# Edge-Fed Square Truncated Circularly Polarized Antenna For Wireless LAN Communication And Medical Applications

**Tulasi Jami, M. Satya Sai Ram**

**Abstract:** ***An edge fed square truncated antenna is designed for wireless LAN and medical communication applications. The designed antenna is providing circular polarization (CP) at dual operating bands of 5.8GHz and 9.2GHz respectively. The circular polarization is achieved by controlling the current distribution over the patch and the truncated corner improved the axial ratio of antenna. The designed antenna is fabricated on FR4 substrate with permittivity 4.4 and height of 1.6 mm. A peak realized gain of 7.5dB at 5.8GHz and 6.4dB at 9.2GHz is obtained from current model. The simulation of proposed antenna model is designed with CST-microwave studio-based Antenna Magus Tool and the measured results analyzed with aniritsu combinational analyzer in anechoic chamber.***

***Index Terms: A Circular Polarization, Edge-Fed, WLAN.***

## I. INTRODUCTION

The rectangular patch microstrip antenna model is the most commonly used antenna model. The length of patch in the antenna is generally less than a half wave length in the dielectric medium and as the fringing fields will act on the patch to extend the effective length of the antenna. Microstrip antennas design are simple and low cost to design using modern printed circuit board technology, except at lower frequencies, where some copper tape and a suitable dielectric substrate may suffice if the antenna is not overly sensitive to dimensional tolerances [1-6].

The patch antenna is designed such that it radiates maximum in the normal to patch element. This is possible by properly selecting the mode of excitation below the patch [7-9]. For a rectangular patch antenna, the length of element is usually between $3^{rd}$ and half wavelength in the substrate. By incorporating various feed arrangements, circular and elliptical polarizations can be obtained with slight modifications in elements and two orthogonal excited modes with equal in amplitudes and 90°-time phase difference also, circular and elliptical polarizations can be achieved. CP can be achieved for a square patch by adjusting the corners of two sides opposite corners, to achieve quadrature phase coupling between the orthogonal TM01 and TM10 cavity modes.

For body-centric communication systems, antennas have become an essential part these days. These systems have possible applications as emergency services, surveillance and health monitoring etc. Moreover, these communication modules demand multi-band and wideband models with small size and emerging technologies [10-12]. Wearable modules prefer novel antennas of good physical model structures and good radiation characteristics.

Though the degree of freedom to select radiating patch and ground structures is good for printed monopole antennas, the optimization of antenna design become a challenging task for the engineer [13-18]. The advancement in communication systems and functional devices need one antenna model with no of operating frequencies and band selectivity case as the main objective. To have the multiple communication-based application frequencies, we need multi-band and wide-band antennas of high bandwidth and considerable gain [19-22]. Short range communication systems prefer wide bandwidth and high-speed data rates property.

## II. ANTENNA GEOMETRY

The proposed antenna consists of square patch element with impedance matching power divider setup at the feed line. The pictorial representation of designed antenna is presented in Fig 1 and the side angle of the antenna is presented as in Fig 2. The detailed dimensions are given in Table 1.

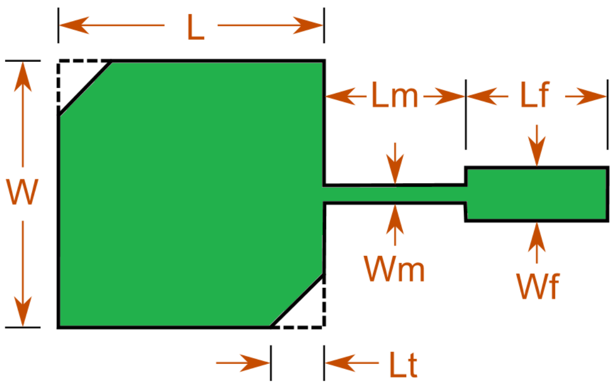


**Fig 1. Corner Truncated Antenna Model**

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**Fig 2. Designed Antenna Sideview**

**Table 1. Antenna Dimensional Parameters**

| S. No | Parameter | Description | Value |
|---|---|---|---|
| 1 | W | Patch width | 17.61 mm |
| 2 | Lt | Truncation length | 2.065 mm |
| 3 | Wm | Matching line width | 535.2 μm |
| 4 | Lm | Matching line length | 10.22 mm |
| 5 | Wf | Feed line width | 1.066 mm |
| 6 | Lf | Feed line length | 10.10 mm |
| 7 | H | Substrate height | 1.096 mm |
| 8 | εr | Relative permittivity | 2.2 |
| 9 | tanδ | Loss tangent of the substrate medium | 0.002 |

## III. RESULTS AND ANALYSIS

The patch antenna achieves a typical broadside gain of 7 dBi at the center frequency. The circular polarization leads to a far reduced performance bandwidth, limited predominantly by the axial ratio performance.

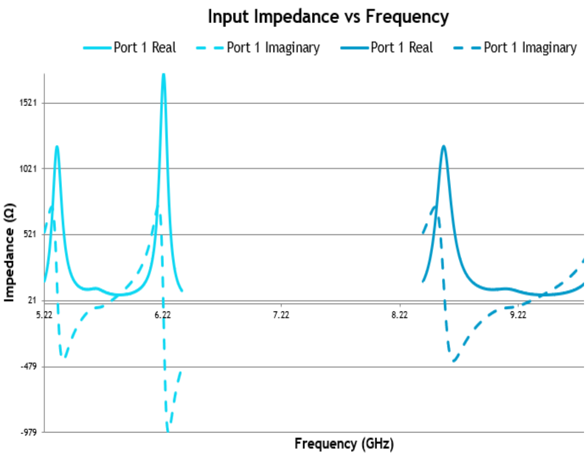



**Fig 3. Frequency Vs Impedance**

Fig 3 shows the typical impedance parameter of antenna at resonant frequency bands. The impedance is nearer to 50 ohms at two bands as shown in the figure. The magnitude of $S_{11}$ less than -10 dB at resonance bands can be observed from Fig 4. At fundamental resonant band of 5.8 GHz, an IBW of 34% and at 9.2 GHz an IBW of 21% is attained.

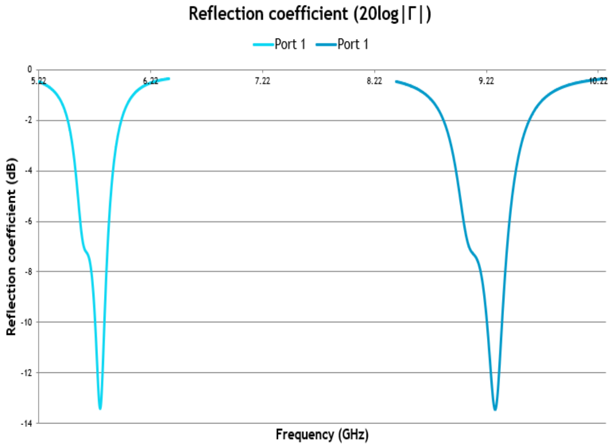



**Fig 4. Frequency Vs Reflection Coefficient**

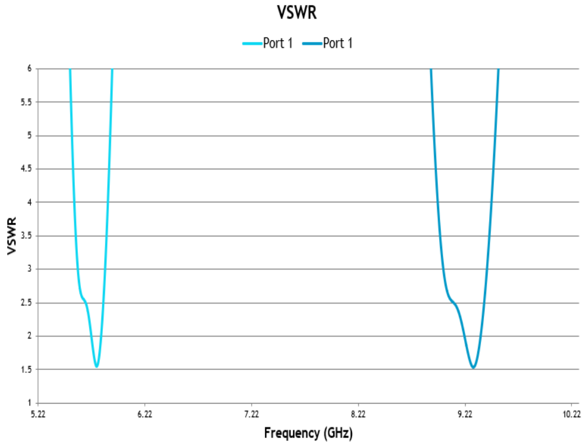
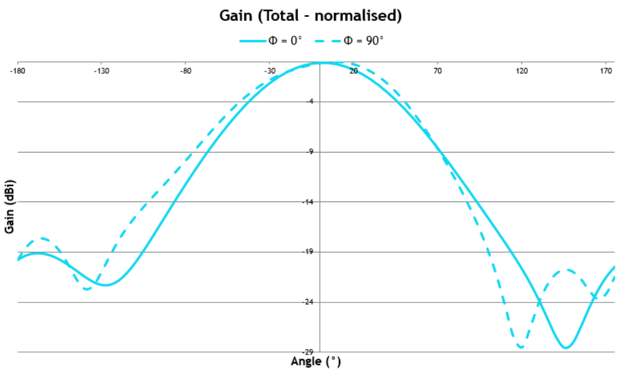



**Fig 5. Frequency Vs VSWR**

Fig 5 shows the VSWR parameter of antenna with 2:1 ratio. It gives information regarding, how much of the power reflected from the antenna device due to impedance mismatch. The reflection coefficient can be calculated from the value of the VSWR.

Reflection coefficient = -10 log [(VSWR-1)/VSWR+1)$^2$] –(1)

The radiation parameters of antenna in 2D-view presented in Fig 6. The radiation plots of Fig 7 and 8 show left hand and right-hand circular polarization. The radiation characteristics are expressed by antenna LHCP and RHCP gain in the units of dB.




(a)



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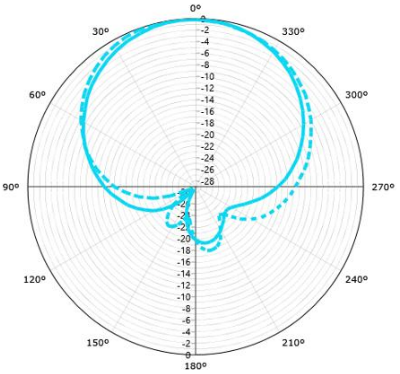
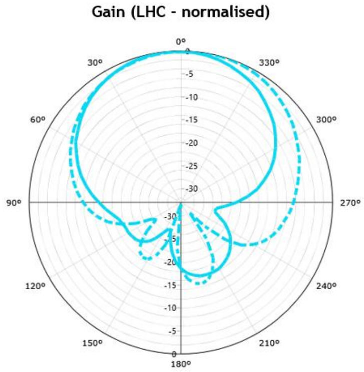
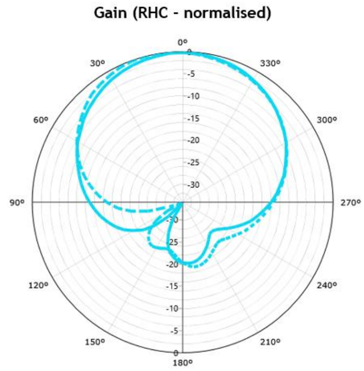



(b)

**Fig 6. Gain Total in 2D and in Polar plot at 5.8 GHz, (a) 2D, (b) Polar Plot**

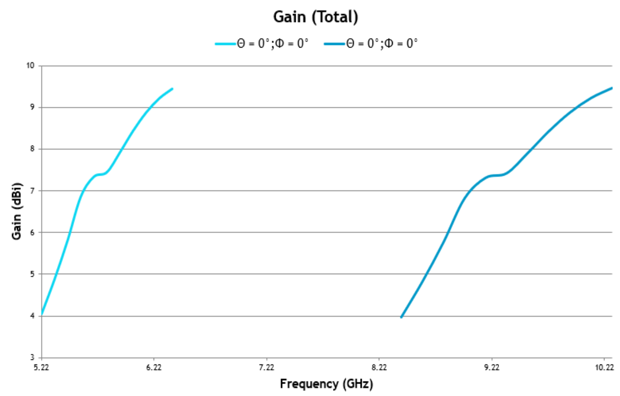



(a)

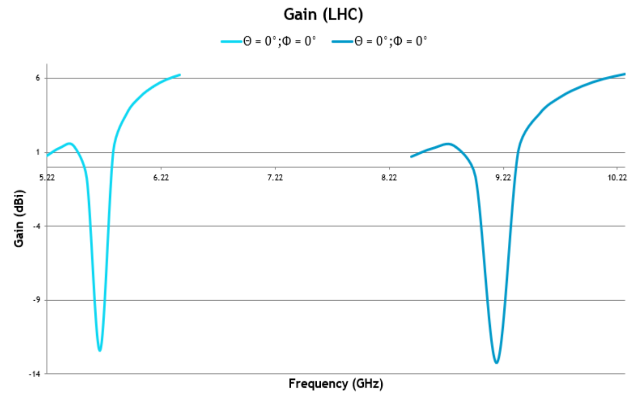



(b)

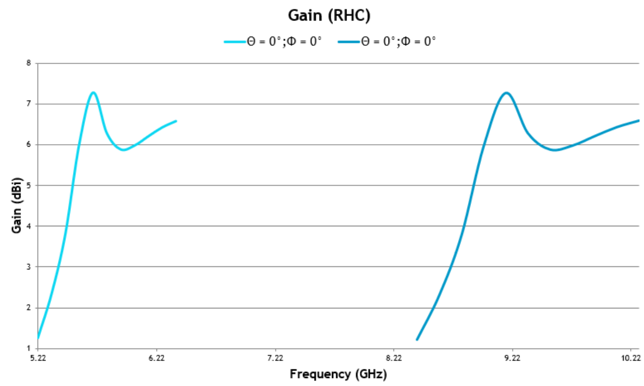
**Fig 7. Radiation Characteristics at 5.8 GHz, (a) LHCP, (b) RHCP**




(a)




(b)




(c)

**Fig 8. Gain Plot (a) Gain Total, (b) Gain LHCP, (c) Gain RHCP**

To vary the center frequency, patch width and length may be varied accordingly. However, to achieve good circular polarization, width of the patch should be equal to length of the patch. By varying matching line width with proper care, the port resistance may be varied, so that electrical length of the matching line should not be influenced. By increasing substrate thickness or height, axial ratio result will be poor. To obtain circular polarization, the truncated corners of the patch should be opposite to each other. Left hand circular and right hand circular polarizations of the antenna depend on the positions of truncated corners. Fig 9 and 10 show the axial ratio in 2D and 3D gain plots respectively..

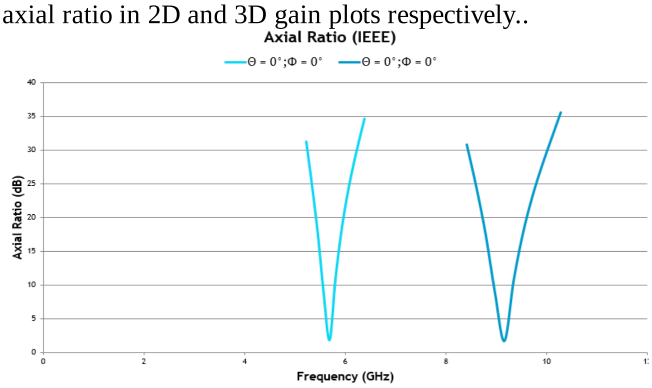
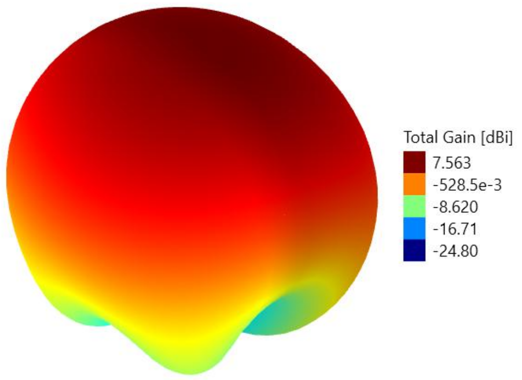
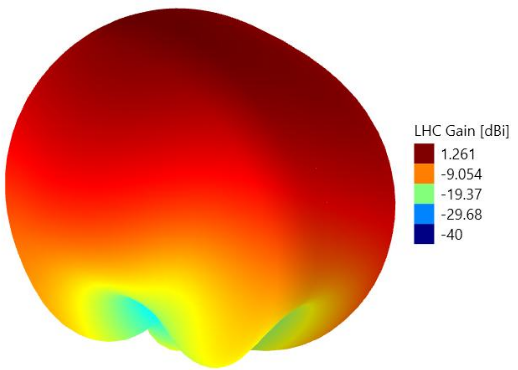


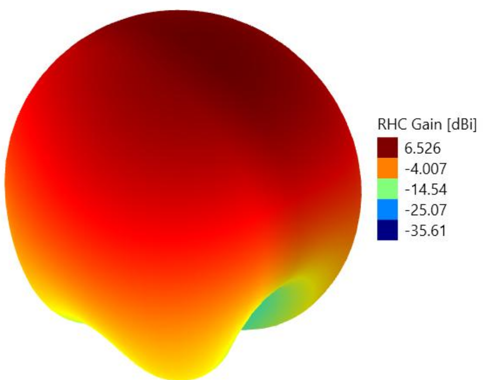

**Fig 9. Axial Ratio of proposed antenna**




**(a) Total Gain**




**(b) LHCP Gain**




**(c) RHCP Gain**

**Fig 10. 3D-Gain Plots (dB)**

DOC among info-modules plays a key role in wireless communications. To minimize the losses in mod-info, HDC between Tx and Rx signals is required. Equation (2) gives the formula to find fidelity factor, i.e. relation between two signals. Here S(t) is Tx signal and r(t) is Rx signal. To have the pulse Tx characteristics of circularly polarized designed antenna, the antenna is analyzed with face to face scenario of 50cm between them.

$$F = Max_{\tau}\left| \frac{\int_{-\infty}^{+\infty} S(t)r(t-\tau)dt}{\sqrt{\int_{-\infty}^{+\infty} S(t)^2 dt \int_{-\infty}^{+\infty} r(t)^2 dt}} \right| \quad \text{--- [2]}$$

Fig 11 shows the time-domain analysis characteristics of antenna with face to face placement between transmitting antenna and the receiving antenna. The signal transmission characteristics present here the graphical view of change in the amplitude and the shapes of the obtained signal wrt input signal. By taking the basic transmission and reception of the pulses here, they have good matching indicating the quick action of antenna to variation in I/P signal.

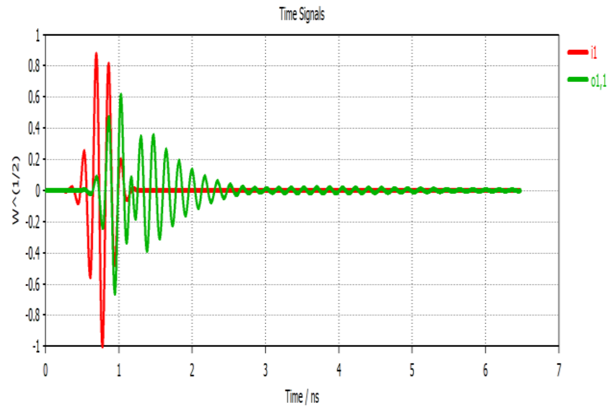



**Fig 11. Time domain analysis**

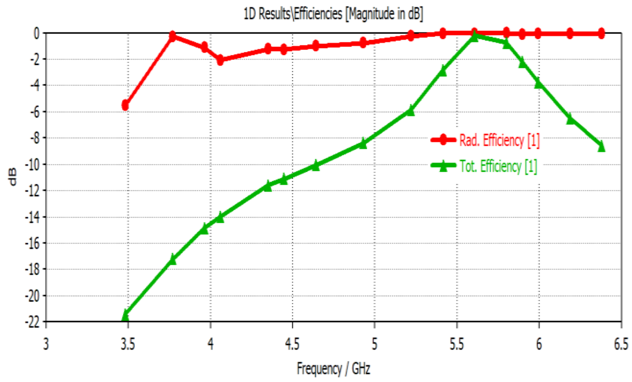



**Fig 12. Frequency Vs Efficiency**

The variation of efficiency with respect to change in frequency is presented in the Fig 12. The total efficiency is high at the resonant frequency 5.8GHz and the radiation efficiency is showing constant characteristics throughout the frequency range.

| Ref. No. | Antenna Dimensions ($mm^3$) | Operating Bands (GHz) | Gain (dB) |
|---|---|---|---|
| [3] | 46X42X1.6 | Single Band | 3.45 |
| [6] | 48X44X1.6 | Dual Band | 4.32 |
| [8] | 54X48X1.6 | Triple Band | 3.65 |
| [11] | 56X52X1.6 | Dual Band | 4.86 |
| [15] | 45X40X1.6 | Single Band | 5.28 |
| Proposed Antenna | 32X17.6X1.6 | Dual Band | 7.56 |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## IV CONCLUSION

A compact circularly polarized antenna for wireless communications and medical applications is proposed in this article. The designed antenna radiating element is occupying the dimension of 32X17.6mm$^2$ on FR4 substrate of height 1.6mm. The axial ratio is improved with truncated corners and the circular polarization is controlled through the current distribution over the radiating element. Dual band circular polarization at 5.8 GHz and 9.2 GHz with impedance bandwidth of 34% and 21% making this model as most suitable device for wireless local area network and medical communication band applications.

## REFERENCES

1. Sai Ram, Circularly Polarized Koch Fractal Triband Antenna for Communication Applications, JEAS, 10, 4, pp 5795-5801, 2015.
2. Phani, Novel Koch fractal circularly polarized micro strip antenna for global positioning system application, LEJPT, 27, pp 31-40, 2015,
3. Khan, Circularly Polarized Slotted Aperture Antenna with Coplanar Waveguide Fed for Broad band Applications, JEST, 11, 2, pp 267 – 277, 2016.
4. Krishna, High Bandwidth Circularly Polarized X-Slot Antenna, FEJEC, 16, 3, pp 561-572, 2016.
5. Raman, Analysis of Circularly Polarized Notch Band Antenna With DGS, JEAS, 11,17, 2016.
6. Rahiman, Circularly Polarized Defected Ground Broadband Antennas for Wireless Communication Applications, LNEE, 434, pp. 419-427, 2017.
7. Priya, Defected Ground Structure Circularly Polarized Wideband Antennas for Wireless Communication Applications, JARDS, 9,18, pp. 122-130.
8. TVRK, Design of CPW fed F-shaped circularly polarized antenna for amateur radio vehicular communications, IJET, 7, 1, 360-365, 2018.
9. Khan, X-Slotted Circularly Polarized Antenna with Parasitic Patches, IJET, 7, 1, pp. 534-538, 2018.
10. M V Rao, Metamaterial inspired quad band circularly polarized antenna for WLAN /ISM/ Bluetooth/ WiMAX and satellite communication applications, AEU-IJECE, 97, 229-241, 2018.
11. N V S, Design and analysis of printed dual band planar inverted folded flat antenna for laptop devices, FEJEC, 16, 1, pp. 81-88, 2016.
12. Prudhvi B, Asymmetric Ground Structured Circularly Polarized Antenna for ISM and WLAN Band Applications, PIER M, 76, 2018, Pp 167–175.
13. Ramkiran, Coplanar Wave Guide Fed Dual Band Notched MIMO Antenna, IJECE, 6, 4, 1732 - 1741, 2016.
14. Jyothi, A Novel Compact CPW- Fed Polarization Diversity Dual Band Antenna using H-Shaped Slots, IJST, 9, 37, 1 - 8, 2016.
15. Prakash, Dual Band Notch MIMO antenna with meander slot and DGS for ultra-wideband applications, JEAS, 12, 15, pp. 4494-4501, 2017.
16. Murthy, Polarization and Frequency Reconfigurable Antenna for Dual Band ISM Medical and Wi-Fi Applications, IJET , 7, 3, pp 651-654, 2018.
17. Manikanta, Analysis of Defected Ground Structure Notched Monopole Antenna, JEAS, 10, 2, 747 - 752, 2015.
18. Naidu, Fractal aperture EBG ground structured dual band planar slot antenna, IJAER, 9, 5, pp. 515 - 524, 2014.
19. [19] Mohan, Trident Shaped Ultra Wideband Antenna Analysis based on Substrate Permittivity, IJAER, 8, 12, pp.1355-1361, 2013.
20. Mounika, CPW Fed Antenna for Wideband Applications based on Tapered Step Ground and EBG Structure, IJST, 8, 9, 119-127, 2015.
21. VGKM, Liquid Crystal Bow-Tie Microstrip antenna for Wireless Communication Applications, JESTR, 4, 2, pp.131-134, 2011.
22. Ram Kiran, Novel compact asymmetrical fractal aperture Notch band antenna, LEJPT, 27, 2, 1-12, 2015.