International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P), Volume-5, Issue-2, June 2016

High Gain Pentagonal Slotted Microstrip Patch Antenna Design for Radio Location Applications

Gurnoor Singh Brar, Jaspreet Singh, Ekambir Sidhu

***Abstract*— This paper presents a novel microstrip antenna design for radio location application. The antenna employs FR4 material as a substrate having dielectric constant of 4.4. The patch, ground and feed are made of copper material. The proposed antenna is rectangular in shape having pentagonal slot in the patch which resonates at 3 GHz with an impedance bandwidth of 28MHz (2.99GHz-3.02GHz) and return loss of -41.12dB. The performance of the proposed antenna has been analysed in terms of gain(dB), directivity(dBi), return loss (dB), VSWR and impedance. The VSWR of proposed antenna is less than 2 at resonating frequency 3GHz. The proposed antenna has gain and directivity of 7.13dB and 6.64dBi respectively. The antenna has been designed and simulated using CST Microwave Studio 2014.**

***Index Terms*— dB, Directivity, Gain, GHz, MHz, Pentagonal slot, Radio Location applications, VSWR**

I. INTRODUCTION

Nowadays, the communication systems are becoming compact in size and hence, the compact antenna with enhanced performance are required for modern communication systems [1][2][3]. The microstrip patch antenna, also acknowledged as patch antenna, is usually fabricated on a dielectric material which acts as an intermediate between radiating patch and ground surface [4]. The size of the antenna depends on the dielectric constant of the substrate. Higher is the dielectric constant, lower is the size of the antenna [5]. The return loss of the microstrip patch antenna can be improved either by using slotted patch [6][7] or a reduced ground [8][9]. These techniques can also be used to improve the return loss along with bandwidth enhancement. The antenna can be fed by various feeding methods like coaxial feed, proximity coupled microstrip feed and aperture coupled microstrip feed [10]. The different shapes of slots have different effect on antenna parameters. Slotting tends to improve the antenna performance in terms of return loss, bandwidth and VSWR [11].

Microstrip patch antenna has been commonly used for wireless applications because of its miniaturization, low cost, light weight, ease of fabrication, ease of mobility and better efficiency. However, the microstrip patch antenna suffers from drawbacks also such as it handles less power and has limited bandwidth [12].

Gurnoor Singh Brar is a student of Department of Electronics and Communication Engineering, Thapar Polytechnic College, Patiala, India

Jaspreet Singh is a student of Department of Electronics and Communication Engineering, Punjabi University, Patiala, India

Ekambir Sidhu is Assistant Professor in Department of Electronics and Communication Engineering, Punjabi, University, Patiala, India since 24th Sept 2012. He is IEEE member and Associate member of IETE (Institute of Electronics and Telecommunication Engineering)

II. ANTENNA GEOMETRY

The proposed antenna is rectangular in shape and has pentagonal slot of radius 10mm. The FR4 (Flame Retardant) material of thickness 1.57 and having 4.4 dielectric constant is used as the substrate for the proposed antenna. Fig. 1(a) and Fig. 1(b) demonstrate the geometry of the proposed antenna. In the proposed antenna patch, the ground and feedline are made of copper material having thickness of 0.02mm. The geometry of the proposed antenna having patch, ground, substrate and feedline is shown in fig. 1(c). The dimensions of the proposed antenna have been tabulated in TABLE I.

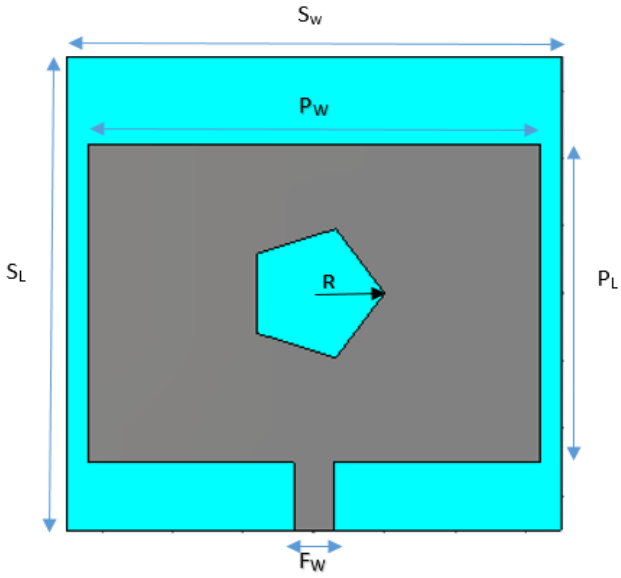

Fig.1 (a) Top view of the proposed system

Fig.1 (b) Bottom view of the proposed antenna

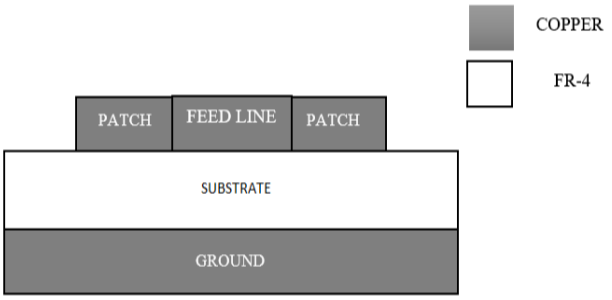

Fig. 1(c) Front view of the proposed antenna

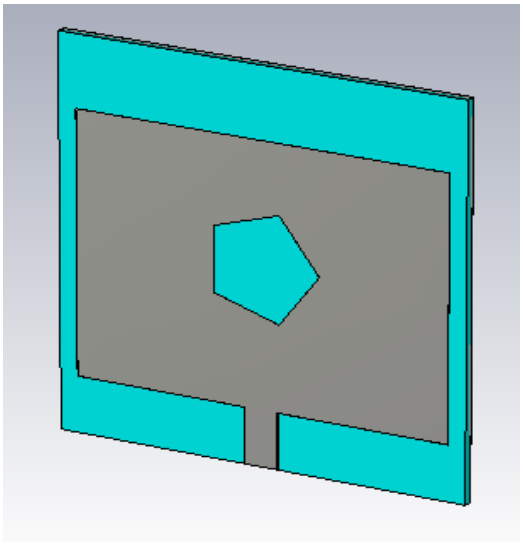

Fig. 1(d) 3-D view of the proposed antenna

TABLE 1. ANTENNA DIMENSIONS

S.No	Parameters	Value(mm)
1.	Length of substrate, S_L	70
2.	Width of substrate, S_W	70
3.	Length of patch, P_L	47
4.	Width of patch, P_W	64
5.	Width of Feedline, F_w	5.7
6.	Radius of slot, R	10

III. RESULTS

In this section, the analysis and simulation for various parameters of the proposed system has been carried out by using CST Microwave Studio 2014. The performance of the antenna has been analyzed in terms of various parameters like gain(dB), directivity(dBi), return loss (dB), VSWR and impedance (ohms). The return loss plot illustrates that antenna is resonant at 3 GHz having return loss of -41.12dB as shown in Fig. 2. The Smith chart of the proposed antenna is shown in Fig.3 which clearly illustrates that antenna has impedance of 49.31 ohms which perfectly matches with the impedance of input SMA connector required to feed the input signal to the antenna. The Fig.3 and Fig.4 illustrates that the proposed antenna has gain and directivity of 7.13dB and 6.64dBi. The VSWR plot of the proposed antenna has been shown in Fig.5 which illustrates that value of VSWR is less than 2 at resonant frequency of the antenna i.e 3GHz. The power flow pattern of the proposed system is shown in Fig.6.

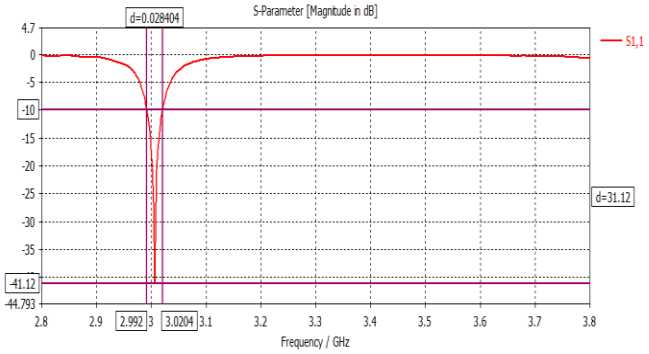

Fig. 2 Return loss plot of the proposed antenna

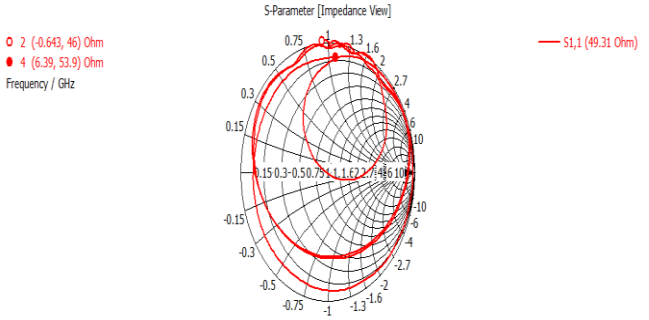

Fig. 3 Smith chart plot of the proposed antenna

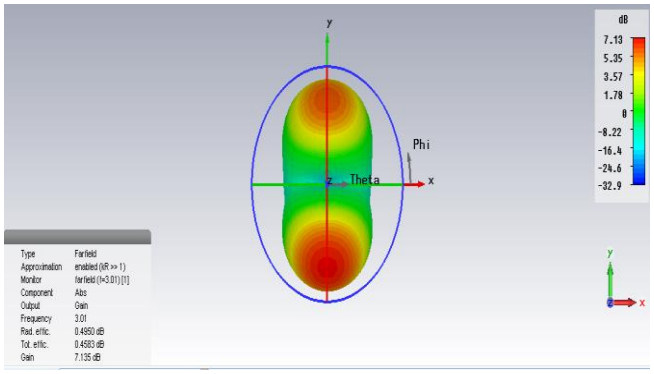

Fig. 4 Gain of the proposed antenna

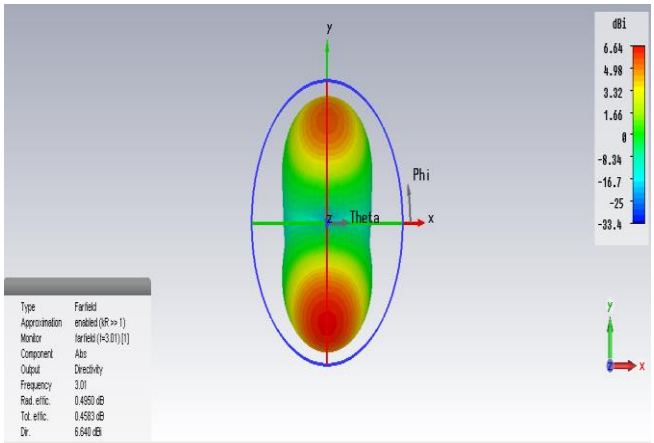

Fig. 5 Directivity of the proposed antenna

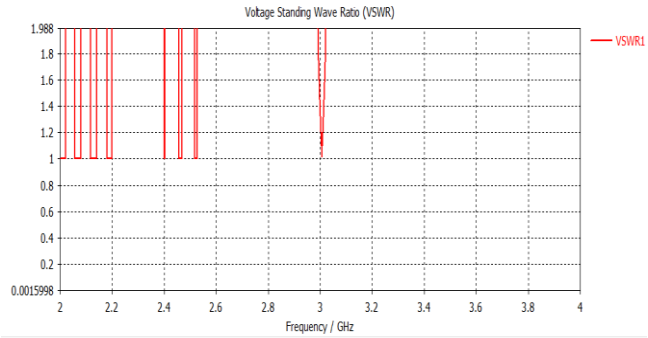

Fig. 6 VSWR plot of the proposed antenna

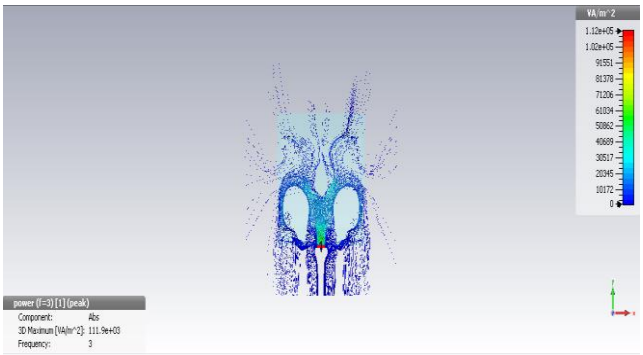

Fig. 7 Power flow pattern of the proposed antenna

IV. CONCLUSION

In this paper, the microstrip patch antenna with a resonant frequency of 3GHz has been designed and analyzed. The proposed antenna has been designed and simulated using CST Microwave Studio 2014. The proposed antenna has gain of 7.13dB and directivity of 6.64 dBi woth corresponding return loss of -41.12 dB at resonant frequency 3GHz. The proposed antenna has the impedance bandwidth of 28MHz (2.99GHz-3.02GHz) which can be used for radio location and Maritime Radio navigation applications.

ACKNOWLEDGEMENT

We would like to thank Prof. Ekambir Sidhu, Assistant Professor, Department of Electronics and Communication Engineering, Punjabi University, Patiala for his support, guidance, assistance and supervision for successful completion this research work

REFERENCES

[1] Balanis C.A., "Antenna Theory Analysis and Design," John Wiley & Sons, 2005.
[2] BahiU. and Bhartia P., "Microstrip Antennas," Artech House, Norwood,1980.
[3] Chen Z.N and Chia M.Y.W., "Broadband Planar Antennas: Design and Application," John Wiley & Sons , 2002.
[4] Ritu Goyal, Y.K. Jain, "Compact Bow Shape Microstrip Patch Antenna with Different Substrates", Proceedings of IEEE Conference on Information and Communication Technologies (ICT), 6505 (1), pp. 1-9, 2013. doi: 10.1109/CICT.2013.6558063
[5] C.A. Balanis, "Antenna Theory Analysis and Design", 2nd Edition John Wiley & Sons, New York, 1996.
[6] Vijay Sharma, V.K. Saxena, K.B. Sharma and D. Bhatnagar, "Radiation performance of an elliptical patch antenna with three orthogonal sector slots," Romanian Journal of Information Science and Technology, vol.14, No. 2, pp. 123-130, 2011.
[7] Tong, K.-F., K.-M. Luk, K.-F. Lee, and R. Q. Lee, "A broad-band U-slot rectangular patch antenna on a microwave substrate", IEEE Trans. Antennas Propagation., vol. 48, pp. 954-960, Jun. 2000. doi: 10.1109/8.865229
[8] Sze, J.-Y. and K.-L. Wong, "Bandwidth enhancement of a microstrip line-fed printed wide slot antenna", IEEE Trans. Antennas Propagation., vol. 49, pp. 1020-1024, July 2001. doi: 10.1109/8.933480
[9] D. Bhardwaj, D. Bhatnagar, S. Sancheti, and B. Soni, Design of square patch antenna with a notch on FR4 substrate, IET Microwave Antennas Propagation. 2, pp. 880-885, 2008.
[10] Roopan, Raveena Bhatoa, Ekambir Sidhu, "High Gain Stacked Micostrip Folded Dipole Yagi Antenna Configurtion for WiMAX applications," IEEE International Conference on Wireless Communication, Signal Processing and Networking (WiSPNET), IEEE Proceeding, 2016.
[11] Amarveer Singh, Ekambir Sidhu, "Novel Microstrip Patch Antenna Design for Bluetooth, IMT, WLAN and WiMAX applications," American Journal of Engineering Research (AJER), vol. 03, Issue 8, pp. 162-170, 2014.
[12] Isha Puri,"Bandwidth and Gain increment of microstrip patch Antenna with Shifted Elliptical Slot", International Journal of Engineering Science and Technology (IJEST), vol. 3, No.7, July, 2011.

Gurnoor Singh Brar is a student of Department of Electronics and communication Engineering, Thapar Polytechnic College Patiala, India. He is pursuing his 5th Semester, Diploma in field of Electronics and Communication from Thapar Polytechnic College. His main areas of interest are Antennas, Embedded System and Energy Harvesting.

Jaspreet Singh is a student of Department of Electronics and communication Engineering, Punjabi University, Patiala, India. He is pursuing Master of Technology in the field of Electronics and Communication Engineering from Punjabi University. His areas of technical interest are Energy Harvesting System and Antenna System. He is a student member of Institute of Electrical and Electronics Engineers (IEEE) and member of American Society of Mechanical Engineers (ASME).

Mr. Ekambir Sidhu is an Assistant Professor at Department of Electronics and Communication Engineering Punjabi University, Patiala since September 2012. His areas of specialization are Antenna Systems and Energy Harvesting Systems. He is an Associate Member (AM) of Institute of Electronics and Telecommunication Engineers (IETE) and member of Institute of Electrical and Electronics Engineers (IEEE). He has research publications in the field of Microwave Antennas, Optical Antennas, Energy Harvesting Systems, Embedded Systems and Wearable Electronics.