15^0, 30^0, 45^0, 60^0. It is seen that at 45^0 angle we a getting a good return loss. In Fig.3(b), the width is changed to 2.5 mm and rotation of the loop is done at the mentioned angles and the change in return loss is observed. Again in Fig.3(c) and Fig.3(d) the width of the printed loop is changed to 3mm and 3.5mm respectively and the change in return loss is observed at the angle (Ø) 0^0,15^0,30^0,45^0,60^0.In Fig.5 we have compared the axial ratio of the mentioned widths with at the angle 45^0.And in Fig. 5(a) and Fig.5(b) we have shown the return loss and axial ratio respectively of the optimized structure which has a width(T_3) of 2.5mm and rotation angle (Ø) of 45^0 from the center. From the discussed simulation it is seen that we are getting an axial ratio less than 3db in 2.5 mm and 3mm width .So, circular polarization exists.

Analyzing the values of the result figures we see that at 2.5mm width and 45° rotation, the double D-loop printed antenna has the best reflection coefficient of -48 dB and axial ratio of 1.08dB. So, the overall dimension of the proposed antenna is 80mm × 80mm × 3.2 mm, where the width (T_3) is 2.5 mm and the double D-loop rotated at an angle (Ø) of 45°.



(a) (b)



(b) (d)

Fig.3. Simulated results of S (1, 1) for T_3 (a) 2mm (b) 2.5mm (c) 3mm (d) 3.5mm

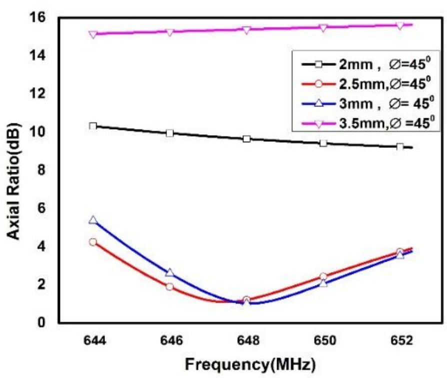
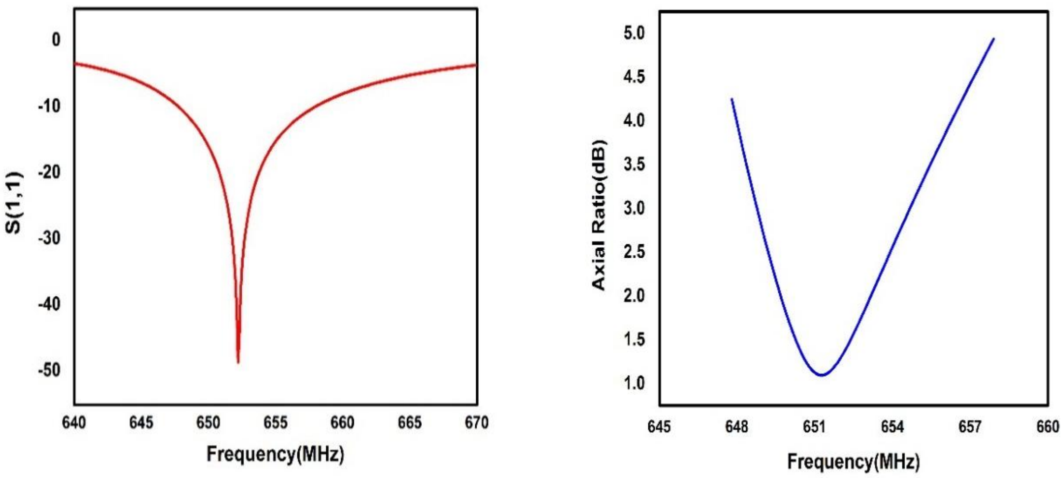


Fig.4. Simulated results for axial ratio



(a) (b)

Fig.5. (a) Optimized S (1, 1) at 2.5mm (T_3) and 45^0
(b)Optimized axial ratio at 2.5mm (T3) and 45^0

V. CONCLUSION

A very compact size double D-loop printed antenna with circular polarization is successfully presented here. The excitation of circular polarization is done by increasing the width of the loop and by rotating it by an angle of 45^0. The overall fabricated size achieved is 80mm x 80mm x 3.2 mm, which has a center frequency at 653 MHz and the peak return loss achieved is -48dB.And the axial ratio achieved is 1.08 dB.

Reference

[1] Constantine A. Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons, 2nd edition
[2] MadhuriSahal, Dr. V. N. Tiwari, "Review of Circular Polarization techniques fordesign of Microstrip Patch Antenna", January 2015.
[3] Reshma Raphael, Sudha T, "Single-Fed Circularly Polarized Patch Antenna for 60 GHz Wireless Applications", 2016 International Conference on Emerging Technological trends.
[4] Zongtang Zhang, Shaoqiu Xiao, *Member, IEEE*, Yan Li, and Bing-Zhong Wang, *Member, IEEE* , "A Circularly Polarized Multimode Patch Antenna for the Generation of Multiple Orbital Angular Momentum Modes" , IEEE Antennas and Wireless Propagation Letters, Vol. 16, 2017.
[5] Jiun-Wen Yang, Ting-Yi Tsai, Chun-Cheng Chan, and Chow-Yen-Desmond Sim, " Small Size Circularly Polarized Patch Antenna for 2.4 GHz WLAN Applications", IEEE 2016.
[6] R. S. Goopta1, Q. D. Hossain and M. A. Hossain " Design of a Linear and Circular Polarization Antenna by Using Single Tuning Stub", ICPSDT 2015.
[7] H. Iwasaki, "A circularly polarized small-size microstrip antenna with a cross slot," IEEE Trans. on Antennas and Propagation, vol.44, pp.1399– 1401, Oct. 1996.
[8] J. H. Lu, C. L. Tang, and K. L. Wong, "Single-feed slotted equilateral-triangular microstrip antenna for circular polarization," IEEE Trans. on Antennas and Propagation, vol.47, pp.1174–1178, July1999.
[9] K. P. Yang, K. L. Wong, and J. H. Lu, "Compact circularly-polarized equilateral-triangular microstrip antenna with Y-shaped slot," Microwave Opt. Technol. Lett. 20, pp.31–34, Jan. 5, 1999.
[10] J. H. Lu, C. L. Tang, and K. L. Wong, "Circular polarization design of a single-feed equilateral-triangular microstrip antenna," Electron. Lett. 34, pp. 319–321, Feb. 19, 1998.
[11] H. M. Chen and K. L. Wong, "On circular polarization design of annular-ring microstrip antennas," IEEE Trans. on Antennas and Propagation, vol. 47, pp. 1289–1292, Aug. 1999.
[12] W. S. Chen, C. K. Wu, and K. L. Wong, "Novel compact circularly polarized square microstrip antenna," IEEE Trans. on Antennas and Propagation, vol. 49, pp. 340–342, March 2001.
[13] C. L. Tang and K. L. Wong, "A modified equilateral-triangular-ring microstrip antenna for circular polarization," Microwave Opt. Technol. Lett. 23, 123–126, Oct. 20, 1999.