© July 2019 | IJIRT | Volume 6 Issue 2 | ISSN: 2349-6002

Design of Microstrip Patch Antenna with Parasitic Elements for Wideband Applications

K.Veerendra[1], G.Padma Ratna[2], S Nagakishore Bhavanam[3]
[1]PG Scholar, Dept. of ECE, University college of Engineering & Technology Acharya Nagarjuna University, India.
[2,3]Asst.Professor, Dept. of ECE, Centre of Excellence in VLSI Design and Antennas University college of Engineering & Technology, Acharya Nagarjuna University, India

***Abstract*- Wideband is the emerging technology for utilizing several wireless communication applications. So, for this the design of micro strip antenna along with parasitic element has presented in this paper. Normally, this micro strip patch antenna has a limitation of lower bandwidth. This limitation can be overcome by using technique called as parasitic element to achieve wider bandwidth. The antenna has been designed by using FR4 epoxy substrate that has the 4.4 dielectric constant and thickness taken as 1.6 mm. This designed antenna is composed of micro strip with parasitic elements and this has technique of micro strip feeding and the antenna return loss, gain and VSWR has simulated by the Hfss software. The return losses are -20.17dB, -17.28dB, -17.85dB, -19.82dB and the respective frequencies are 18.4Ghz, 23.3Ghz, 27.6Ghz, 33.7Ghz and this has the VSWR in between of 1 to 2. The designed antenna has a wideband of 30.05 GHz. The observed results are applicable in the k-band, ka-band & Q-band respectively**

Index terms- Parasitic element, Microstrip antenna, Bandwidth, Return loss, VSWR, HFSS

I. INTRODUCTION

Microstrip patch antenna was introduced in the year 1970. This antenna has become popular in now-a-days because it can be used in various applications such as radar, astronomical purpose, satellite system and in many other fields.

These micro strip patch antenna has ground plane on one side and has patch on another side. The dielectric substrate is present between this patch and ground plane. There are of various different shapes available for the patches are of elliptical, square, pentagonal, octagonal, circular ring, rectangular etc.., and also there are of several feeding techniques that can be used are coaxial probe, aperture coupling and micro strip feed line

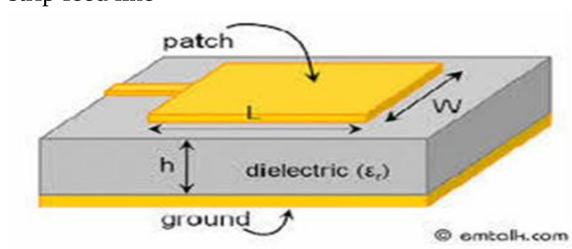

Figure 1.1 Microstrip Patch Antenna Geometry

The several advantages of this micro strip patch antenna are low-profile antennas, inexpensive to manufacture, it's fabrication is easy, installation of this antenna is simple, flexible to provide wide variety of applications. But, the main disadvantage of this micro strip patch antenna is they have lesser bandwidths and this problem can be overcome by adding a parasitic element to the micro strip patch antenna which results in wide bandwidth. This wideband technology has widely used in the commercial, industry and telecommunication applications.

In this paper, the patch antenna with addition of a parasitic element has been designed and the purpose is to increase the bandwidth. The length of parasitic element will determine the frequency of resonant and the width will determine the bandwidth of antenna.

The proposed antenna has designed successfully and achieved the characteristics of wideband that offers huge wideband that can be used for many applications and also this antenna has achieved multi-frequency bands with their respective gains and vswr in the acceptable range. The effect of the design parameters has been studied & discussed in the paper and this type of antenna is used for astronomical purpose, Inmarsat I-5 system, radar, direct broadcasted system (dbs), iridium next satellite, kacific k-1 satellite and terrestrial microwave communication.

II. ANTENNA DESIGN

The proposed antenna was designed by taking parameters as length is of 4.34 mm and width is of 12.16 mm and has thickness of h = 1.6 mm and it is developed on FR4 epoxy substrate with a dielectric constant of 4.4.

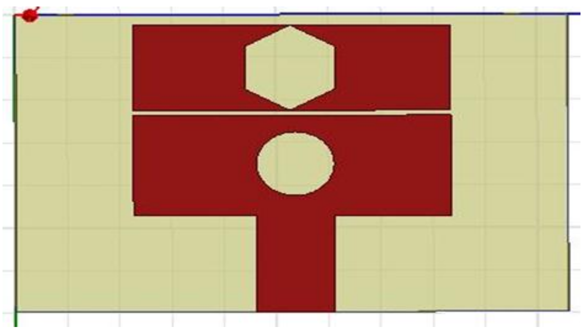

Figure 2.1 Top View of the Designed Antenna

The length of the substrate is taken as of 13.94 mm and width of substrate is taken as 21.16 mm. The patch and ground plane is chosen as perfect metallic conductors and the microstrip feed here taken as the lumped port with an impedance of 50 ohms.

If an additional patch has been placed nearer to the main patch, then such type of patch is called as parasitic patch. The gap between these patches is taken as low and by cutting the slots of shapes like hexagonal and circle at an appropriate position inside the patches there will be of optimum bandwidth.

2.1 Procedure for Design

1. First choose the frequency of resonant f_r substrate thickness (h) and dielectric constant $\in_r$.

2. The width and length of patch is calculated as follows:

1. Width of patch is taken as

$$W = \frac{c}{2 f_r}\sqrt{\frac{2}{\in_r + 1}}$$

2. Length of the patch is taken as

$$L = L_{eff} - 2\Delta L$$

Where effective length is

$$\in_{reff} = \frac{\in_r + 1}{2} + \frac{\in_r - 1}{2}[1 + 12\frac{h}{w}]^{-1/2}$$

where

Normalized extension length is

$$\Delta L = 0.412h\frac{(\in_{reff} + 0.3)(\frac{w}{h} + 0.264)}{(\in_{reff} - 0.258)(\frac{w}{h} + 0.8)}$$

3. The length of the substrate is taken as $L_s = L + 6h$ and the width of the patch is taken as $W_s = W + 6h$.

where

c is free space velocity.

$\in_r$ is substrate dielectric constant.

L is patch length.

W is patch width.

h is patch height.

Ls is substrate length.

Ws is substrate width.

III. SIMULATION RESULTS

The simulation for this proposed antenna has been done using the HFSS software. It is one of the several commercial tools that are used for design of antenna and also for design of complex radio high frequency circuits including the transmission lines and filters. The parameters that are observed such as Return loss, VSWR and Gain has simulated and the results are shown as below. The designed antenna has high bandwidth of 30.05 GHz and also the antenna can operate in the k-band, ka-band and Q-band applications.

3.1 Return loss

The return loss means power loss in the signal that will reflect back as discontinuity in the transmission lines of a signal. If all the power is reflected from an antenna and of nothing is radiated, then return loss is zero.

$$RL = -20\log_{10}|\Gamma|(dB)$$

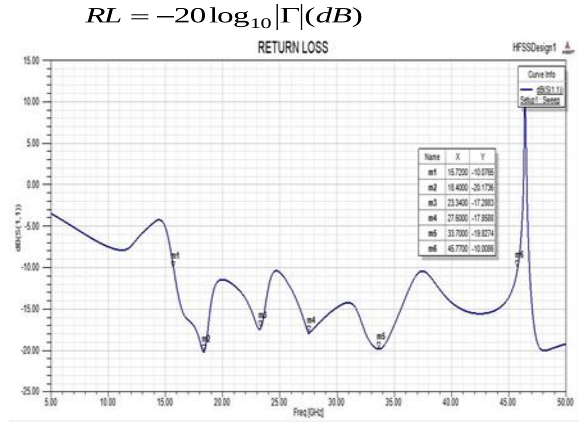

Figure 3.1 Return Loss of the Simulated Designed Antenna

The S11 Parameters of the designed antenna are obtained as -20.17(dB), -17.28(dB)-17.85(dB) and -19.82(dB) at the frequencies of 18.40 GHz, 23.34 GHz, 27.60 GHz and 33.70 GHz respectively.

3.2 Gain

The ratio of power which is required at an input of a loss-free antenna to the power that is supplied to the input of given antenna and this gain is usually express in dB. The proposed antenna obtained the overall gain about 5.06 dB.

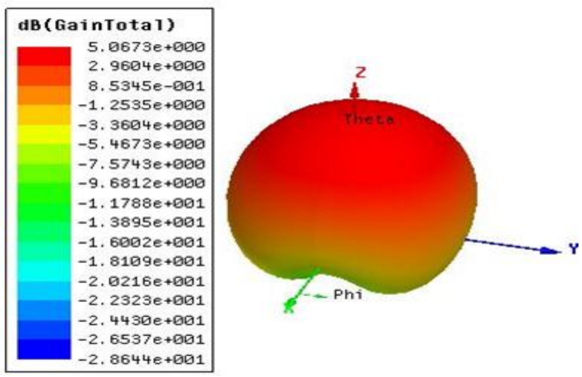

Figure 3.2 Total Gain of Simulated Antenna Design

IV. CONCLUSION

The proposed microstrip patch antenna gives the wide bandwidth of 30.05 GHz and also operates at multiple-bands such as k-band, ka-band and Q-band. This designed will works in the applications such as Inmarsat I-5 system, terrestrial microwave communications, direct broadcast system (DBS), iridium next satellite, radar and astronomical purpose. The designed microstrip antenna with parasitic element can be evaluated by the HFSS software.

ACKNOWLEDGMENT

The author will likes to thank Faculty Department of Electronics and communication Engineering, Acharya Nagarjuna University for providing the Centre of Excellence (CoE) in VLSI Design & Antenna. I also like to thanks Er.G.PadmaRatna and Dr.S.Nagakishore sir for guiding the research work to get best results.

REFERENCES

[1] Eko Tjipto Rahardjo, Yulianto La Elo, Fitri Yuli Zulkifli "Design of Wideband Microstrip Antenna with Parasitic Element for 4G or LTE Application" Universities Indonesia Depok, Indonesia. IEEE, 2018.

[2] Sk. Nagurvali, S Nagakishore Bhavanam, Vasujadevi Midasala, J Lavanya, "Design and Simulation of Srichakra Shape Microstrip Tri-Band Patch Antenna", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8 Issue-7, May 2019, Pages: 615-618.

[3] J Lavanya, S Nagakishore Bhavanam, Vasujadevi Midasala, M Sekhar, "Design of Spiral Antenna for Multiband Applications", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8 Issue-5, March 2019, Pages: 1160-1163

[4] S Nagakishore Bhavanam, D. Sharmila, M. Purnachandra Rao, P. S. V. Subbarao, "Design of a Multiband Octagonal Patch Antenna", Indian Journal of Science and Technology, Vol 12 (3), DOI: 10.17485/ijst/2019/v12i3/141596, January 2019, ISSN (Print): 0974-6846, ISSN (Online): 0974-5645,Pages: 1-6.

[5] Vasujadevi Midasala, S Nagakishore Bhavanam, B Mourya "Performance Optimization Of Multiband Microstrip Patch Antenna By Incorporating EBG Structures", Journal of Advanced Research in Dynamical and Control Systems (JARDCS),ISSN: 1943-023X, Issue 17, Special Issue, 2017, Pages: 2066-2075.

[6] S Nagakishore Bhavanam, K. V. Prashanth, Vasujadevi Midasala, "Design Of EBG Based Artificial Ground Plane Using HFSS 15.0",Special Issue on Signal Processing and Communication Engineering Systems, International Journal of Pure and Applied Mathematics, ISSN: 1311-8080 (Printed Version), ISSN 1314-3395 (On-Line Version), Vol.117, No.18, 2017, Pages 61-65.

[7] Dr. V. Siva Naga Raju, S Nagakishore Bhavanam, Vasujadevi Midasala, P Ramesh"Multi Frequency Antenna Design By Using HFSS 15.0",Special Issue on Signal Processing and Communication Engineering Systems, International Journal of Pure and Applied Mathematics, ISSN: 1311-8080 (Printed Version), ISSN 1314-3395 (On-Line Version), Vol.117, No.18, 2017, Pages 215–219.

[8] S Nagakishore Bhavanam, Rokkam Satya Kalyan "Design of a Novel Coaxial Feed Triple Frequency Patch Antenna with Slots and Shorting Pin", ELSEVIER Journal-Procedia Computer Science, ISSN: 1877-0509, Volume 85, 2016, Pages 345–351.

[9] P.Dinesh, S Nagakishore Bhavanam, B Bhaskara Rao “Design of Multi Frequency Antenna Using HFSS 14.0”, Acharya Nagarjuna University Journal of Engineering & Technology, ISSN: 0976-3414, Special Edition, March 2017, pp. 57-60.

[10] S Nagakishore Bhavanam, and B. Lakshmi Narayana "Design & Simulation of Tripple Frequency Triangular Patch Antenna by Using HFSS 14.0", International Journal of Applied Engineering Research, vol. 10, No. 20 April 2015, ISSN: 0973-4562(print), ISSN: 1087-1090 (Online), pp. 18585-18588.

[11] S Nagakishore Bhavanam et al, “Design & Simulation of single frequency Rectangular Patch Antenna by Using HFSS” International Journal of Engineering Research and Applications (IJERA), Vol. 5, Issue 4, Part-V, April 2015, ISSN : 2248-9622, pp.06-09.

[12] Vasujadevi M and S Nagakishore Bhavanam “Design of Vivaldi Antenna - By Using COMSOL Multiphysics Software", Acharya Nagarjuna University Journal of Engineering & Technology (ANUJET), Vol.6, No. 1 &2, July-Dec 2014, ISSN: 0976-3414, pp.1-7.

[13] S.NagakishoreBhavanam,B.LakshmiNarayana "Design & Simulation of Tripple Frequency Triangular Patch Antenna by Using HFSS 14.0". DRDO Sponsored 2nd IEEE International Conference on Innovation in Information, Embedded and Communication Systems, Karpagam College of Engineering, Coimbatore, Tamilnadu, during 19th -20thMarch 2015, pp.1348-1351

[14] S Nagakishore Bhavanam, M. Sekhar and Dr. P. Siddaiah "Triple Frequency Circular Patch Antenna" IEEE International Conference on Computational Intelligence and Computing Research (IEEE ICCIC-2014) organized by IEEE Phodhigai & IEEE-SIPICOM Sections, Coimbatore, Tamilnadu, 18-20 December, 2014, pp.1231-1233.

[15] S Nagakishore Bhavanam, M. Sekhar and Dr. P. Siddaiah "Rectangular Patch Antena Aray Design at 13GHz frequency Using HFSS". IEEE Publications, ISBN: 978-1-4799-3975-6 (IEEE Xplore), 978-1-4799-3974-9 (CD), 978-1-4799-1594-1 (Print), pp. 43-46.