Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 7, S. 323-326, 4, 2023

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 7, pp. 323-326, 4, 2023

Research Article

IJANSER

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

Circularly Polarized L-Shaped Defected Ground Antenna for WLAN Communication Systems

Aynur Sena Çetinkaya[1], Merih Palandöken [2]

[1] *Department of Electrical and Electronics Engineering /Faculty of Engineering and Architecture, Izmir Katip Celebi University, Turkey*
[2] *Department of Electrical and Electronics Engineering /Faculty of Engineering and Architecture, Izmir Katip Celebi University, Turkey*

[1*] *aynursenacetinkaya@gmail.com*

(Received: 17 April 2023, Accepted: 22 May 2023)

(DOI: 10.59287/ijanser.725)

(1st International Conference on Contemporary Academic Research ICCAR 2023, May 17-19, 2023)

ATIF/REFERENCE: Çetinkaya, A. S. & Palandöken M. (2023). Circularly Polarized L-Shaped Defected Ground Antenna for WLAN Communication Systems. *International Journal of Advanced Natural Sciences and Engineering Researches*, 7(4), 323-326.

Abstract – With Industry 4.0, the evolution of technology has accelerated. As the information shared by people has increased, homes, cities and working environments have begun to be equipped with smart systems with the requirements of the age. IOT (internet of things) is spreading around the world. As a benefit of the advantages of wireless communication, technologies that provide information transmission using radio waves have gained importance. The increasing population in the world and its direct effect on demand require factories to keep production under control. This allows for renewal in manufacturing by triggering the contemporary transformation of the world. The transfer of this data has become an important issue as well as the increase in the amount of data generated. Wireless communication is provided by using radio frequency and studies are carried out on the 2.4 GHz ISM band frequency, which is the most frequently used. In this paper, circular polarized reader antenna with resonance frequency at 2.4 GHz and gain of 4.7 dBi is proposed. Resonance frequency covered by WLAN (wireless local area network) (2.4, 2.5 GHz). Impedance bandwidth -10 dB is between the frequencies 2.28 GHz and 2.53 GHz. The size of the designed antenna is 114mm x 65mm x 0.8mm.

Keywords – Circular Polarized, Wi-Fi Antenna, WLAN, 2.4 GHz, IOT

I. INTRODUCTION

In the evolving digital systems, the importance of wireless communication components has increased with the emergence of new generations of 5G and 6G in accordance to the need for the new component designs to be used in this technology [1,2.3].

Wi-Fi communication, which transmits data wirelessly with radio frequency, turns into a non-stop system where every new design instantly leads to another new idea, with its wide usage area and being frequently preferred. Most frequently used frequency in ISM band is 2.4 GHz frequency to provide communication in wireless local networks and this situation continues with the development of microwave systems and antennas by utilizing different materials in designs [4]. Geetharamani et al. propose metamaterial-based antenna design operating at 2.4 GHz resonance frequency.

Studies to increase antenna performance have been continued in both design and metamaterial branches [5].

Results from material-based changes is therefore the reason why the versatile different antenna geometric models have been used including metamaterial based resonating structures addressed in different microwave component designs [6, 7, 8] even suitable for the Wi-Fi applications [5,9-11] and in millimeter frequencies. In study [5], metamaterial has used to reduce the size of the antenna. Complementary split-ring resonator has implemented to the antenna and the comparison of two antennas with and without the method has simulated. Complementary split-ring resonator contributed to the antenna efficiency at the desired frequency. In study [10], metamaterial development-based microwave design structure has studied with split-ring resonators (SRRs) and complementary split-ring resonators (CSRRs) coupled to planar transmission lines. In [11], it has observed that the spiral resonator (CSR2) structure, which can be used in dual band miniature antenna applications, has applied and circular polarization has captured at both 658 MHz and 2.74 GHz operating frequencies. Efforts continue to increase the efficiency of antennas and to reduce the cost and size in this process. These developments are carried out both by making changes in antenna designs and by studies in the field of metamaterials. It is an important factor that the antennas are need-oriented and budget-friendly according to the size and material of designed antenna. The communication distance is directly affected by the antenna gain.

In this paper circularly polarized antenna at 2.4 GHz resonance frequency is presented. Material and parameters are detailed in section II, result values and observations explained in section III. In section IV, result and parametric changes are reviewed. In section V, summary information about the study was compiled.

II. Materials and Method

The proposed antenna structure is shown in fig. 2. Antenna has been designed with FR-4 material and copper patch. FR-4 has a permittivity of 4.5. Substrate thickness is designed as 0.8 mm. Outer size of the antenna is 114 x 65 mm^2. Designed antenna has feed line structure with length parameter L2. The feed of the designed antenna is provided by connecting the L2 feed line to the patch surrounding the quarter and corner of the antenna with lengths L2 and X2. The corner patch is added vertically a rectangular patch and a slot. The substrate thickness is 0.035 mm.

III. Results

Including rectangular patch has a positive effect on AR value to decrease as it is shown in Table 1. Circular polarization is observed when both electric field components are equal to each other and have a phase difference of 90 degrees:
Polarization of designed antenna is affected by the lengths L1 and L2 directly. AR values are mostly affected by the changing of feed width W1 It has observed that the AR value increased when the feed width has expanded. On designed antenna port location simulated along Lh distance. The most optimized result of the reflection coefficient is simulated 5 mm above the edge of the antenna.

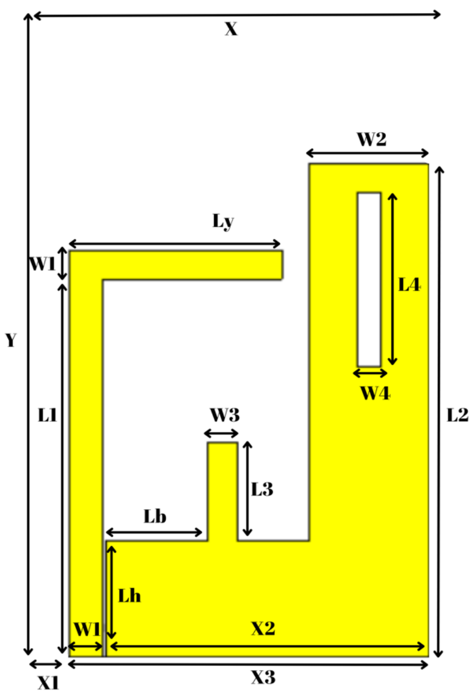

Fig. 2 Antenna structure

Parameters (in mm): X=65, Y=114, L1=65.1, L2=85, Lh=20, L3=Lb=17, L4=30, Ly=35.5, W1=W3=5, W2=20, W4=4, X1=5, X2=54, X3=60.

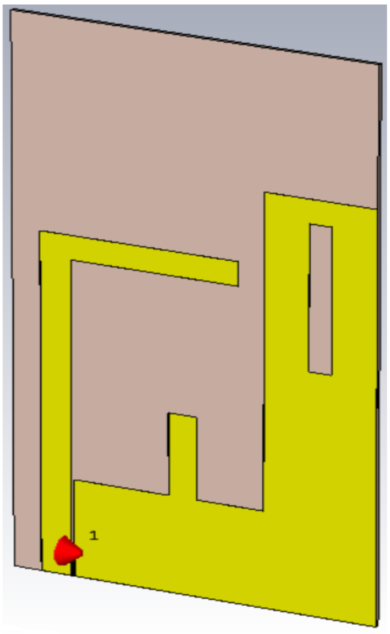

Fig. 3 Antenna Structure with Discrete Port

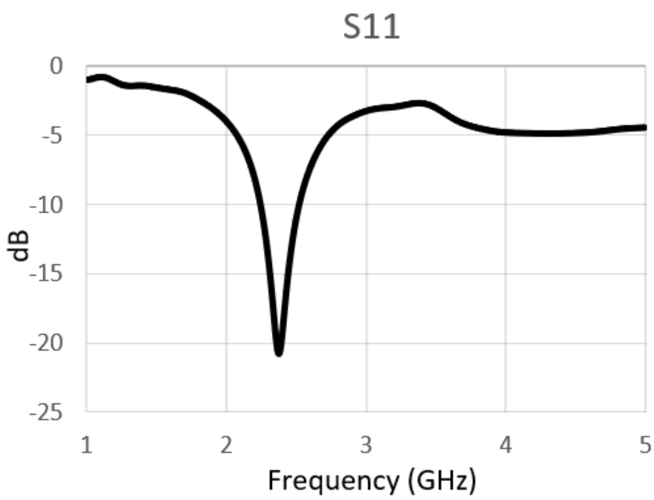

Fig. 4 Simulated S11 Result at 2.4 GHz 17.66dB

Before the settings were adjusted, the designed antenna had a resonance frequency in the 3-3.5 MHz band when the range of L1 was between 52-55 mm, and the reflection coefficient was above -10 dB.

Axial ratio values get better after including rectangular patch but it was not enough to take S11 parameters to desired frequency and values. Closer to 2.4 GHz on S11 graph were obtained by subtract the vertical slot on patch but AR is increased.

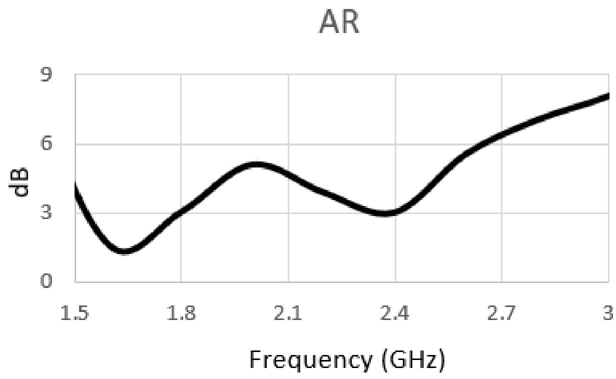

Fig. 5 Axial Ratio

Frequency is pulled to 2.4 GHz by adjusting feed length (L1) and rectangular patch length (L3). During the process axial ratio values increased and 2.99 dB AR obtained L1 and L3 parameters are 61.5 and 17 mm respectively. Table 1 shows the variation of the axial ratio and reflection coefficient values at their resonance frequencies according to L3 parameter when L1 fixed at 64 mm. Frequency and axial ratio values determined at 2.4 GHz and below 3dB for circular polarization. The vertical slot did not affect the 2.4 GHz reflection coefficient values as it was effective in the 3-3.5 GHz band.

Table 1. AR an S11 variations

L3 (mm)	AR (dB)	S11 (dB)
15	2.89	-20.6 (2.51GHz)
16	3.4	-18.7 (2.46GHz)
17	5.9	-18.7 (2.42GHz)
18	4.7	-20.8 (2.38GHz)

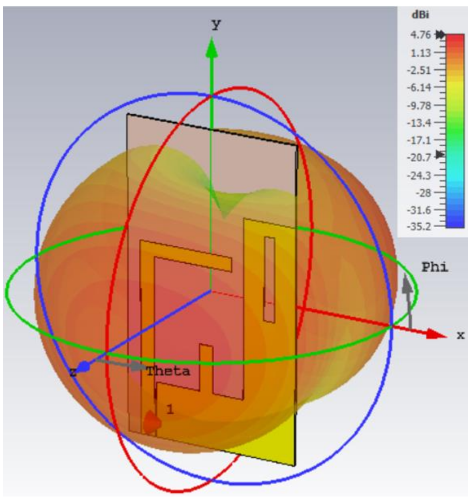

Fig. 6 Gain at 2.4GHz 3D Radiation Pattern

Simulation results of reflection coefficient at 2.4 GHz is -17.66 dB. Bandwidth is 2.28-2.53 GHz. Gain of the designed antenna is 4.7 dBi. Polarization of antenna is circular and 2.99 dB obtained. Presented antenna is easy to fabricate cause of FR-4 substrate thickness. Size of the antenna is 65 x 114 mm^2. Designed antenna parameters has been optimized by parametric sweep simulations.

IV. DISCUSSION

Antenna has been realized in three steps including the rectangular patch and slot effects observed by numerical computations, frequency range adjusted by parametric changes and lengths of feed and vertical rectangular patch. The latter parameters have a big effect on both polarization and reflection coefficient values. In order to understand the effect of each parameter separately, parametric sweep has been used then combined for collective effect on results. At the beginning, the vertical slot has not affected the frequency value but decreases the S11 parameters below -10 dB.

.

V. CONCLUSION

The presented antenna can be used for Wi-Fi applications operating at 2.4 GHz resonance frequency with low bandwidth. The idea behind the attempt on obtaining the circular polarization is to decrease the polarization sensitivity of receiving antennas relying on the relative positioning of hotspot communication router antennas with respect to the nearby receiving antennas. This radiation feature is realized by adjusting geometric parameters of the radiating patch. Designed antenna is thin, middle sized and easy to integrate for IOT systems.

REFERENCES

[1] Rymanov, Vitaly, Tolga Tekin, and Andreas Stöhr. "Double mushroom 1.55-μm waveguide photodetectors for integrated E-band (60-90 GHz) wireless transmitter modules." RF and Millimeter-Wave Photonics II. Vol. 8259. SPIE, 2012.

[2] Montero-de-Paz, Javier, et al. "Compact modules for wireless communication systems in the E-band (71–76 GHz)." Journal of Infrared, Millimeter, and Terahertz Waves 34 (2013): 251-266.

[3] Palandöken, Merih, et al. "Compact metamaterial-based bias tee design for 1.55 μm waveguide-photodiode based 71–76GHz wireless transmitter." Progress in Electromagnetics Research Symposium, PIERS. 2012.

[4] U. Ozkaya, L. Seyfi. "Dimension optimization of microstrip patch antenna in X/Ku band via artificial neural network." *Procedia-Social and Behavioral Sciences*, 2015, 195, 2520-2526.

[5] Satish, K. (2015). *Jain Ayush Shrivastava*. Miniaturization of microstrip patch antenna using metamaterial loaded with SRR, IEEE: Gautam Shrivas.

[6] Palandöken, Merih, and Mustafa HB Ucar. "Compact metamaterial-inspired band-pass filter." Microwave and Optical Technology Letters 56.12 (2014): 2903-2907.

[7] Palandoken, M., and H. Henke. "Fractal negative-epsilon metamaterial." 2010 International Workshop on Antenna Technology (iWAT). IEEE, 2010.

[8] Palandoken, M., and H. Henke. "Fractal spiral resonator as magnetic metamaterial." 2009 Applied Electromagnetics Conference (AEMC). IEEE, 2009.

[9] Zhang, H., Li, Y.-Q., Chen, Xi, Yun-Qi, Fu, & Yuan, N.-C. (2009). Design of circular/dual- frequency linear polarization antennas based on the anisotropic complementary split ring resonator. *IEEE Transactions on Antennas and Propagation*,*57*(10), 3352–3355

[10] Baena, J. D., Bonache, J., Martín, F., Sillero, R. M., Falcone, F., Lopetegi, T., et al. (2005). Equivalent-circuit models for split-ring resonators and complementary split-ring resonators coupledto planar transmission lines. *IEEE Transactions on Microwave Theory and Techniques*,*53*(4), 1451–1461

[11] Zhou, L., Liu, S., Wei, Y., Chen, Y., & Gao, N. (2010). Dual-band circularly-polarised antenna based on complementary two turns spiral resonator. *Electronics Letters*,*46*(14), 970–971.