Compact Broadband Cup Shaped Monopole Patch Antenna for Modern Communication System

Pawan Kumar Jain[1,2], Braj Raj Sharma[1], K. G. Jangid[2], Sumita Shekhawat[2], D. Bhatnagar[2]
[1]Department of Physics, Swami Keshvanand Institute of Technology, Management &Gramothan, Jaipur, 302017 (INDIA)
[2]Microwave Lab, Department of Physics, University of Rajasthan, Jaipur-302004 (INDIA)
Email - pawan_hep@gmail.com
Received 15.10.2018 received in revised form 13.12.2018, accepted 15.12.2018

Abstract: This paper exhibits the design and performance of microstrip feed modified cup shaped patch antenna with monopole ground with overall size 32 mm × 28 mm × 1.59 mm. The simulator, which is used for optimization is CST Microwave studio 2014. Proposed antenna renders broadband extended between frequency range of 2.57- 6.57 GHz, with flat gain (close to 3-4 dBi). This antenna may be a useful tool for WLAN, Wi-MAX communication bands and lower as well as median UWB bands.

Keywords: Cup shaped patch, CST Microwave Studio, Monopole ground, UWB

1. INTRODUCTION

In modern wireless communication system, compact size and broadband antennas play a crucial role [1-2]. IEEE 802.11 and IEEE 802.16 standards allocated 2.4/5.2/5.8 GHz WLAN bands and 2.5/3.5/5.5-GHz Wi-MAX bands respectively. These bands have wide applications in smart phones, hand hold computers and various wireless portable devices. In present scenario of modern wireless communication system, designing of antennas for covering all these bands with characteristics of low profile, compact size, omni-directional pattern are challenging task for researchers [3-5]. Monopole antennas have the advantages of wide bandwidth, easy impedance matching, and good radiation efficiency. There are various reported antenna designs for these wireless communication systems, but the most are narrowband or dual-bands structure [6-8].

In this communication, a modified cup shaped patch structure with monopole ground is discussed. This antenna is simulated in free space and its performance is reported in next sections.

2. ANTENNA DESIGN AND RESULT ANALYSIS

The front and back geometrical parameters of proposed planar antenna are accessible in Figure 1. A 1.59 mm thick FR-4 substrate with loss tangent 0.025 and relative permittivity (ε_r) = 4.4 is utilized for the proposed design. In this structure, we discussed a cup shaped modified patch antenna structure which is the combination of an elliptical patch and rectangular patch to get enhanced performance. The dimensions of the antenna are selected to resonate in the desired frequency band allocated for the WLAN/Wi-MAX/UWB communication systems. A width of 1.9 mm feed lines is used to excite the proposed patch structure. The optimized parameters of the proffered structure are reported in table 1 & 2.

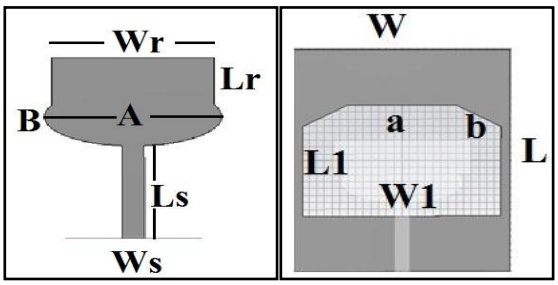

Figure 1: Front and back view of proposed antenna structure

Table 1 : Optimized Dimensions of Patch Structure

Dimension of proposed antenna design	Value (in mm)
Semi major axis of elliptical patch (A)	15.56
Semi minor axis of elliptical patch (B)	6
Length of rectangular part of patch (Lr)	4.77
Width rectangular part of patch (Wr)	14.2
Width of feed line (Ws)	1.9
Length of feed line (Ls)	10.1

Table 2: Optimized Dimensions of Ground

Dimension of proposed antenna design	Value (in mm)
Length and Width of the Substrate/ Ground (L× W)	32×28
Length of cut (L1)	16.0
Width of cut (W1)	25.7
Dimension of arm (a) in cut	14
Dimension of arm (b) in cut	6.62

Variation of simulated reflection coefficient (S_{11}) with frequency for cup shaped monopole patch antenna is indicated in fig.2. A clear and efficient resonance is observed at frequencies 3.026 GHz, 4.825 GHz and 5.849 GHz in the simulation results. The impedance bandwidth of cup shaped monopole patch antenna is approximately 4 GHz in the desired frequency range 2.57 GHz - 6.57 GHz.

The simulated variation of VSWR with frequency has shown in Fig.3. The value of VSWR at all resonance in the desired bandwidth range is less than 2, which shows that the considered antenna has an excellent matching.

The simulated input impedance of antenna at three different resonant frequencies 3.02 GHz, 4.82 GHz and 5.84 GHZ are (50.56+j-0.01) ohm, (49.73+j0.12) ohm and (50.11-j1.69) ohm respectively shown in figure 4. These results also indicate excellent matching between the feed network and antenna structure.

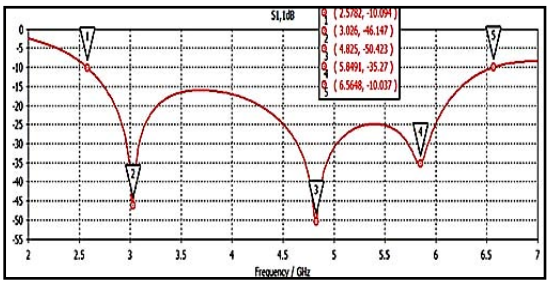

Figure 2: Variations of reflection coefficient with frequency

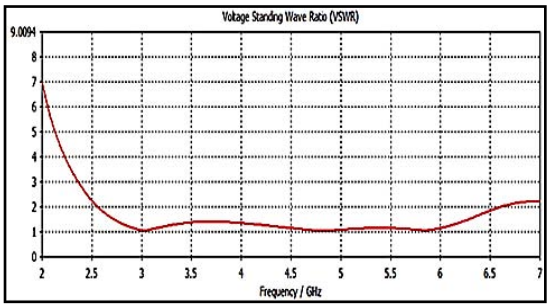

Figure 3: Variations of VSWR with frequency

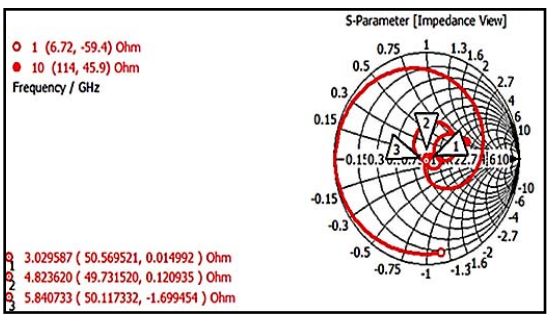

Figure 4: Variation of Input impedance with frequency

The simulated variation of gain with frequency of the proposed antenna has shown in figure 5. The simulated results show that the gain values of the antenna in the operating frequency range is constant and approximately equal to 3.5 dBi which is quite acceptable for compact size and lossy dielectric material i.e. FR-4.

The two dimensional simulated E- and H-plane radiation patterns of antenna obtained at three resonance frequencies 3.02 GHz, 4.82 GHz and 5.84 GHz has shown in Figure 6(a), 6(b) and 6(c), respectively. The E-plane patterns at these frequencies are almost omni-directional and resemble with those of a monopole antenna structures.

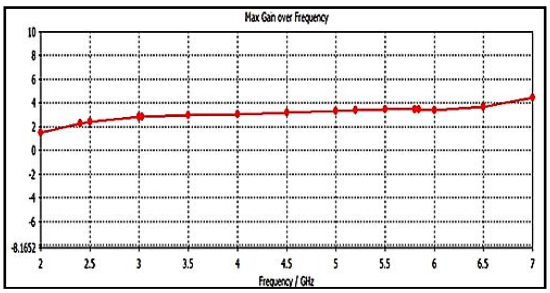

Figure 5: Variations of gain with frequency

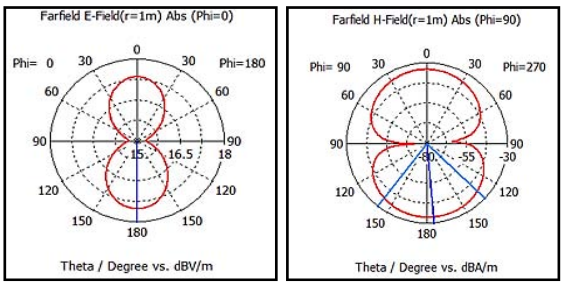

Figure 6(a): E-field and H- radiation pattern for frequency 3.02 GHz.

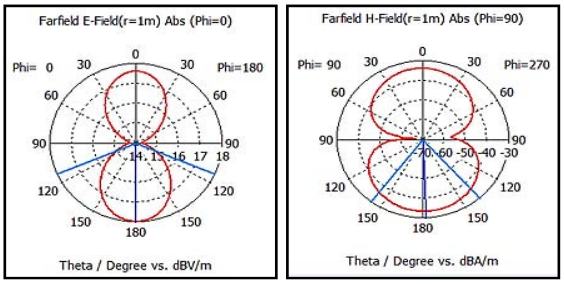

Figure 6(b): E-field and H- radiation pattern for frequency 4.82 GHz.

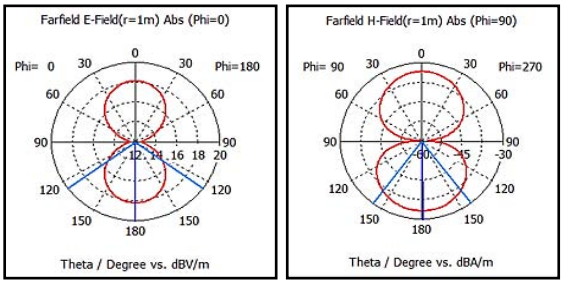

Figure 6(c): E-field and H- radiation pattern for frequency 5.84 GHz.

3. CONCLUSION

In this paper, the design and performance of a microstrip feed modified cup shaped patch antenna with monopole ground is reported. This antenna resonates at three frequencies 3.02GHz, 4.82 GHz and 5.84 GHz with wide impedance bandwidth of 4GHz between frequency range of 2.57- 6.57 GHz, and flat gain (close to 3-4 dBi).The radiation pattern at different resonates frequencies are omni directional. The proposed antenna is compact in size and gives excellent performance so that it can be very useful in various WLAN / Wi-MAX/UWB bands systems for wireless communication applications.

5. ACKNOWLEDGEMENT

Authors are thankful to Swami Keshvanand Institute of Technology, Management and Gramothan for providing necessary support for carrying out present work.

REFERENCES

[1] J. Anguera, A. Andújar, M.C. Huynh, C. Orlenius, C. Picher, and C. Puente, "Advances in antenna technology for wireless handheld devices" , International Journal on Antennas and Propagation, (2013), 1-25, 2013.

[2] K.L. Wong, Planar Antennas for Wireless Communications," Wiley Inter-Science: New York, 2003.

[3] S. S. Huang, J. Li and J. Z. Zhao, "A novel compact planar triple band monopole antenna for WLAN/Wi-MAX applications" , Progress in Electromagnetics Research Letters, (2014), 50, 117–123.

[4] A. Mehdipour, A. R. Sebak, C. W. Trueman, and T. A. Denidni, "Compact multiband planar antenna for 2.4/3.5/5.2/5.8-GHz wireless applications" , IEEE Antennas Wireless Propag Lett, (2012), 11, 144-147.

[5] L. Xu, Z. Y. Xin, and J. He,"A compact triple band and fork shaped antenna for WLAN/Wi-MAX applications," Progress in Electromagnetics Research Letters, (2013), 40, 61-69.

[6] K. G. Jangid, P. K. Jain, B. R. Sharma, V. K. Saxena, V. S. Kulhar and D. Bhatnagar, "Ring slotted circularly polarized U-shaped printed monopole antenna for various wireless application", Advance Electromagnetics, (2017), 6(1), 70-76.

[7] J. Kaur, R. Khanna, and M.A. Kartikeyan, "Novel dual band multistrip monopole antenna with defected ground structure for WLAN/ IMT/ BLUETOOTH/ Wi-MAX applications", International Journal of Microwave and Wireless Technologies, (2014), 6, 93-100.

[8] K. G. Jangid, P. K. Jain, Neelam Choudhary, Brajraj Sharma, V. K. Saxena, V. S. Kulhar and D. Bhatnagar, "U-shaped slots loaded patch antenna with defected ground plane for multiband modern communication systems", Journal of Engineering Science and Technology, (2018), 13(5), 1396-1410.