International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019

Defected Ground Structure Printed Antenna with Triangular Slot

D. Shyam Prasad, Samiran Chatterjee

Abstract**:** ***Double Layer Single Feed dual resonant frequency patch antenna is presented in this paper. After design the patch, we are etched triangular and rectangular slots at the top and bottom layer of the patch. After design the antenna structure, we got a remarkable result and the operating frequencies are used for the various applications of microwave Communication. Two triangular slots are designed at the top layer from the both sides of the patch with one rectangular slot from the bottom layer and also one h-type slot is introduced at the middle portion from the rest at bottom layer to obtain the desired resonant frequency. The different shapes of the patch used to improve the gain bandwidth performance of the antenna. We get two operating frequencies for this triangular shaped printed antenna. 1st frequency is applicable for microwave radiometry from aircraft to measure ocean wind speed and rain characteristics in hurricanes and the other is used to design BeO POWER CHIP RESISTOR which is applicable for Microwave and RF high power communication, microwave amplifiers and power dividers. This paper includes an extensive analysis of simulated results for this above mentioned microstrip printed patch antenna. All results are simulated and verified by the network analyzer. Due to the basic characteristics of proposed printed antenna, it is suitable for the applications in long distance radio telecommunication systems. It is also applicable for satellite communication and microwave relay systems.***

Keywords : Compact, Ground Plane, Layer and Feed, Operating Frequency, Slot.

I. INTRODUCTION

In the recent days of low power communication, the young engineers are search for such type of devices which is very handy, tiny, light weight and possibility of miniaturization. So, in this aspect the microstrip printed antenna is bring a positive interest to the engineers and especially who are willing to work in the microwave communication fields [1]. Due to the miniaturization of microwave devices, we use microstrip antenna for any types of communication irrespective of other devices. But in recent microwave and wireless communication, the engineers are required more than one resonant frequency due to the more coverage range for the communication. Requirements of two resonant frequency because most of young engineers are used multiple frequency bands for the communication and they want such type of device which can cover all the frequency. Due to this reason, the wireless engineers are designed antennas which are used for multiband operation with multiband characteristics. With the multiband characteristics, the other characteristics are to design the antenna in such a way which is consisting of the process of size reduction. It is one of the new techniques in which we cut different slots in the proper positions of usual antenna which is known by conventional antenna [2-5]. The meaning of size reduction is resonant frequency reduced by a large amount when compared to our usual antennas [6-12]. There are another some antennas are there which are same as patch antenna and the names are DRA (Dielectric Resonator Antenna) and Fractal Antenna [13-18]. But for designing the above mentioned two antennas, the engineers are facing some problems. Due to the requirement of high dielectric constant, DRA is not able to design, and fractal antennas structure is very complicated for design.

So, in recent days the compact printed antenna is smaller in size and also possible to miniature so, the young engineers are looking for the keen interest for this antenna and patch antennas demand are increased for the various communication especially for mobile and microwave communication [9-10]. The proposed work in this paper is presented by design of printed patch antenna which is combined with equal triangular slots which gave two operating frequencies. Designing of the proposed antenna in this paper is done due to etched two equal triangular slots on the both sides of the patch from top layer, one rectangular slot cut at the top from the bottom layer and also one h-type slot (Fig.-2) is introduced at the middle portion from the rest at bottom layer i.e. at ground plane for the improvement in return loss and performance of the antenna. We are used high value of dielectric constant in here for design of proposed antenna for the high percentage of size reduction [2-5]. The main aim is to design our proposed antenna with the increase of operating bandwidth and large increment of frequency ratio. We use the method of moment (MoM) based software [19] and the results are verified by using of Vector Network Analyzer. For the light weight, low cost and small size, the proposed antenna is applicable of satellite communication and related microwave relay systems.

II. ANTENNA STRUCTURE

Designed printed antenna configurations with PTFE substrate are shown in below figures. Two equal triangular slots (T1, T2) are cut both sides from edge of the patch at top layer is shown in figure-1.

Revised Manuscript Received on November 30, 2019.
* Correspondence Author
D Shyam Prasad*, EIE Department, CVR College of Engineering, Hyderabad, India, Email: devula_shyam@yahoo.co.in
Samiran Chatterjee, ECE Department, Vignan's Institute of Management and Technology for Womem, Hyderabad, India. Email: samiranengineer@gmail.com

One rectangular slot cut at the top from the bottom layer and one h-type slot is introduced at the middle portion from the rest at bottom layer i.e. at ground plane is shown in figure-2. Dimensions and location of SMA connector which is used as a probe for designed antenna feeding point also displays in figure which radius is 0.8 mm.

The material is designed for our antenna is made with epoxy substrate whose dielectric constant is 1.6 mm. The co-axial probe with 0.8 mm radius is used at point (2,-3) considering the axis at X-Y plane (0,0) . Figure-1 shows The top view of designed antenna is displays in Figure 1 and also and ground plane structure with same PTFE substrate displayed in Figure-2.

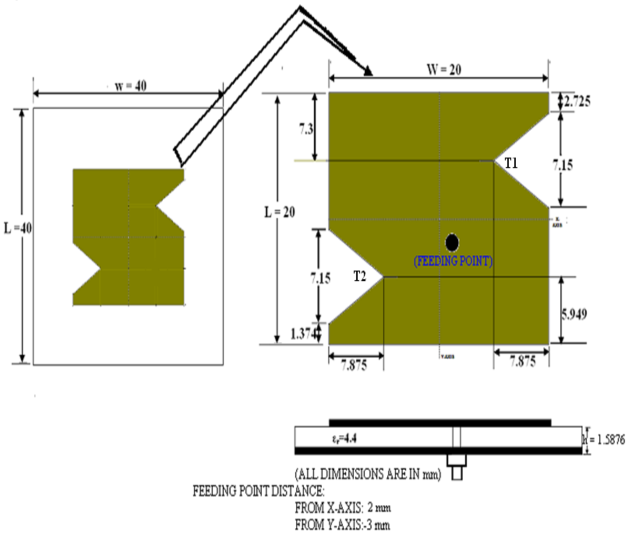


Figure 1: Top View of Designed Antenna

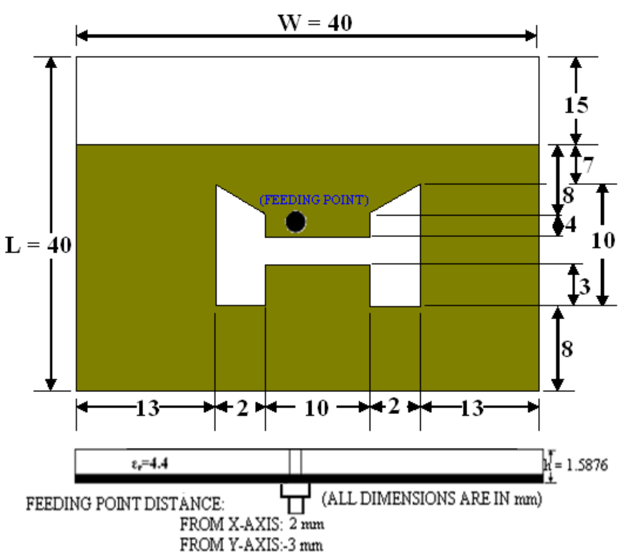


Figure 2: Bottom View of Designed Antenna

The designed antenna is designed with same PTFE substrate with 40mm x 40 mm patch. The top layer of proposed antenna is designed exactly in the middle of the square patch i.e. 20mm x 20mm square patch.

III. SIMULATED RESULTS AND ANALYSIS

Here, we are studying the sensitivity analysis of different geometric or physical parameters or both on the solution of the designed antenna and all the analysis of designed antenna are performed and designed here. Different analyses of parameter of designed antenna are discussed for improvement the performance of the antenna. Figure 3 displays the power loss of designed antenna.

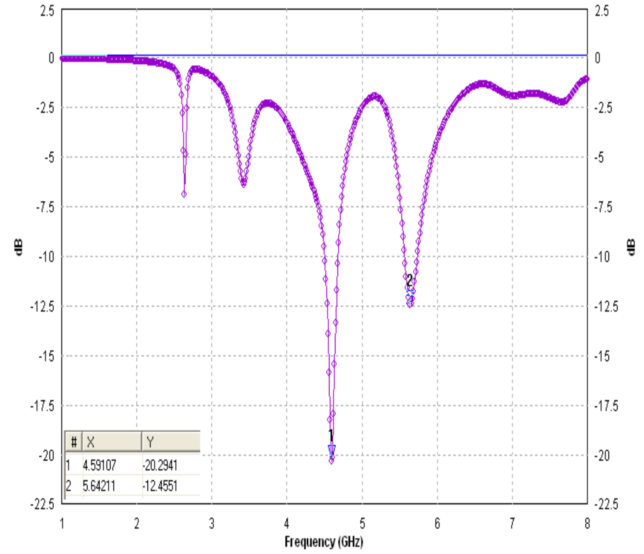
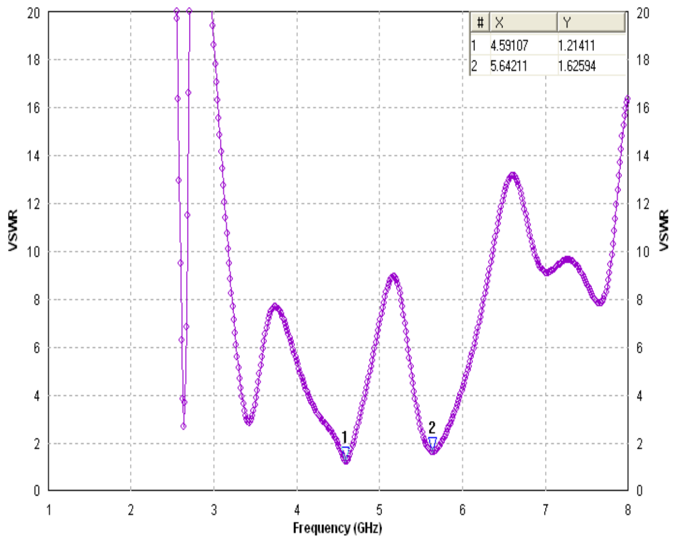


Fig 3: Designed Antenna simulated Power Loss

For the insertion of slots in the proper position of the patch, the operating frequency is achieved with improved power loss with increased frequency ratio. We are achieved three resonant frequencies for the designed antenna with large return loss. The achieved frequency obtained at 4.59 GHz and 5.64 GHz with power loss of -20.29 dB and -12.46 dB with corresponding bandwidth of nearly 178.07 MHz and 169.91 MHz respectively.



. **Fig 4: Designed antenna power delivered with frequency**

Figure 4 displays the power delivered of the designed antenna for the achievable frequency. The powers delivered for corresponding achievable frequency obtained are 1.21 and 1.63. All the values are in acceptable range i.e. 2:1 range.

III.I. Simulated radiation pattern

The following figures are displaying the simulated electric and magnetic power pattern of radiation for the designed antenna and that all patterns are measured and verified.

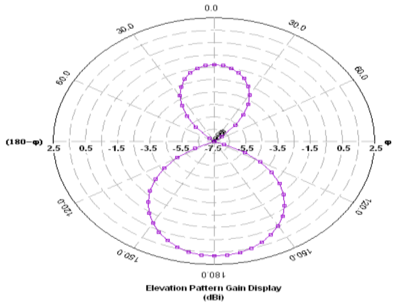


Fig 5: Simulated Electric Power pattern of radiation for 4.59 GHz

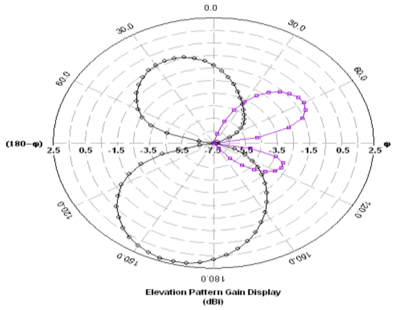


Fig 6: Simulated Magnetic Power pattern of radiation for 4.59 GHz

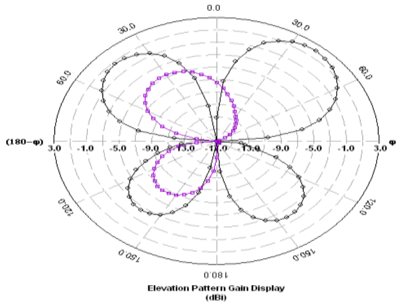


Fig 7: Simulated Electric Power pattern of radiation for 5.64 GHz

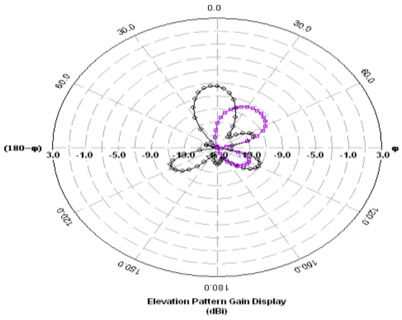


Fig 8: Simulated Magnetic Power pattern of radiation for 5.64 GHz

Now, with the following table we are combine all the results for are achievement for our designed antenna which is discussed under below:

TABLE A:
SIMULATED POWER PATTERN OF RADIATION FOR DESIGNED ANTENNA

ANTENNA STRUCTURE	OPERATING FREQ.(GHZ)	RATIO OF OPERATING FREQ.	3 DB BEAM WIDTH (^{0})	ABSOLUTE GAIN (DBI)
1	f_1= 4.59		214.89 ^{0}	2.30
	f_2= 5.64	f_2/ f_1=1.229	323.84 ^{0}	2.08

TABLE II:
SIMULATED POWER LOSS FOR DESIGNED ANTENNA

ANTENNA STRUCTURE	OPERATING FREQUENCY (GHZ)	POWER LOSS (dB)	10 DB BANDWIDTH (MHZ)
1	f_1= 4.59	-20.29	178.07
	f_2= 5.64	-12.46	169.91

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The prototype models of designed antenna are displayed in Figure 9 and 10. After fabrication of antenna, we are tested the antenna results with network analyzer named Agilent N5 230A.

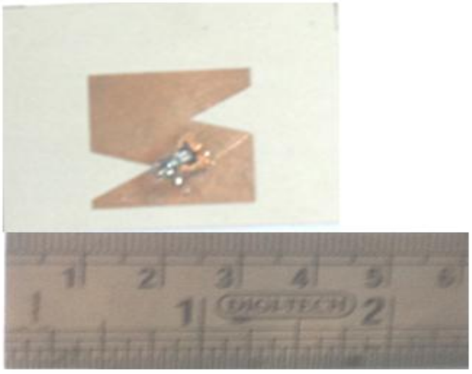


Fig 9: Top view Prototype model of designed antenna

Fig 10: Bottom view Prototype model of designed antenna

After measuring all the results, we compare the results with software results and comparison of the result is displayed in Figure 11. The difference between the results is done for the soldering effect of SMA or tolerance problem of the substrate.

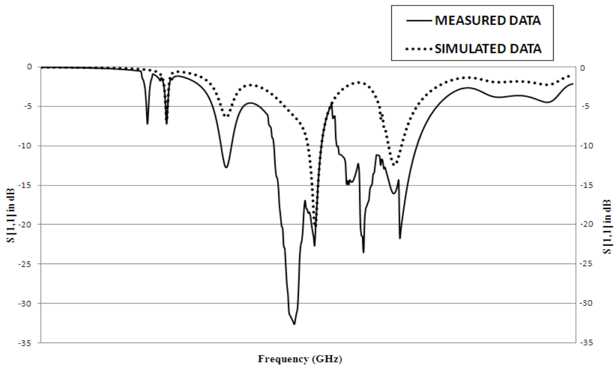


Fig 11: Designed antenna results comparison

V. CONCLUSION

Double Layer Single Feed dual resonant frequency patch antenna is presented in this paper. After design the patch, we are etched triangular and rectangular slots at the top and bottom layer of the patch. After design the antenna structure, we got a remarkable result and the operating frequencies are used for the various applications of microwave Communication. All the results are simulated by method of moment-based software and verified by network analyzer. Two triangular slots are designed at the top layer from the both sides of the patch with one rectangular slot from the bottom layer and also one h-type slot is introduced at the middle portion from the rest at bottom layer to obtain the desired resonant frequency achieved in power loss nearly -20.29 dB as well as in power delivered value nearly 1.21. Other observation is for designed antenna, the 3dB beam-width of the power pattern of radiation nearly 214.89° which is extremely large beam for the desired applications. Any change of feeding location the results also gives less bandwidth with fewer resonances.

ACKNOWLEDGEMENT

We acknowledge gratefully all the faculty members and management of CVRCE and VMTW for their support and continuous encouragement to do the work with positive thinking.

REFERENCES

1. I. Sarkar, P. P. Sarkar, S. K. Chowdhury A new compact printed antenna for mobile communication. 2009 Loughborough Antennas & Propagation Conference 16-17 Nov. 2009, Loughborough, UK.
2. Samiran Chatterjee, Joydeep Paul, Kalyanbrata Ghosh, P. P. Sarkar, D.Chanda (Sarkar) and S. K. Chowdhury “A Compact Microstrip Antenna for WLAN Communication”, National Conference of Electronics, Communication and Signal Processing, 2011, Paper ID: 116
3. U. Chakraborty, S. Chatterjee, S. K. Chowdhury, and P. P. Sarkar, “Triangular Slot Microstrip Patch Antenna for Mobile Communication”, India Conference (INDICON), 2010 Annual IEEE, pp 4-7, Paper ID: 511
4. J. -Y. Jan and L. -C. Tseng, “Small planar monopole Antenna with a shorted parasitic inverted-L wire for Wireless communications in the 2.4, 5.2 and 5.8 GHz bands” , IEEE Trans. Antennas and Propag., VOL. 52, NO. 7, July 2004, pp -1903-1905.
5. S. Chatterjee, U. Chakraborty, I.Sarkar, S. K. Chowdhury, and P. P. Sarkar, “A Compact Microstrip Antenna for Mobile Communication”, India Conference (INDICON), 2010 Annual IEEE, pp 1-3, Paper ID: 510
6. Danideh, A., R. S. Fakhr, and H. R. Hassani, “Wideband coplanar microstrip patch antenna,” Progress In Electromagnetics *Research Letters*, PIER 4, 81–89, 2008.
7. Samiran Chatterjee, Joydeep Paul, Kalyanbrata Ghosh, P. P. Sarkar and S. K. Chowdhury “A Printed Patch Antenna for Mobile Communication”, Convergence of Optics and Electronics conference, 2011, Paper ID: 15, pp 102-107
8. J. Bahl and P. Bhartia, “Microstrip Antennas”, Artech House, Dedham, MA, 1980.
9. P Ravali, S Chatterjee, KR Reddy, N Raju, AR Kumar,” Size Deduced Printed Antenna for W-LAN Applications” - Advances in Decision Sciences, Image Processing …, 2020, Springer book Series
10. U. Chakraborty, S. Chatterjee, S. K. Chowdhury, and P. P. Sarkar, "A compact microstrip patch antenna for wireless communication," *Progress In Electromagnetics Research C*, Vol. 18, 211-220, 2011
11. R.Fallahi, A.-A.Kalteh, M. Golparvar Roozbahani, "A novel UWB elliptical slot antenna with band-notched characteristics," *Progress In Electromagnetics Research C*, Vol. 18, 211-220, 2011
12. Samiran Chatterjee, Santosh Kumar Chowdhury, Partha Pratim Sarkar and Debasree Chanda Sarkar, “Compact Microstrip Patch Antenna for Microwave Communication”, Indian Journal of Pure & Applied Physics, Vol. 51, November 2013, pp 800-807.
13. Werner, D.H and S.Ganguly, “An overview of fractal antenna engineering research”, IEEE Antennas and Propagation Magazine, Vol. 45, No. 1, 38-57, 2003
14. A.Aggarwal and M.V.Kartikeyan, “Pythagoras Tree: A Fractal Patch Antenna for multi-frquency and ultra-Band-Width Operations”, Progress in Electromagnetics Research C, Vol. 16, 25-35, 2010
15. Gianvittorrio, J.P and Y. Rahmat-Samii, “Fractal Antennas: A novel antenna miniaturization technique and applications”, IEEE Antennas and Propagation Magazine, Vol. 44, No. 1, 20-36, 2002
16. Carles Puente Baliarda, Jordi romeu and Angel Cardama, “The Koch Monopole: A small fractal antenna”, IEEE Transactions on antennas and propagation, Vol. 48, No. 11, 1773-1781, November-2000
17. M. Saed and R. Yadla, “Microstrip fed low profile and compact dielectric resonator antenna”, Progress in Electromagnetics Research, PIER-56, 151-162, 2006
18. Aldo Petosa and Apisak Ittipiboon, “Dielectric Resonator Antennas: A Historical review and the current state of the Art”, IEEE Antennas and Propagation Magazine, Vol. 52, No. 5, pp 91-116, October 2010
19. Zeland Software Inc. IE3D: MOM-Based EM Simulator. Web: http://www.zeland.com

AUTHORS PROFILE

Mr. D. Shyam Prasad working as Sr. Asst. Professor in CVR College of Engineering, Hyderabad, Telangana. His research area includes Signal Processing, Antenna, and Sensor Networks.

Dr. Samiran Chatterjee working as an Associate Professor in ECE department at Vignan’s Institute of Management and Technology for Women, Hyderabad, Telangana. His research interest in the field of Antenna Design, FSS, Biomedical Application, Mobile Communication, Embedded Systems and Real Time applications.