2019 5th International Conference for Convergence in Technology (I2CT)
Pune, India. Mar 29-31, 2019

Dual Polarized Patch Antenna Design for LTE and WLAN Application

Anita Shinde
Department of E&TC, PG Student,
Amrutvahini college of Engg,
Sangamner,422605,India
anitashinde987@gmail.com

Prof. Mahesh B. Kadu
Department of E&TC, Faculty of
Amrutvahini college of Engg,
Sangamner,422605,India
mahesh.kadu@gmail.com

Dr. Rekha P. Labade
Department of E&TC, Faculty of
Amrutvahini college of Engg,
Sangamner,422605,India
rplabade@gmail.com

***Abstract*—This paper describes design of microstrip patch antenna validating dual band and dual polarization behavior of radiations for the multi-band communication applications. Designed antenna has been simulated for 2.40 GHz of resonance frequency having geometrical extents of 38 mm X 49 mm providing dual band behavior comprising Long Term Evolution (LTE) 4-G band (2.40 GHz – 2.49 GHz) and WLAN band (5. 35 GHz - 5. 85 GHz). Inserting slots on the radiating corners of patch width has been carried to accomplish the circular polarized (CP) by utilizing the identical geometry. Among the two bands, LTE bad is operated in linear polarization where, WLAN band is committed to operate in circularly polarized feature with ≤ 3dB axial ratio, giving orthogonal E-field circulations at WLAN band. Single feeding mechanism provides CP operations and the designed geometry accomplishes the straightforwardness about simplicity in the radiating antenna structure.**

Keywords*—CADFEKO; dual polarization; LTE; patch antennas; WLAN.

I. Introduction

Wireless transmission schemes were discovered with a wide extension in design and development of communicating antennas. The radio antenna structures must be designed and developed that fulfilling fundamental transmitting properties and protocols which are specified by regulatory radio communication agencies and institutes.

Essentially antennas will be utilized to transmit radio waves at specific frequencies and distance with desirable abilities as return loss, VSWR, transmission bandwidth, polarization, impedances [1].

On respects with wireless communication systems, radio antennas must be adjusted with same physical alignments between transmitting and receiving ends. If those antennas are not aligned at the same orientating plane, then the issue of cross polarization may occurs within the communicating antenna systems and hence leads the miscommunication among them. The similar assignment of antennas toward reception end representable the linear polarizing (LP) wireless communication indicating antennas are aligned in the same plane of orientation either horizontal or vertical. [2]

CP antennas could make profits of diverged orientations in between of transmitting and receiving communication systems. Also, radio wire placements don't bring huge impacts once bandwidths and other performance parameters of radiating antennas. Those CP can be generated by utilizing two orthogonal feeds, same amplitudes but -π/2 phase contrasts around these two feeds and or by utilizing single feed geometry and truncating the patch coroners at the width-edges [5]-[8].

In this proposed work detailed investigation and examination of double band double polarized antenna approach is presented. The proposed antennas consist truncations at radiating corners and single feed mechanism to operate this antenna at LTE and WLAN frequency bands.

II. Geometry of the Dual band Patch Antenna

Proposed antenna design has been started by selecting lower edge resonance frequency of 2.40 GHz providing the simple geometry without truncations on its corners. Antenna has been designed by considering the transmission line formulae of antenna designing theory listed in (1) to (4) [8].

The geometrical details of suggested dual band antenna are shown in Fig. 1. The structure of the proposed antenna is simulated on FR4 glass epoxy material with loss tangent tanδ

$$Fr = \frac{\upsilon o}{2Lp} * (\varepsilon r)^{-\frac{1}{2}} \tag{1}$$

$$Wp = \frac{C}{4fr} * (\varepsilon \mathrm{e} + 1)^{-\frac{1}{2}} \tag{2}$$

$$\mathcal{E}reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2\sqrt{\left(1+\frac{12h}{W}\right)}} \tag{3}$$

$$Leff\ =\ 0.25\lambda r * (\varepsilon eff)^{-\frac{1}{2}} \tag{4}$$

$$\lambda r = \frac{C0}{fr} * (\varepsilon eff)^{-\frac{1}{2}} \tag{5}$$

$$\Delta\mathrm{L}{=}\frac{\Delta\mathrm{L}}{\mathrm{h}} = 0.412\left(\frac{(\mathcal{E}\mathrm{reff}+0.3)\left(\frac{\mathrm{W}}{\mathrm{h}}+0.264\right)}{(\mathcal{E}\mathrm{reff}-0.258)\left(\frac{\mathrm{W}}{\mathrm{h}}+0.8\right)}\right) \tag{6}$$

$$Lp =\ Leff - \Delta L \tag{7}$$

value of 0.02 and relative permittivity of which is 4.4. Substrate has dimension of 38mm X 49mm X 1.6mm. For good impedance matching over wide bandwidth, the patch dimensions are carefully adjusted having dimension of rectangular path is Wp=29mm, Lp=28mm and feed of 21mm X 3 mm respectively. Circular polarizations has been achieved by symmetrical truncations of radiating corners and slotting over the patch with ΔL=6 mm

Antenna has been excited using the Microstrip fed technique. Advantages of microstrip feeding are low spurious radiation, easy fabrication, easy to match.

The proposed dual band microstrip antenna is examined on 1.6 mm thick dimensions [9]-[11]. The infinite rear-ground plane is considered to achieve multiband operation from the designed antenna. Table I. shows all dimension of proposed rectangle patch antenna.

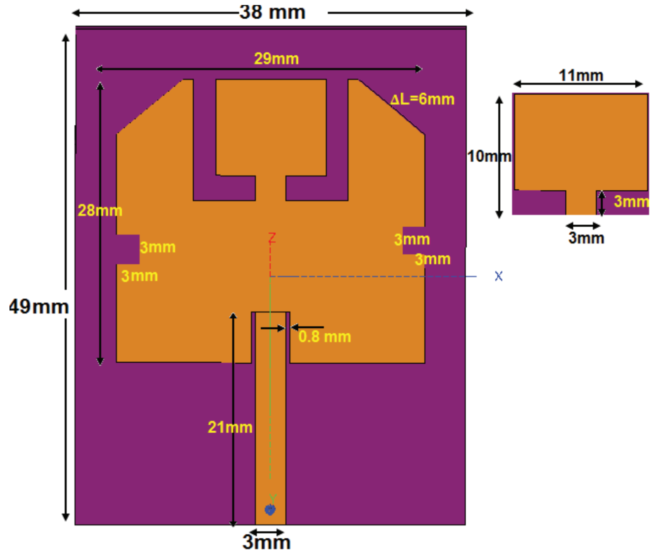


Fig. 1.Geometrical detailsof the dual band rectangular Microstrip patch antenna.

TABLE I. DIMENSION OF PROPOSED ANTENNA

Parameters	Value
Fr	2.40 GHz
$\in r$	4.4
H	1.6 mm
Lf	21 mm
Wf	3 mm
Lp	28 mm
Wp	29 mm
Ls	49 mm
Ws	38 mm
ΔL	6 mm

III. Results and Analysis

The antenna designing is accomplished by MOM based CADFEKO EM-simulation software [12]. The structure development of the proposed double band antennae is seemed in Fig. 2.Feed bevel is utilized having 0.8 mm spacing to achieve the matched impedance condition from the designed antenna. Patch truncation at radiating coroners are carried out to achieve orthogonal current distributions at operating bands hence attains circular polarization operation.

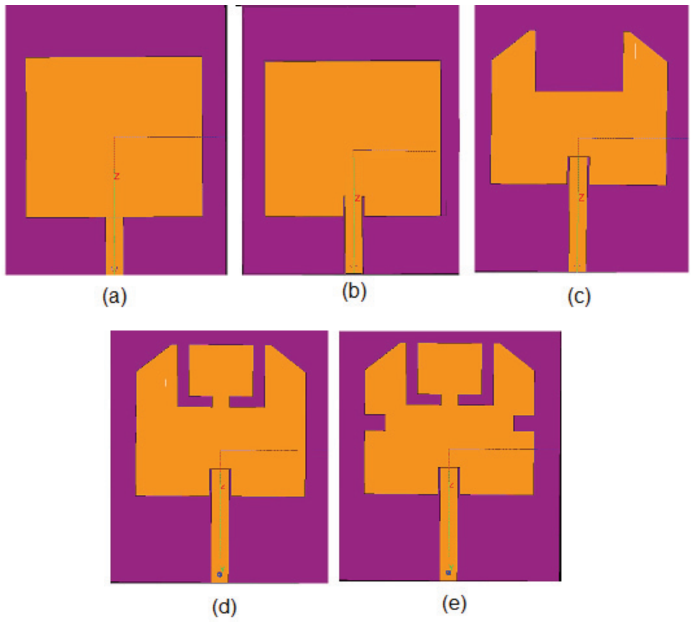


Fig. 2. Development of the proposed antenna.

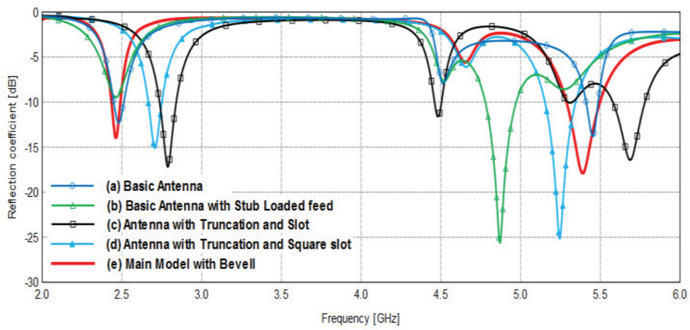


Fig. 3. Return loss plot of respective design.

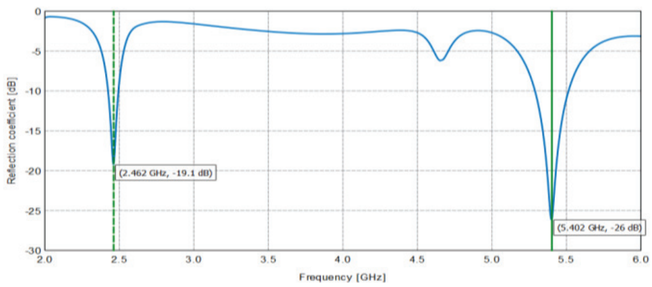


Fig. 4.Plot of return loss with simulated frequency.

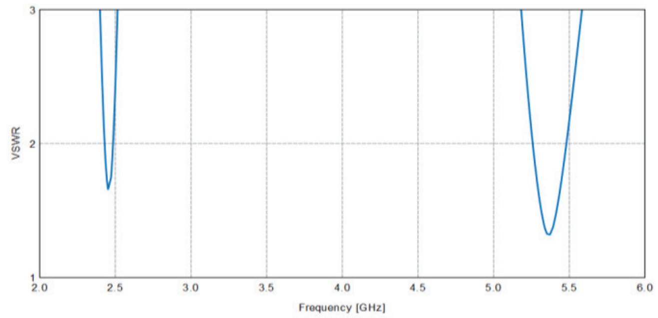
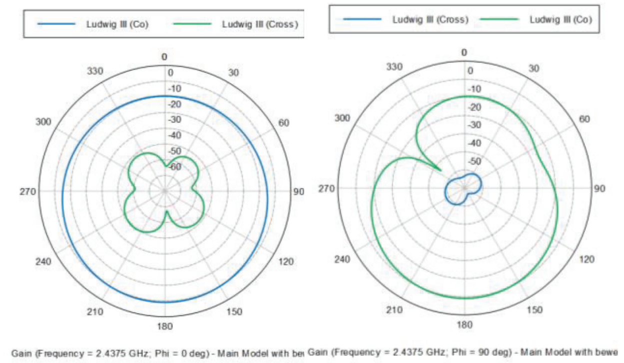


Fig. 5. Plot of VSWR as a function of frequency.

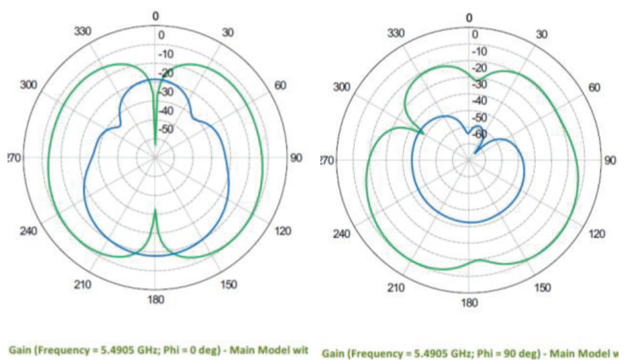
The reflection coefficient (S11) of designed element is visualized in Fig. 3 and 4, where it may be seen that the proposed antenna displays two reverberating modes at 2.40 GHz and 5. 5GHz frequencies consequently making the designed antenna appropriate for both LTE and WLAN bands.

The VSWR plot the proposed antenna is shown in Fig. 5. VSWR of proposed antenna lies between1 to 2 at LTE and WLAN band OF working frequencies

The simulated antenna radiating performance in terms of the co-polar and cross-polar considerations are shown in Fig. 6 for at resonating frequencies of LTE-2.4 GHz (a) and WLAN-5.5 GHz (b). Proposed antenna shows radiation pattern nearly omnidirectional in H-plane and bi-directional in E-plane, provided that antenna has good radiating properties at their operating bands.



(a)



(b)

Fig.6. Radiation patterns of proposed antenna at 2.4 GHz and 5.5 GHz.

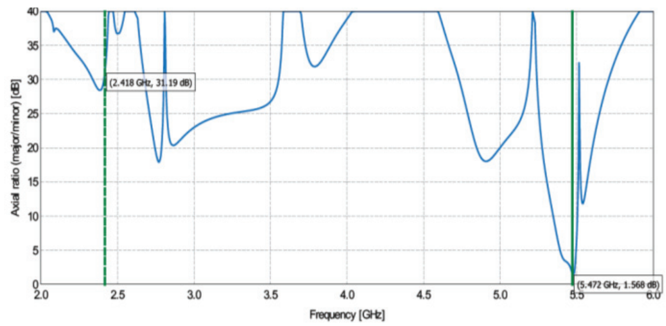


Fig.7. Plot of Axial ratio for at 2.4GHz and 5.5 GHz bands.

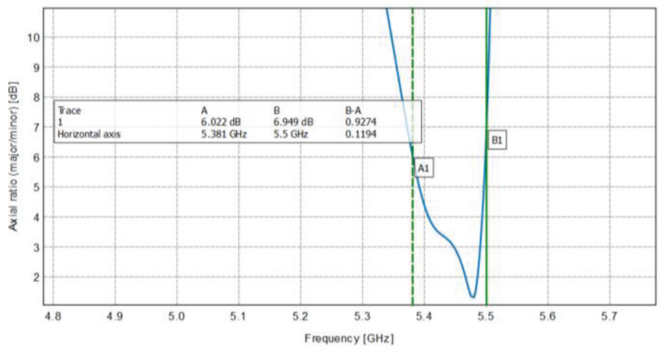
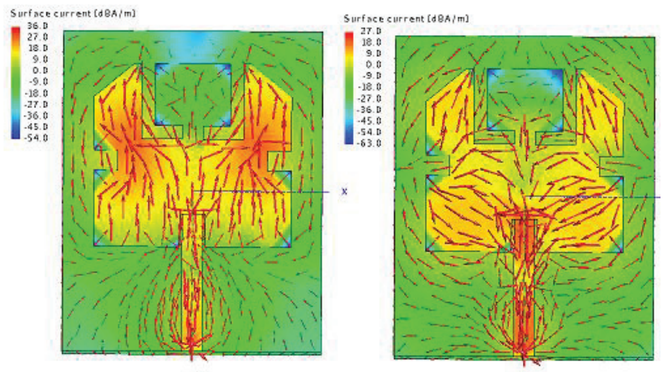


Fig.8. Plot of Axial ratio at 5.5 GHz.

Simulated antenna axial ratio plot at all simulating frequencies are shown in Fig. 7. It can be observed that simulated LTE band obeys 40 dB of axial ratio at LTE-2.40 GHz and WLAN band obeys 1.56 dB axial ratio at 5.44 GHz frequency hence LTE band follows linear polarization operation where, WLAN band follows circular polarized operation having 119 MHz of axial ration bandwidth as shown in Fig. 8.

From Fig. 9 it has been noticed that, simulated current distribution at LTE frequency (2.4 GHz) has linear distribution obeying linear polarized operation. Simulated current at WALN band obeys orthogonal current distribution fields providing two currents over the patch at WLAN band (5.5 GHZ) hence simulated WLAN band is circularly polarized functioning band.



(a) (b)

Fig.9. Simulated instantaneous current magnitudes of designed antenna at (a) 2.4 GHz and (b) 5.5 GHz.

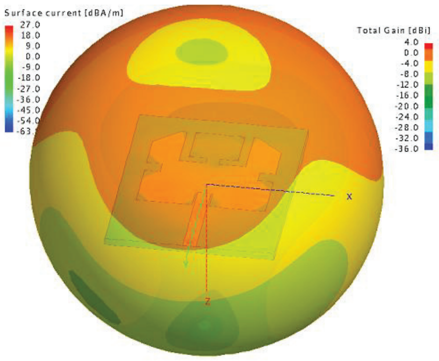


Fig.10. Simulated 3-D gain distribution of proposed antenna.

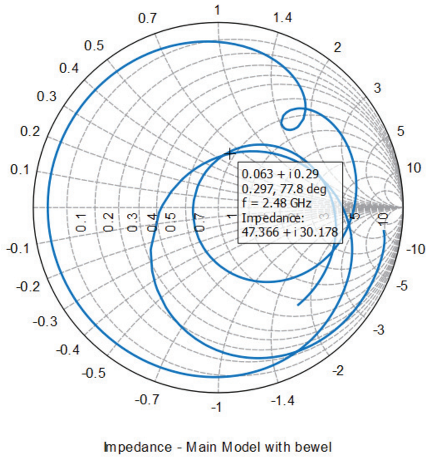


Fig.11. Simulated Schmitt chart of proposed antenna.

Simulated antenna total gain in dBi is shown in Fig. 10. Simulated antenna archives 4.0 dBi of total isotropic gain in all operating frequencies.

Simulated impedance chart of proposed antenna shown in the Fig. 11. Designed antenna obeys matched 50 ohm impedance at LTE and WLAN bands at its excitation port.

IV. CONCLUSION

Development of dual band and dual polarized microstrip patch antenna for LTE and WLAN applications has been presented. Proposed antenna works under the linearly polarized LTE band of 2.40 GHz to 2.49 GHz band with ≤ -10 dB return loss. Designed antenna also exhibits WLAN band of 5.35 GHz to 5.85 GHz with circularly polarized operating characteristics with 117 MHz of ≤ 6 dB axial ratio bandwidth. Hence proposed antenna shows dual polarized operating behaviour at LTE and WLAN bands with ≤ -10 dB reflection coefficient magnitudes. Antenna current distributions at LTE band are in linear directions where, at WLAN and formation of orthogonal current distributions are observed. Truncation of radiating coroners is carried out to achieve the circular polarizing WLAN band. Proposed antenna attains 4.0 dBi of isotropic gain at all simulating frequencies. Proposed antenna has good remedy for existing faded wireless communication network.

REFERENCES

[1] D. Pozar, "Microstrip Antennas: The Analysis and Design of Microstrip Antennas", IEEE Press, 1995.

[2] Y. Lin, S. Lin H. Chen, "A new coupling mechanism for circularly polarized annular-ring patch antenna," IEEE Trans. Antennas Propag., vol. 56, pp. 11–16, Jan. 2008.

[3] Hemanth Sampath, Vinko Erceg, "Dual-polarization versus single-polarization MIMO channel measurement results and modeling", IEEE Trans. on wireless comm., vol. 5, January 2006.

[4] R. P. Labade, Narayan Pisharoty, S. B. Deosarkar, "Circularly polarized microstrip antenna for WLAN", IEEE, December 2012.

[5] Nasimuddin, K. P. Esselle, "Wideband circularly polarized stacked microstrip antennas," IEEE Antennas Propag. Lett., vol. 6, pp. 21–24, January 2007.

[6] C. Balanis, "Antenna Theory, Analysis and Design" second edition, John Wiley and Sons, New York, 1997.

[7] K. P. Ray and Girish Kumar, "Broadband Microstrip Antennas", Artech House: Boston.

[8] P. Bhartia and R. Garg, "Microstrip Antenna Design Hand- book", Artech House: Boston2001.

[9] Azar, J. E K Graebner, "Experimental determination of thermal conductivity of printed wiring boards", Proceedings of the Twelfth IEEE Semi-Therm Symposium, March 1996.

[10] H. Huang, Y. Liu, S. X. Gong, "Broadband dual-polarized omnidirectional antenna for 2G/3G/LTE/WIFI applications", IEEE Antennas Wireless Propag. Lett., vol. 15, pp. 576-579, 2016.

[11] X. L. Quan, R. L. Li, "A broadband dual-polarized omnidirectional antenna for base stations", IEEE Trans. Antennas Propag., vol. 61, no. 2, pp. 943-947, Feb. 2013.

[12] CADFEKO Manual for Suite 6.2