International Journal on Future Revolution in Computer Science & Communication Engineering
Volume: 3 Issue: 12
ISSN: 2454-4248
50 – 52

Circularly Polarized Stacked Microstrip Patch Antenna (Square Patch) for Satellite Applications

Ruchika Singh
Research Scholar
Dept. Of ECE
Kautilya Institute of Engineering & Technology
rsruchi009@gmail.com

Satish Parashar
Professor
Dept. Of ECE
Kautilya Institute of Engineering & Technology
satish.parashar2007@gmail.com

Dr. Devendra Kumar Singhal
Professor
Dept. Of ECE
Arya College of Engg and I.T,
Kukas, Jaipur,India
devendraggc@gmail.com

Abstract-This paper presents design of circularly polarized Circulo-rectangle Patch with Stacked Square patch Antenna operating at 11.18GHz to 13.2 GHz. Proposed antenna is fabricated on FR4 epoxy substrate having dielectric constant of 4.4. Simulation results show that antenna is tuned at 11.50 GHz resonant frequency and provides 28.76% bandwidth and 4.84dB gain. This antenna finds applications in satellite applications, radio astronomy service, radiolocation service and radio navigation applications. The antenna is simulated on HFSS virtual tool.

Keywords— *Micro strip patch antenna, Impedance Bandwidth, HFSS Stacked microstrip antenna, Circularly polarized antenna.*

*****

I. INTRODUCTION

Antennas are the key element in the field of wireless communication system. There are different types of antennas like Parabolic Reflectors, microstrip Antennas, Slot Antennas, and Folded Dipole Antennas [1-3]. Every type of antenna has its own properties and applications. It can be said that antennas are the backbone for wireless communication without which the world could have not reached at this age of technology.

In today's world of wireless communication, a very significant role is played by microstrip antenna. A patch antenna has a very simple construction using a conventional Microstrip fabrication technique [4]. Rectangular and circular shaped patches are the most commonly preferred [5-7]. By using these patch antennas attractive characteristics like circular polarization, dual band operation, frequency agility, large band width, flexible feed line, beam scanning and multiple band frequencies.

Now days Microstrip antenna is mostly preferred due to its low profile, light weight, and the ease with which they can be integrated with active devices [1]. Recently, circularly polarized (CP) microstrip antennas are used for satellite communications [8-10] and in radio frequency identification (RFID) readers [11, 12]. Microstrip-fed Circularly Polarized antennas can be classified as single-feed or dual-feed according to the number of feeders employed. Single-feed patch antennas are used for eliminating the need for 90◦ hybrid couplers [13-15].

The combination of rectangular and circular patch is presented in this paper which provides significant performance with circular polarization. For increasing the bandwidth, stacked arrangement is simulated. For tuning the antenna in a specific frequency range, size of parasitic circular patch is optimized. For enhancing the performance, the gap between two substrates are chosen 0.8 mm. microstrip feeding technique is used due to ease of construction and matching the impedances between patch and source.

This Paper is divided into four sections. Section I describes the introduction. Antenna geometry is presented in section II. Section III consist the simulation results of Circulo-rectangle Patch with Stacked Circular patch Antenna. Paper is concluded in section IV.

II. ANTENNA GEOMETRY

A conventional Circular patch antenna having radius 'a' = 6.5 mm is integrated with square of 18*18 square mm designed on FR-4 epoxy substrate (εr = 4.4, tanδ = 0.025, substrate thickness 'h' = 0.8 cm) as shown in Figure 1. The circulo-rectangle patch is fed through Microstrip line of 2.46*9.14 square mm with associated 50 ohm feed line. Stacked arrangement of circulo-rectangle patch with circular patch is used. Both these patches are prepared on FR4 epoxy substrate and separated through an air gap of thickness 'd'= .8 mm. This arrangement is simulated with method of moment based HFSS simulation software.

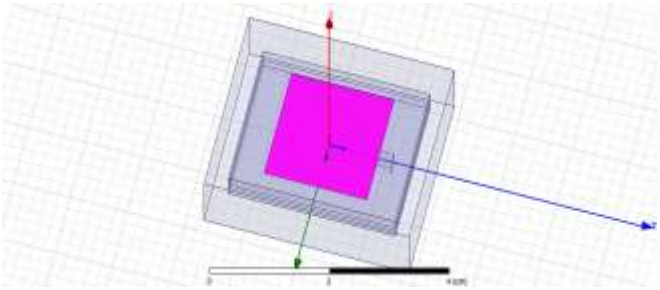

Figure 1: Geometry of proposed antenna

 ISSN: 2454-4248
50 – 52

Table 1: Basic parameter for proposed antenna

Upper substrate dimension	23 mm*29.3 mm*1.6 mm
Lower substrate dimension	23 mm*29.3 mm*1.6 mm
Air gap thickness	0.8 mm
Dielectric substrate	FR4 epoxy
Permittivity	4.4
Loss tangent (tanδ)	0.025
Simulator	HFSS
Lower bound frequency	8 GHz
Upper bound frequency	15GHz

III. SIMULATION RESULTS

Proposed antenna is simulated on HFSS virtual tool. The simulated return loss versus frequency plot is shown in figure 2. Return loss is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. It presents the reflections of antenna towards source due to mismatching of impedances with respect to frequency. This figure shows the value of return loss for proposed stacked arrangement is -22.5 dB at resonant frequency 11.18 GHz to 13.2 GHz. The simulated impedance bandwidth is calculated from Figure 2 for proposed stacked arrangement is 13.06 % and 9.24 %.

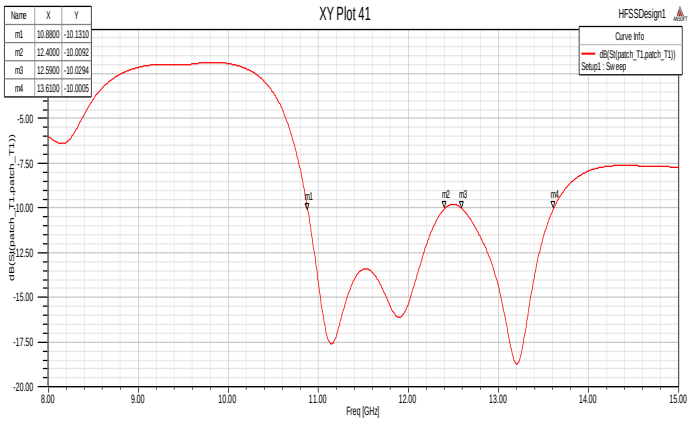

Figure 2: Plot between return loss and frequency

The variation of simulated input impedance of stacked arrangement as a function of frequency is shown by in Fig 3. The input impedance of this proposed stacked arrangement at resonance frequency 11.18 GHz and 13.2 GHz is 50 ohm which again suggests excellent matching between antenna and feed arrangement at resonant frequency.

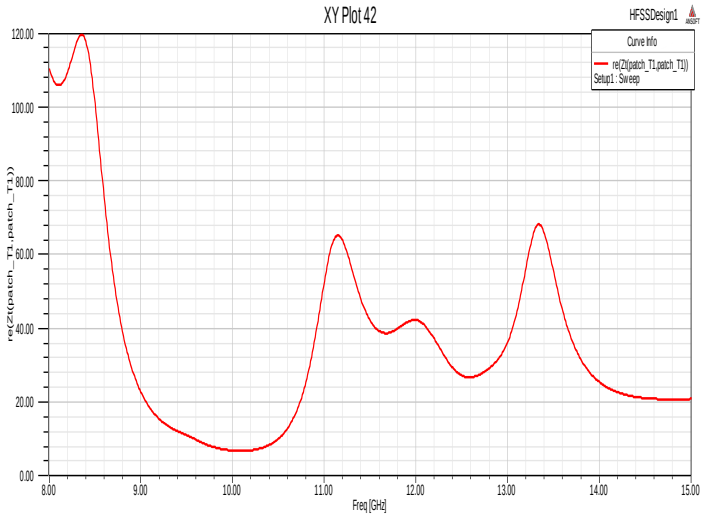

Figure 3: Simulated input impedance of proposed arrangement with frequency

The VSWR variation with frequency for proposed Circulo-rectangle Patch with Stacked Circular patch Antenna is shown in Figure 4. The parameter VSWR is numerically describes how well the antenna impedance is matched to the radio or transmission line. The VSWR value at resonant frequency 11.18 GHz and 13.2 GHz, which indicates excellent matching between antenna and feed arrangement.

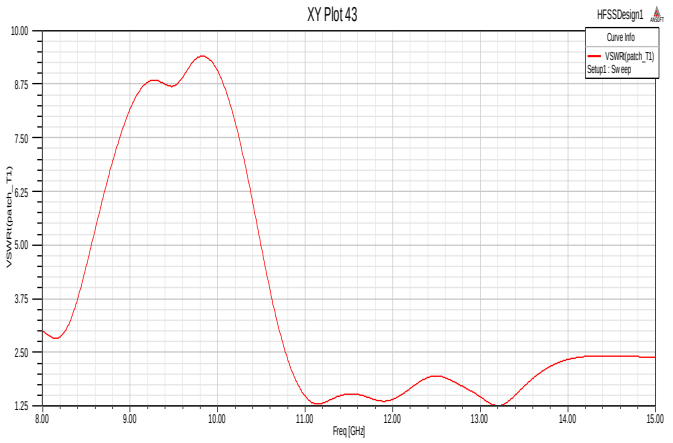

Figure 4: Simulated variation of VSWR of proposed arrangement with frequency

The simulated axial ratio variation with theta of proposed stacked arrangement is shown in Figure 5. Axial ratio parameter tells about the polarization nature of an antenna. From the axial ratio plot, it is realized that value of axial ratio for proposed stacked arrangement is 1.25 dB which is lower than desired 3dB value means it is circularly polarized.

 ISSN: 2454-4248
50 – 52

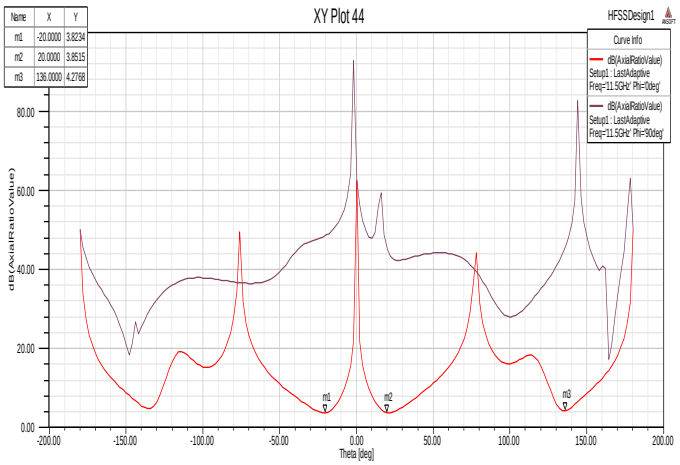

Figure 5: Simulated variation of axial ratio of proposed arrangement with theta

The simulated radiation pattern plot for Circulo-rectangle Patch with Stacked Circular patch Antenna is shown in Figure 6. The radiation pattern shows radiation pattern at frequency 11.5 GHz. Maximum gain of 4.84 dB is achieved.

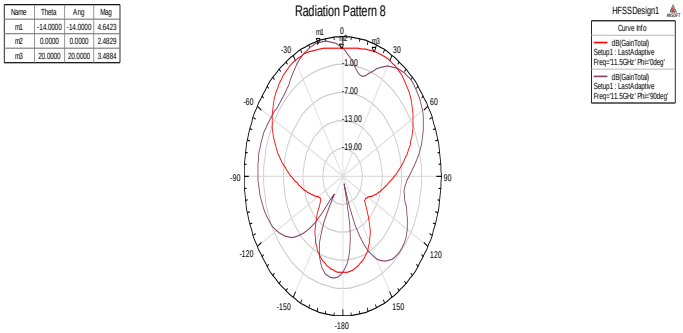

Figure 6: Radiation pattern of proposed arrangement

The radiation pattern in 3D is shown in figure 7.

Figure 7: Simulated 3D radiation pattern of proposed arrangement

IV. CONCLUSION

In this paper, the performance of proposed Circulo-rectangle Patch with Stacked Circular patch Antenna is analyzed. Proposed antenna provides circular polarization with significant bandwidth and gain. 13.2 % and 9.25 % bandwidth is obtained with gain of 4.84 dB at resonant frequency 11.5 GHz. Antenna finds applications in satellite applications, radio astronomy service, radiolocation service and radio navigation applications.

REFERENCES

[1] Balanis, "Antenna Theory - Analysis and Design," John Wiley & Sons, Inc 1997.
John D Kraus, Ronald J Marhefka, Ahmad S Khan ,Antenna & Wave Propagation, Fourth edition, TMH India.

[2] D.M. Pozar, "Microstrip Antennas," Proc. IEEE, Vol.80, No.1, pp. 79-81, January 1992.

[3] J.R. James and P.S. Hall (eds.), Handbook of Microstrip Antennas, Peter Peregrinus Ltd., on behalf of the IEEE, Vol. 1 and 2, London, UK, 1989.

[4] I.J. Bahl and P. Bhartia, Microstrip Antennas, Artech House, Norwood, MA, 1980.

[5] Moradi, K. and S. Nikmehr, "A dual-band dual-polarized microstrip array antenna for base stations," Progress In Electromagnetics Research, Vol. 123, 527–541, 2012.

[6] Tiang, J. J., M. T. Islam, N. Misran, and J. S. Mandeep, "Circular microstrip slot antenna for dual-frequency RFID application," Progress In Electromagnetics Research, Vol. 120, 499–512, 2011.

[7] Garcia-Aguilar, A., J.-M. Inclan-Alonso, L. Vigil-Herrero, J.- M. Fernandez-Gonzalez, and M. Sierra-Perez, "Low-profile dual circularly polarized antenna array for satellite communications in the X band," IEEE Trans. Antennas Propag., Vol. 60, No. 5, 2276–2284, 2012.

[8] Tang, X., H. Wong, Y. Long, Q. Xue, and K. L. Lau, "Circularly polarized shorted patch antenna on high permittivity substrate with wideband," IEEE Trans. Antennas Propag., Vol. 60, No. 3, 1588–1592, 2012

[9] 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.

[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)*, Dec. 2014.

[11] P.S. Hall, "Multioctave bandwidth log-periodic microstrip antenna array," IEE Proceedings H - Microwaves, Antennas and Propagation, Volume: 133, Issue: 2, 2015.

[12] M. K. A Rahim and P. Gardner, "Design of Nine Element Quasi Microstrip Log Periodic Antenna," Proceedings of RF and Microwave Conference, pp 132-135, October 5-6, 2004, Malaysia.

[13] Son Trinh-Van, Han Byul Kim, Gina Kwon, and Keum Cheol Hwang, "Circularly Polarized Spidron Fractal Slot Antenna Arrays For Broadband Satellite Communications In Ku-Band", Progress In Electromagnetics Research, Vol. 137, 203–218, 2013.

[14] Sekhar M,Siddaiah P, "Performance of Feed on Dual Frequency Antenna in Ka-Band", International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering Vol. 2, Issue 5, May 2014.