Circularly Polarized D Shaped Microstrip Antenna for Satellite Communications

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Abstract— This paper describes design and simulation of Circularly Polarized D Shaped Microstrip Antenna. Proposed D shaped antenna is simulated on HFSS Simulation Software Tool. Proposed antenna covers the frequency range from 1.98 GHz to 2.05 GHz and also has -19.69 dB reflection coefficient. Antenna can be used for Satellite Communication and Mobile Satellite Services (MSS). Proposed antenna have axial ratio less than 3 dB and provides circular polarization at 2 GHz frequency.

Key words: Microstrip Patch Antenna, Circular Polarization, HFSS Satellite Communication, Bandwidth

I. INTRODUCTION

The concept of microstrip antenna was firstly discovered by Deschamps in 1953 [1]. Patent of microstrip antenna was approved in 1955 [2] but after availability of good substrate it was firstly fabricated during the 1970's. At that time, for wide range of microwave systems, Microstrip antenna was very good choice after continuous development by researchers. Due to wide range of applications and uses, characteristics of microstrip antenna continuously improved by efforts of scientists [3-5]. Antenna which have portable features with light weight, low profile, compact and multiband applications, was necessitated for wireless communication. Microstrip antenna fulfilled all these features with eliminating the requirement of separate antennas for different application [6]. Microstrip antenna is well desired for wireless communications systems due to small size with respect to other antennas and ease of installation [7-9].

Key element of these communication systems is antenna in system performance and size. It must be simultaneously fulfill three types of necessities: i) Design characteristics (compact size, small weight, in circuit fabrication, and no obstructive to customer), ii) Electrical characteristics (large bandwidth, good efficiency, improved radiation characteristics, reconfigurability, and suitability in terms diversity), and iii) Fabrication constraints (minimum cost, reliable, packaging features) [10-13].

For minimization of transmission losses, Antenna should match the polarization at transmitters and receivers [11]. Attractive solutions for polarization matching is circularly polarized antennas which allows flexible behavior between antennas at transmitters and receivers. It also minimizes the effect of multipath propagations, improves weather penetration and mobility between the transmitter and the receiver [12-15]. It is a challenging to design microstrip antenna with circular polarization. Following steps are required to design circularly polarized antenna. The first step is calculation of design specification of antenna to work in a specific operating frequency. In second step, using perturbation segment to a basic single fed microstrip antenna or by exciting the antenna with double feed lines having equal in magnitude but orthogonally physical phase shift [16-18]. The structure and the size of the perturbation have to be optimized to achieve axial ratio less than 3 dB at operating frequency [19].

In this paper, Circularly Polarized D Shaped Microstrip Antenna is presented to meet the requirements in terms of the return loss, gain and polarization. Section I covers literature survey. Design Geometry and Specifications of proposed Microstrip antenna is described in Section II. Section III explains simulation results.

II. ANTENNA DESIGN

The geometrical structures of Circularly Polarized D Shaped Microstrip Antenna is shown in figure 1 and Table I. D shaped Microstrip patch is designed on the substrate of 50*70 square mm. Rectangular patch of 21.42*27.8 is combined with Semi circular patch of 21.42mm diameter. The microstrip line feeding technique is used. For impedance matching between D shaped patch and microstrip line of 3mm width, quarter wave line of 11*0.4 square mm is used. Two slots of 5*1 mm are cut near the quarter wave line and D shaped patch. FR4 substrate which has relative permittivity of 2.2, with a thickness of 1.6 mm and loss tangent of 0.025 is used.

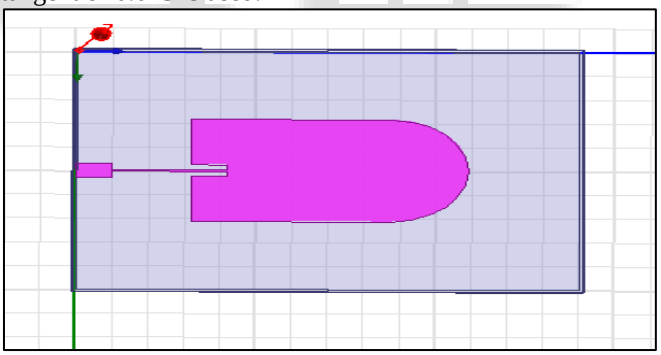

Fig. 1: Geometry of Circularly Polarized D Shaped Microstrip Antenna

Height	1.6 mm
Dielectric substrate	FR4
Permittivity	4.4
Loss tangent (tanδ)	0.025
Simulator	HFSS
Lower bound frequency	1 GHz
Upper bound frequency	5 GHz

Table 1: Basic parameters of proposed Antenna

III. SIMULATION RESULTS

Simulation Results of Circularly Polarized D Shaped Microstrip Antenna is discussed in this section.

A. Reflection Coefficient v/s frequency plot

The variation of reflection coefficient v/s frequency for Circularly Polarized D Shaped Microstrip Antenna is shown in figure 2. It is observed that antenna is tuned at 2 GHz with reflection coefficient -19.69 dB. Antenna have less than -10 dB reflection coefficient at 1.98 GHz to 2.05 GHz and provides 3.5 % bandwidth.

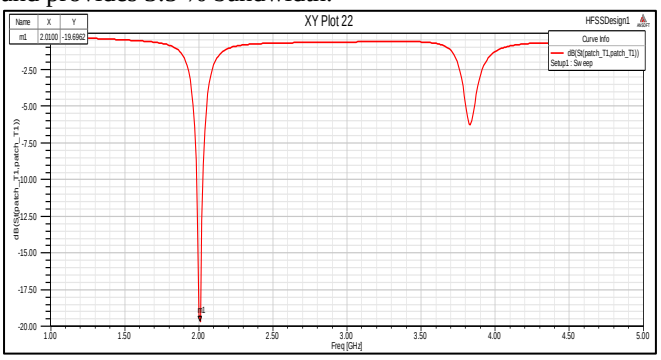

Fig. 2: Reflection coefficient versus frequency plot

B. Radiation Pattern

Radiation pattern in 2D is shown in figure 3, it is observed that Gain of 1.0238 is achieved with no minor lobes.

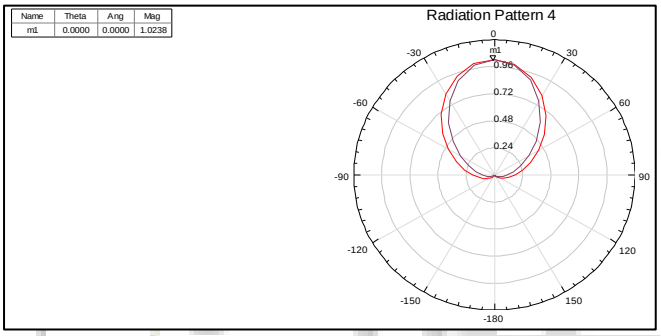

Fig. 3: Radiation Pattern in 2D

Radiation pattern in 3D is shown in figure 4, it is observed that Radiation is above ground plane.

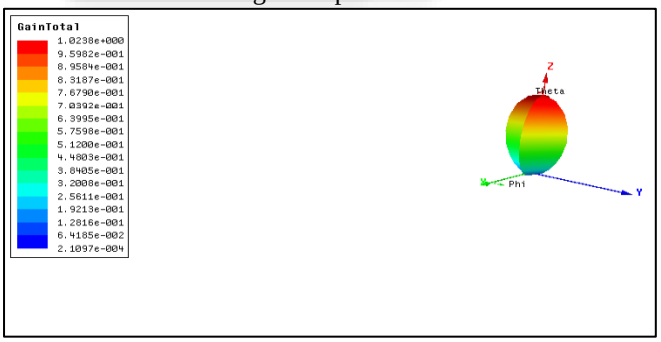

Fig. 4: Radiation Pattern in 3D

C. Axial Ratio plot

As shown in figure 5, axial ratio is less than 3 dB means proposed antenna provides circular polarization at those frequencies. Axial ratio is 0.7990 dB at 2 GHz frequency.

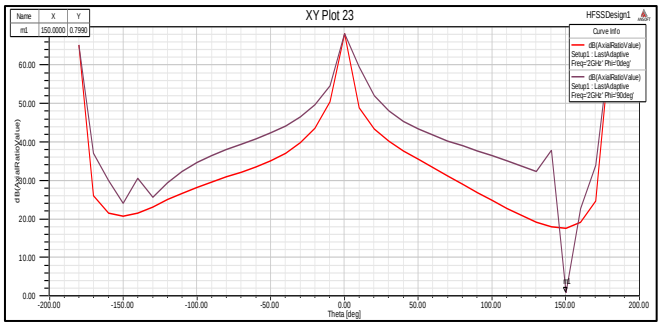

Fig. 5: Axial Ratio plot

D. VSWR v/s frequency plot

The variation of voltage standing wave ratio v/s frequency for Circularly Polarized D Shaped Microstrip Antenna is shown in figure 6. It is observed that antenna is tuned at 2 GHz with VSWR of 1.2476. VSWR is very closed to 1 which represents excellent matching between antenna and feed line.

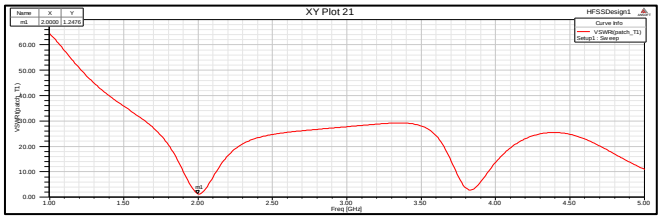

Fig. 6: VSWR v/s frequency plot

E. Smith Chart

Smith chart represents the variation of simulated input impedance of proposed arrangement as a function of frequency which is shown in figure 7.

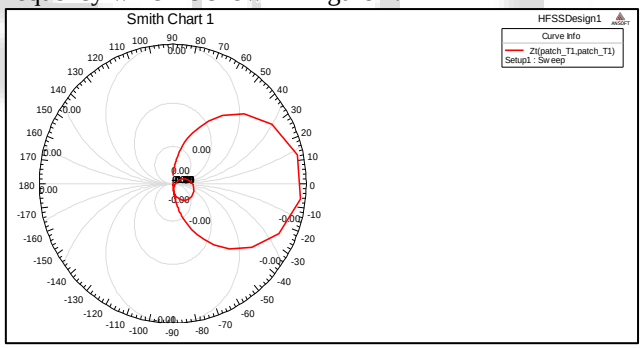

Fig. 7: Smith Chart

The circle at corner represents the circular polarization and good matching between feed and patch.

IV. CONCLUSION

Design and simulation of Circularly Polarized D Shaped Microstrip Antenna is presented. Proposed antenna can be used for the frequency range from 1.95 GHz to 2.05 GHz. Proposed antenna also having axial ratio less than 3 dB so it provides circular polarization and can be used for the applications such as Satellite Communication and Mobile Satellite Services (MSS).

REFERENCES

[1] John L. Volakis, Antenna Engineering Handbook 4th edition, McGraw-Hill, 2007.
[2] Thomas A. Milligan, Modern Antenna Design 2nd edition, John Wiley & Son Inc, 2005.

[3] J. S. Roy and M. Thomas, "Design of A Circularly Polarized Microstrip Antenna For Wlan", Progress In Electromagnetics Research M, Vol. 3, 79–90, 2008
[4] D. M. Pozar and D. H. Schaubert, Microstrip Antennas, "The Analysis and Design of microstrip Antennas and Arrays", IEEE Press, 1995.
[5] Thoetphan Kingsuwannaphong, Vitawat Sittakul, "Compact Circular Polarization Microstrip Antenna," International Conference on Communication and Signal Processing, April 6-8, 2016, India
[6] Nasimuddin, Y. Yong, Z.N. Chen, A. Alphones, "Circularly Polarized F-Shaped Slot Microstrip Antenna with Wide Beamwidth," in proceedings of the European Microwave Conference, EuMC , 2009 , pp. 1531–1534.
[7] J.-S. Row, C.-Y. Ai "Compact Design of Single-Feed Circularly Polarised Microstrip Antenna" IEEE Electronics Letters, vol.40, issue: 18, 2004, pp. 1093-1094.
[8] P. N. Rao; N. Sharma, "Fractal Boundary Circularly Polarised Single Feed Microstrip Antenna," IEEE Electronics Letters, vol. 44, issue:12, 2008, pp 713-714.
[9] Kin-Lu Wong, "Compact and Broadband Microstrip Antennas", John Wiley & Sons, Inc, 2002.
[10] Tapan Nahar and O.P.Sharma, "Bandwidth Enhancement of Corporate fed Bowtie Antenna Array operating in L band by changing the substrate material and ground plane length," International Journal of Computer Application (IJCA), Vol.107, Issue 4, Dec. 2014.
[11] A.G. Derneryd,"Extended analysis of rectangular microstrip resonator antennas," IEEE Trans. Antennas Propagat., Vol. AP-27, No.6, pp.846-849, November 1979.
[12] K.R. Carver and J.W. Mink, "Microstrip Antenna Technology,"IEEE Trans. Antennas Propagation Vol. AP-29, No.1, pp. 2-24, January 1981.
[13] W.F. Richards, Y.T. Lo, and D.D. Harrison, "An Improved Theory of Microstrip Antennas with Applications,"IEEE Tras. Antennas Propagat. Vol. AP-29, No.1, pp.38-46, January 1981.
[14] J.R. Moisig and F.E. Gardiol", General Integral Equation Formulation for Microstrip Antennas and Scatterers," Proc. Inst. Elect. Eng., Pt. H, Vol. 132, pp.424-432, 1985.
[15] Balanis,"Antenna Theory Analysis and Design", third Edition, Wiley India.
[16] Tapan Nahar and O.P.Sharma, "Performance Comparison of Modified Structures of Corporate fed Microstrip Antenna Array for L band," International Journal of Electronics Circuits and Switching (IFRSA-IIJECS), Vol.4, Issue 1, ISSN: 2277-5870, Jan. 2015
[17] Ravi Kant and D.C.Dhubkarya,"Design & Analysis of H-Shape Microstrip Patch Antenna, "Global Journal of Research in Engineering, Vol. 10, Issue 6 (Ver 1.0), pp. 26-29, Nov. 2010.
[18] Tapan Nahar and O.P.Sharma, "A Modified Multiband Bowtie Antenna Array used for L band Applications," International Journal of Engineering Research & Technology (IJERT), Vol.3, Issue 11, ISSN: 2278-0181, Nov. 2014.
[19] Govardhani.Immadi, M.S.R.S Tejaswi, M.Venkata Narayana,N.Anil Babu , G.Anupama , K.Venkata Ravi teja "Design of Coaxial fed Microstrip Patch Antenna for2.4GHz BLUETOOTH Applications" Journal of Emerging Trends in Computing and Information Science VOL. 2, NO. 12, December 2011.

