iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** V **Month of publication:** May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5473

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Design of Microstrip Patch Antenna with Branch Feeding Technique for Tetra Band Applications

Er. Navdeep Kaur[1], Er. Kavnreet Kaur[2]
[1, 2]Khalsa College of Engineering & Technology, Amritsar, India

Abstract: This paper takes research on design of multiband microstrip patch antenna. The proposed patch antenna can resonate at seven unique frequencies between 2 GHz and 9GHz out of which four are considered to be useful bands. To accomplish multiband frequency, proposed finite element method is employed to design the rectangular Microstrip Patch Antenna (MPA). The circular patch is designed and then united with more circles to make a new design. The proposed antenna is designed on FR4 Epoxy substrate with specifications: relative permittivity = 4.4, relative permeability = 1, di-electric loss tangent =0.02 and thickness = 1.6 mm .The return loss for all the resonant frequencies is less than -10dB. The proposed design exhibits individual gain of 8.9 dB at 7.1 GHz where overall gain is 3.1 dB in the final iteration, and is used public sector applications i.e. military, business radio (police and fire) and in space science like radio astronomy. Frequency above 6 GHz are going to be used in future mobile communication in 5G.

Index Terms: MPA, Feeding techniques, Return loss and Gain

I. INTRODUCTION

Antennas is a device which is used for wireless communication between two or more stations by transmitting signals from one station to another [1]. A microstrip patch antenna (MPA) is made of thin di-electric substrate with the ground of metallic material such as copper, gold. Now-a-days the need of wireless communication has grown [2]. Wireless systems are required to be small in size due to its characteristics to be mobile. Microstrip patch antenna is the major allure for researchers over the past work because their structures are probably easy to fabricate.

Research on microstrip antenna in the 21st century if focused at small sized, increased gain, wide bandwidth, multiple functionality [3-4]. To meet such features and requirements, the microstrip patch antenna have been proposed because of its low profile, less in cost, small in size.[1] Microstrip Patch Antenna consists of rectangular patch which is conductor in nature of length "L" and width "W" on one side of dielectric substrate with the thickness of "h" and dielectric constant "ε_r" with the base named ground. Parameters like return losses, gain and VSWR are calculated in this paper.

Return loss or reflection loss is the reflection of signal power from the insertion of a device in a transmission line or optical fibre. Whereas , antenna gain is the ratio of maximum radiation intensity at the peak of main beam to the radiation intensity in the same direction produced by an isotropic radiator or omni - directional antenna having the same input power. Isotropic antenna is standardised to have a gain of unity. The gain function can be described as : $G\ \theta,\phi = \frac{p(\theta,\phi)}{\frac{Wt}{4\pi}}$. Various feeding mechanisms are used to supply Microstrip patch antennas. These methods are categorised into contacting and non-contacting technique. Generally contacting methods are microstrip line feeding and co-axial plane feeding. On other hand, non- contacting techniques are proximity coupled feeding, aperture coupled feed. We are using branch line feeding technique because it gives less return losses, is reliable and easy to fabricate.

II. ANTENNA DESIGN

Designing an antenna in wireless application meant that the antenna dimension couldn't be bulky. With this regard objective is to design a reduced sized multi band micro strip patch antenna, design idea was taken from broadband antennas with branch feed line technique. This is a type of microstrip line feeding technique, in which the width of conducting strip is kept small as compared to the patch and has the advantage that the feed can provide a planar structure [4].

The structure of proposed multiband microstrip patch antenna is shown in figure 1, which is designed with di-electric constant 4.4 and loss tangent of 0.02. The total volume of proposed antenna is about (18×35×1.6) mm^3 and it resonates for various frequencies discussed further. The dimension of microstrip patch antenna is displayed in Table 1 below:

S.No	PARAMETERS	VALUES (mm)
1.	Feed Width (F_W)	1
2.	Feed Length (F_L)	4
3.	Position of linefeed	4.5, 4, 1.6
3.	Ground length(G_L)	18
4.	Ground width(G_W)	35
5.	Height (H)	1.6
6.	Rectangular cut in linefeed (L*B)	1*1

TABLE 1: Dimensions of proposed microstrip patch antenna.

Geometry of 0^{th} Iteration of proposed antenna is show in figure 1 with the dimensions of 18*35*1.6 as mentioned in the Table 1. Its results are discussed further in this paper where best return loss is observed at 4.8GHz i.e. -20.6 dB and overall gain is 7.4 dB

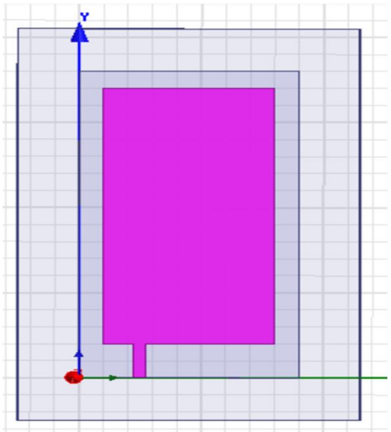


Figure 1: 0^{th} Iteration of Proposed Antenna

Now in order to improve its parameters we have etched rectangular slot and introduce new type of feeding technique as shown in figure 2. Here we observed the return loss is improved to -25.24 dB by introducing this slot in line feed. Further results will be discussed in this paper.

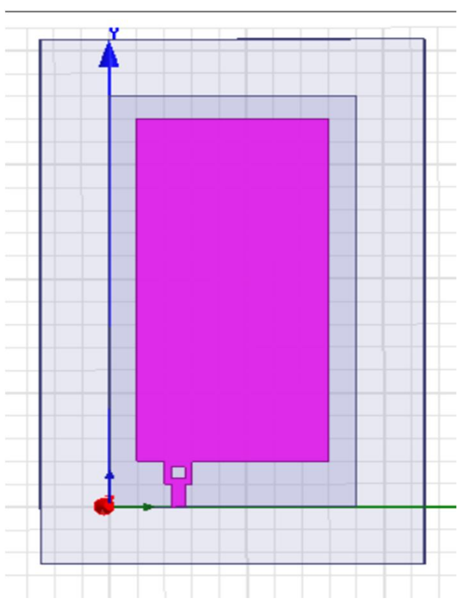


Figure 2: 1^{st} Iteration of Proposed Antenna

In second iteration rectangular slots are etched to introduce different shapes which is inspired from dollar sign as shown in figure 3.

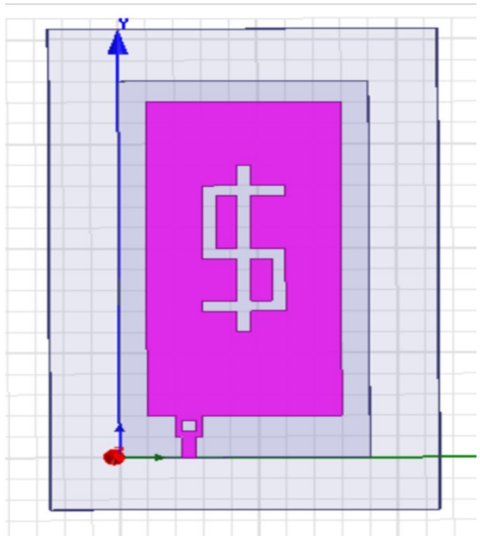


Figure 3: 2nd Iteration of Proposed Antenna

In the third iteration SRR is introduced to improve its characteristics as shown in the figure 4.

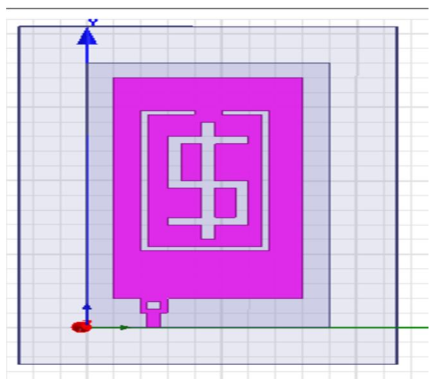


Figure 4: 3rd Iteration of Proposed Antenna

In the final Iteration U shaped slot is etched and further results are observed further mentioned in this paper accordingly.

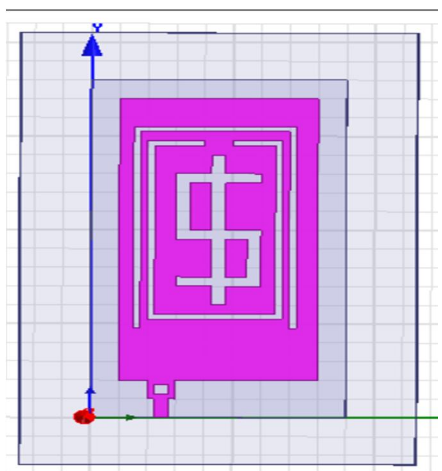


Figure 5: 4th Iteration of Proposed Antenna

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

III. RESULTS AND DISCUSSIONS

The proposed antenna is designed and simulated by using HFSS V13 (High Frequency Structure Simulator Software) version 13 Software. The different parameters such as return loss, VSWR, gain and radiation pattern has been observed and analysed.

A. Return Loss and VSWR

Return loss is an important parameter of antenna. It is the difference between forward and reflected power in dB. The return loss is the ratio of reflected power over transmitted power. The acceptable value of return loss is below -10dB for the antenna to work efficiently. The return v/s frequency curve of 0^{th}, 1^{st} and 2^{nd}, 3^{rd} and 4^{th} iteration are shown in Figure 6, 7, 8, 9 and 10 respectively. It is observed that in 0^{th} Iteration best result is at 4.18 GHz is -20.6 dB and in 1^{st} Iteration at 5.36 GHz is -25.24 dB, in 2^{nd} Iteration at 5.27 GHz is -24.29 dB , in 3^{rd} Iteration at 5 GHz is -23.53 dB and in 4^{th} Iteration at 6.18 GHz is -39.63 dB of Proposed Antenna. Moreover return loss and gain for various resonant frequencies is given in Table 2. A very low return loss can be achieved at frequency of 6.18GHz which is -40 dB approx.

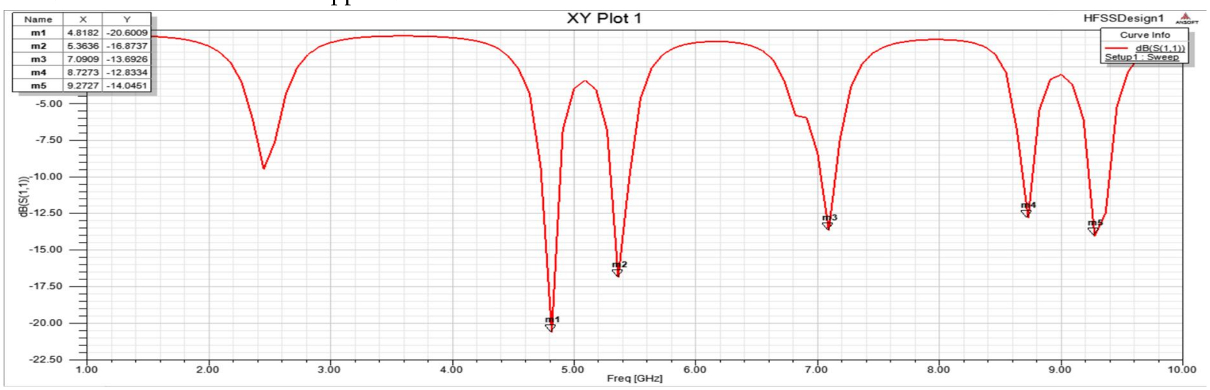


Figure 6: Return loss of 0^{th} iteration

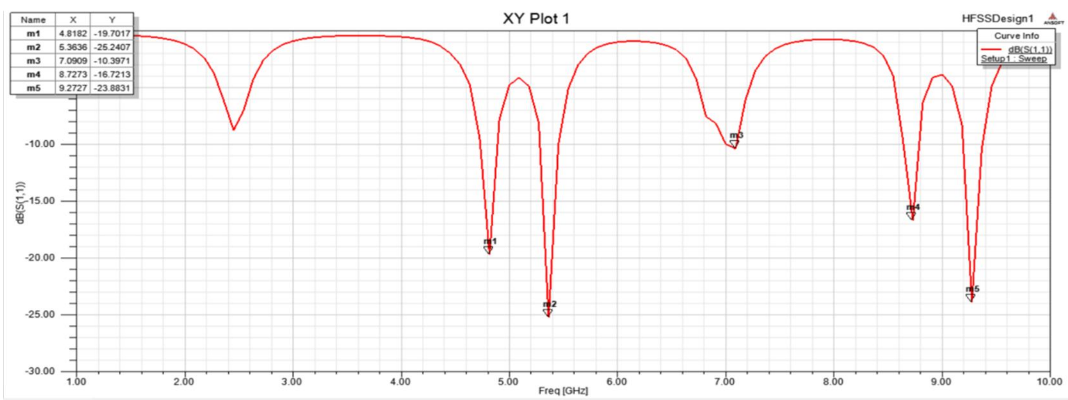


Figure 7: Return loss of 1^{st} iteration

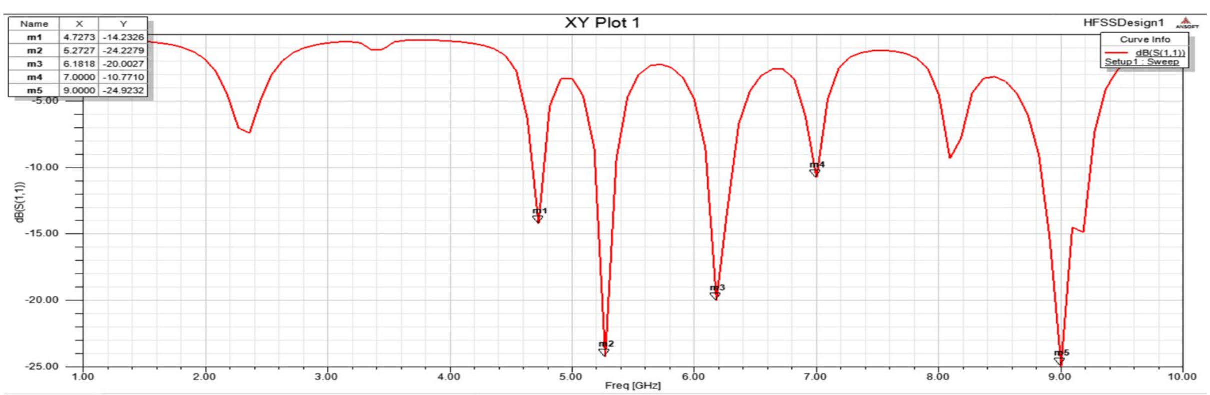


Figure 8: Return loss of 2^{nd} iteration

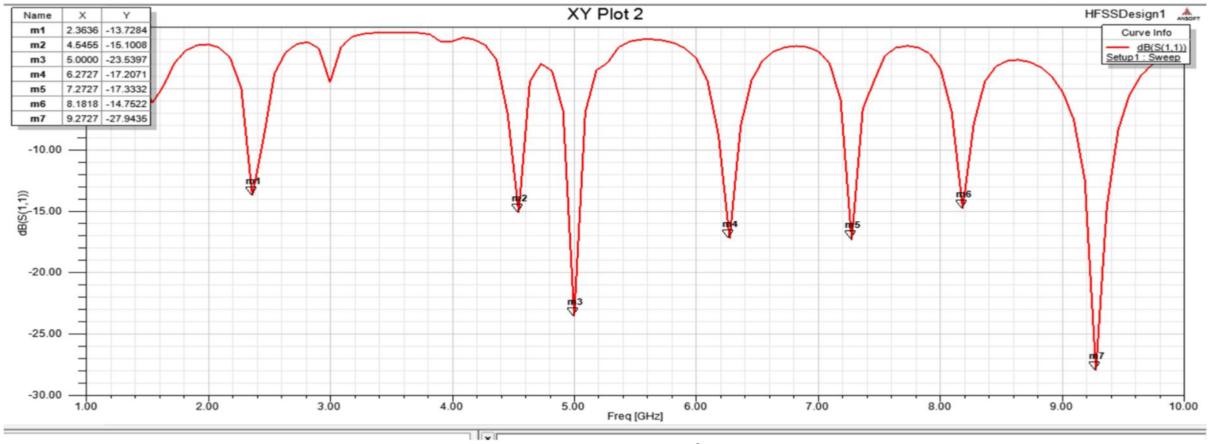


Figure 9: Return loss of 3rd iteration

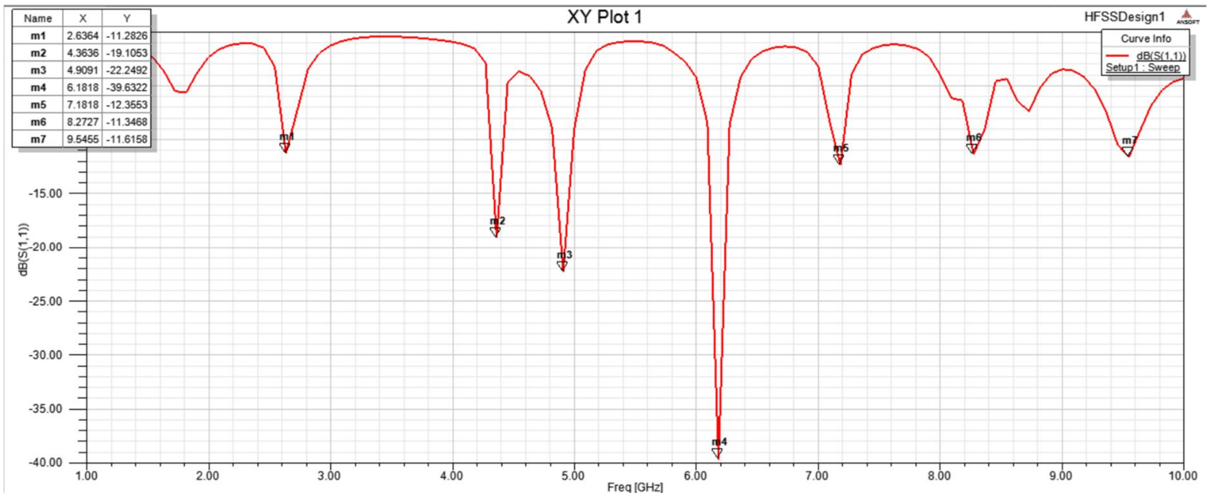


Figure 10: Return loss of 4th iteration

VSWR is Voltage Standing Wave Ratio it shows the impedance mismatch between the feeding system and antenna. Higher VSWR means higher mismatch. The acceptable value of VSWR is less than 2 and it is a dimension less quantity. The VSWR v/s frequency curve of 0th, 1st, 2nd 3rd and 4th iteration of proposed antenna are shown in Figure 11, 12, 13, 14 and 15 respectively. The comparisons of simulated results are shown in Table 2.

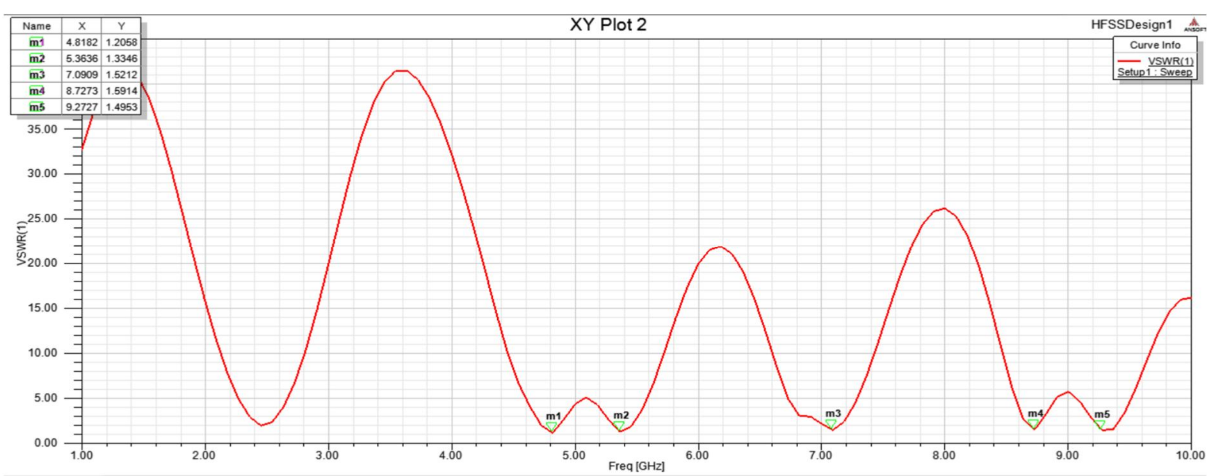


Figure 11: VSWR v/s frequency curve of 0th iteration of proposed antenna

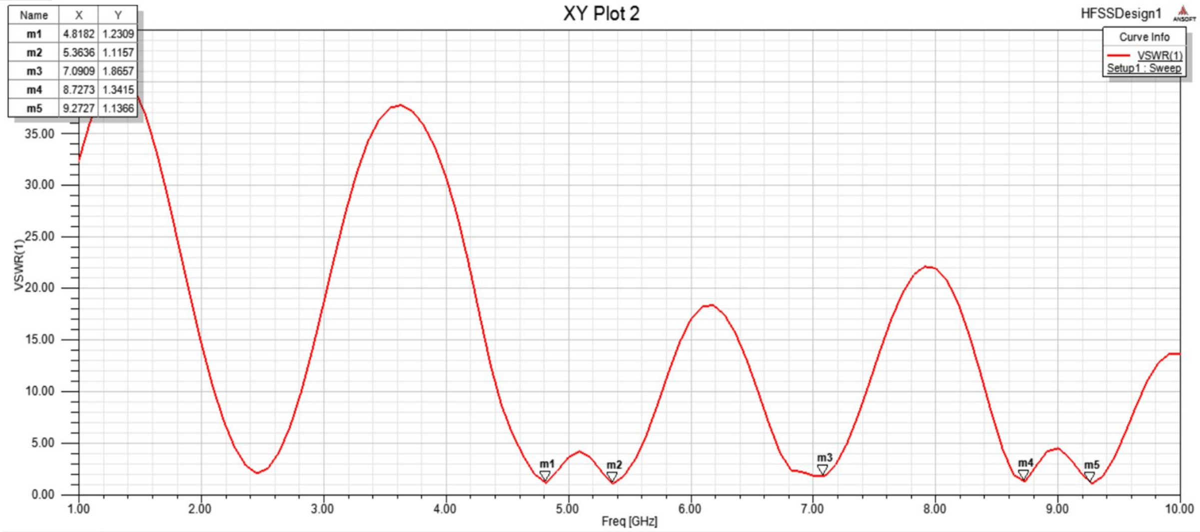


Figure 12: VSWR v/s frequency curve of 1st iteration of proposed antenna

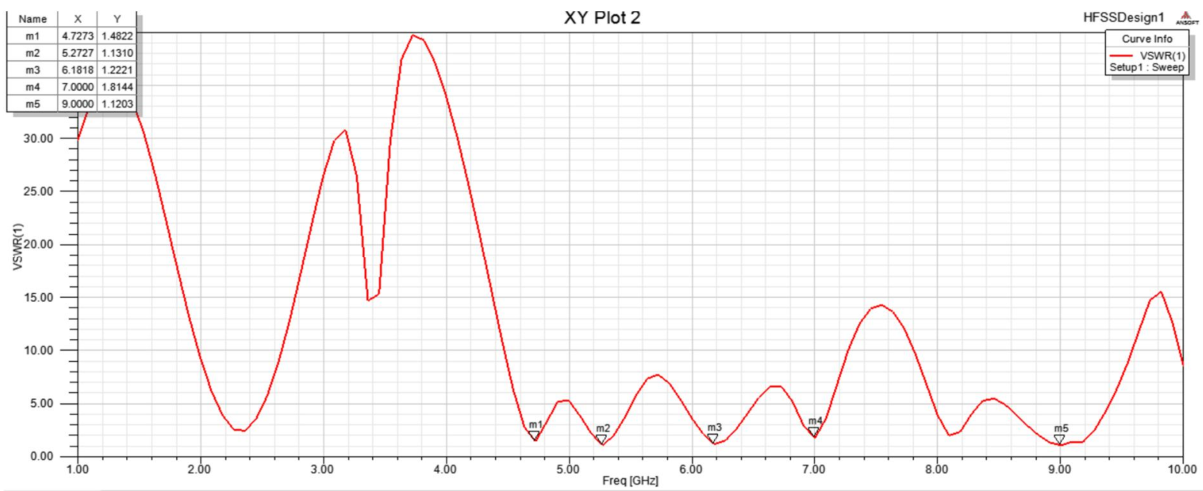


Figure 13: VSWR v/s frequency curve of 2nd iteration of proposed antenna

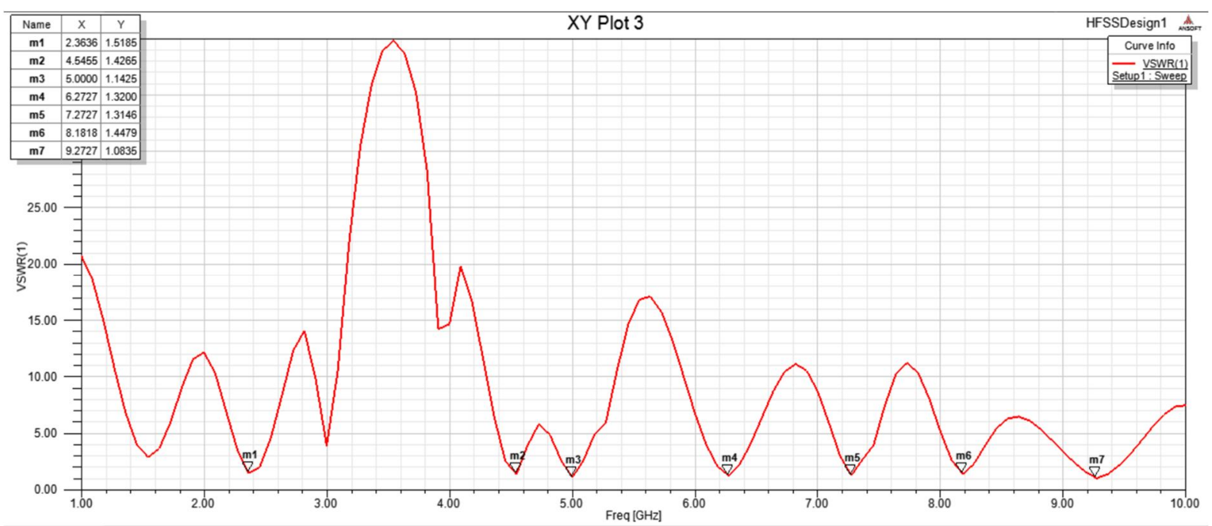


Figure 14: VSWR v/s frequency curve of 3rd iteration of proposed antenna

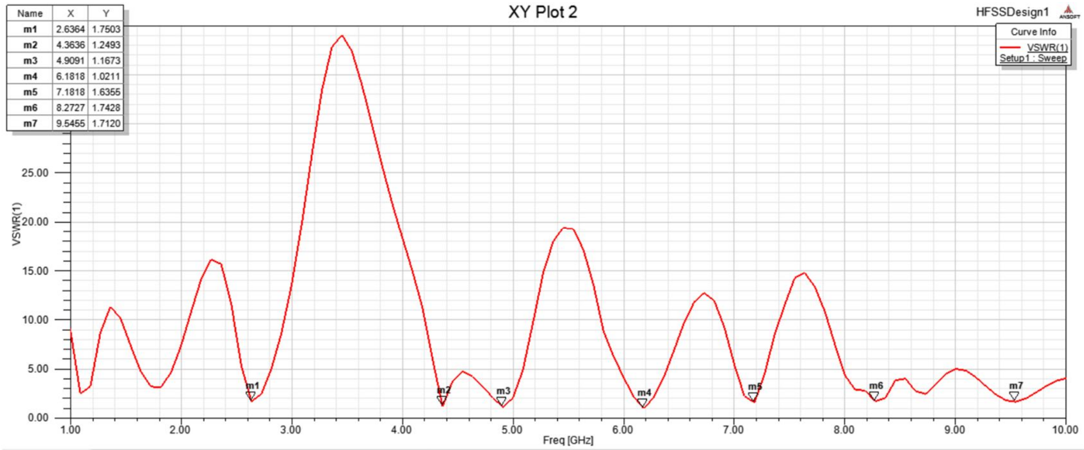


Figure 15: VSWR v/s frequency curve of 4th iteration of proposed antenna

IV. GAIN

The outcome of simulated results of return loss and gain confirms the good performance for proposed design of microstrip patch antenna. It can be seen from figure 7.4 dB is overall gain obtained in 0th iteration, 5.5 dB is overall gain obtained in 1st iteration , 2.7 dB is overall gain obtained in 2nd iteration , 3.01 dB is overall gain obtained in 3rd iteration , 3.1 dB is overall gain obtained in 4th iteration. Gain shows the directional capability and efficiency of antenna. The acceptable value of antenna gain is 3dB or more. The 3-D overall gain plot of proposed antenna for 0th, 1st, 2nd, 3rd and 4th iteration is shown in Figure 16, 17, 18, 19 and 20.

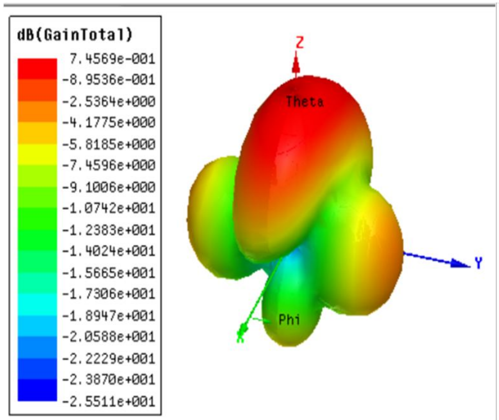


Figure 16: Gain of 0th iteration of proposed antenna

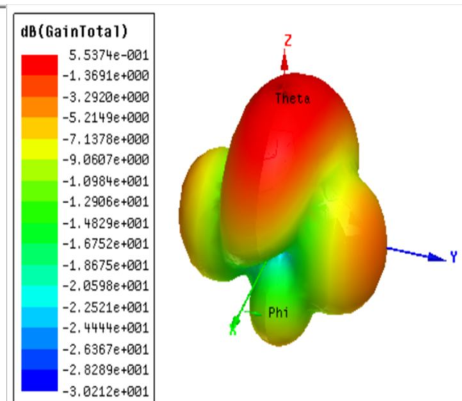


Figure 17: Gain of 1st iteration of proposed antenna

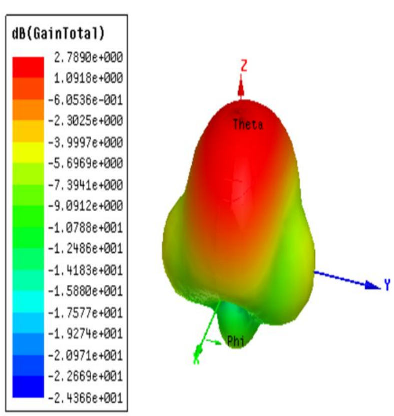


Figure 18: Gain of 2nd iteration of proposed antenna

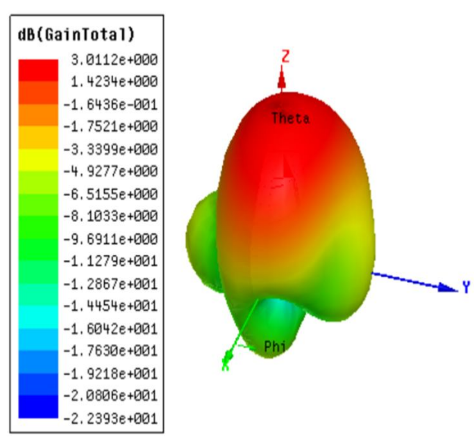


Figure 19: Gain of 3rd iteration of proposed antenna

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

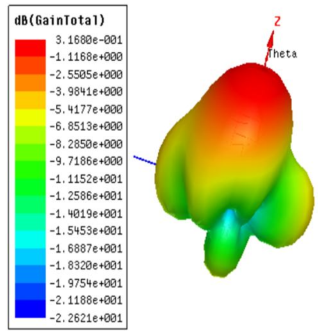


Figure 20: Gain of 4th iteration of proposed antenna

Table 2: Comparison of Various Iterations of Proposed Antenna

ANTENNA	ITERATIONS	FREQUENCY in (GHz)	RETURN LOSS (dB) S11	OVERALL GAIN (dB)	GAIN AT VARIOUS FREQUENCIES (dB)	VSWR
PROPOSED ANTENNA (18*35)	ITERATION 0	4.81	-20.6	7.4	-1.7	1.2
		5.36	-16.87		2.1	1.3
		7.09	-13.69		1.3	1.5
		8.72	-12.83		-8.4	1.5
		9.27	-14.04		4.6	1.4
	ITERATION 1	4.81	-19.7	5.5	-1.9	1.2
		5.36	-25.24		5.7	1.1
		7.09	-10.39		1.09	1.8
		8.72	-16.72		-9.1	1.3
		9.27	-23.88		4.7	1.1
	ITERATION 2	4.72	-14.23	2.7	-3.01	1.4
		5.27	-24.22		-1.28	1.1
		6.18	-20		4.83	1.2
		7	-10.77		3.09	1.8
		9	-24.92		6	1.1
	ITERATION 3	2.36	-13.72	3.01	-6.4	1.5
		4.54	-15.1		-5.9	1.4
		5	-23.53		-3.4	1.1
		6.27	-17.2		4.6	1.3
		7.27	-17.33		1.3	1.3
		8.18	-14.75		3.8	1.4
		9.27	-27.94		5.6	1
	ITERATION 4	2.63	-11.28	3.1	-5.21	1.7
		4.36	-19.1		-6.56	1.2
		4.9	-22.24		-3.91	1.1
		6.18	-39.63		3.7	1
		7.18	-12.35		8.9	1.6
		8.27	-11.34		1.4	1.7
		9.54	-11.61		6.7	1.7
EXISTING ANTENNA(40×40)		3.4	-29	3.6		

V. CONCLUSION

In this paper, a design of multiband microstrip patch antenna is proposed, which covers the frequency range between 2GHz and 9GHz. The return loss for all resonant frequency is ≤ -10 dB . The maximum gain is 8.9 dB in final iteration. The fourth iteration possess tetra band microstrip patch antenna. The proposed antenna can be used for public sector applications i.e. military, business radio (police and fire) and in space science like radio astronomy. Frequency above 6 GHz are going to be used in future mobile communication in 5G.

REFERENCES

[1] F.Daneshmandian, P.Dekhoda and A.Tavakoli, "A miniaturization circularly polarised microstrip antenna for GPS applications," IEEE 22nd Iranian Conference on Electrical Engineering (ICEE), pp.1653-1656,2014

[2] K. V. Kumar, V. I. Nair and V. Asokan, "Design of a microstrip fractal patch antenna for UWB applications," IEEE 2nd International Conference on Innovation in Information Embedded and Communication Systems (ICIIECS), 2015.

[3] M. M. M. Ali, A. M. Azmy and O. M. Haraz, "Design and implementation of reconfigurable quad-band microstrip antenna for MIMO wireless communication applications," IEEE 31st National Radio Science Conference (NRSC), pp. 27-34, 2014.

[4] M.Sahoo, S.Pattnaik and S.Sahu, "Design of compact UWB hexagonal monopole antenna with frequency notch characteristics," International Conference on Circuit, Power and Computing Technologies (ICCPCT),2015.

[5] M.Susila.T.R.Rao and A.Gupta, "A novel fractal antenna design for UWB wireless communications,"IEEE, International Microwave and RF Conference (IMaRC),pp.118-120,2014.

[6] N.Prema, Anil Kumar, "Design of multiband microstrip patch antenna for C and X" , optik 127 (2016)8812-8818

[7] P.S. Bakariya, S. Dwari, M. Sarkar, M.K. Mandal, "Proximity-Coupled microstrip antenna for bluetooth, WiMAX, and WLAN applications," IEEE AntennasWirel. Propag. Lett. 14 (2015).

[8] S.Behera and D.Barad, "A novel design of microstrip fractal antenna for wireless sensor network," IEEE, Inernational Confrence of Power, Energy, Information and Communication, pp. 0470-0474,2015.

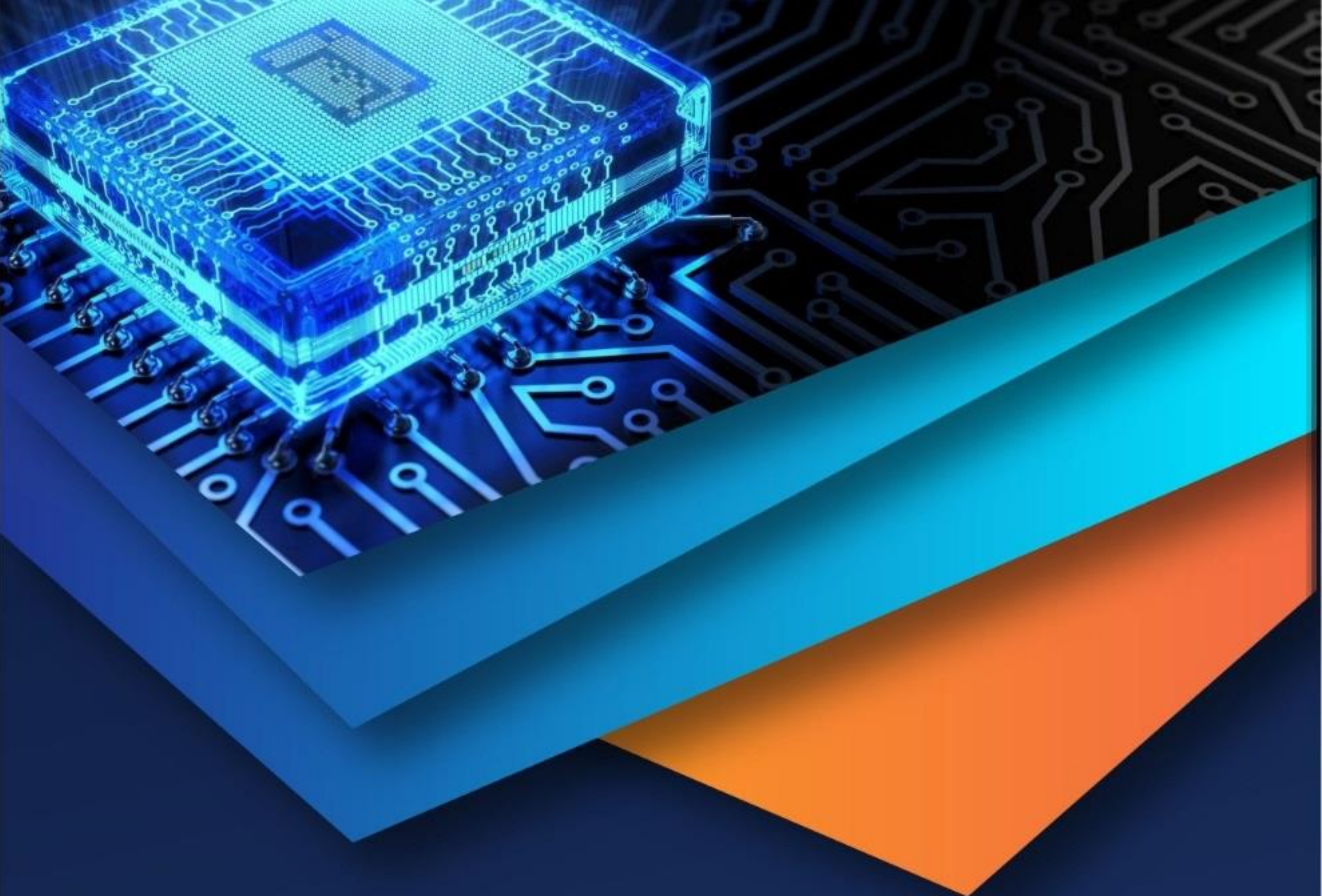
[9] T.Landeau, O.Losito, G.Palma, V.Portosi, A. Jouanneaux and F.Prudenzano, "Multiband Rohmbus Monopole Antenna," GeMic, pp.367-370,2015

[10] V.vaid and S.Agarwal, "Bandwidth optimization using fractal geometry on rectangular microstrip patch antenna with DGS for wireless applications," International conference on medical Imaging, M-health and Emerging Communication Systems (MedCom), pp.162-167,2014

[11] V.D.Raj, A.M.Prasad, M.Satyanarayana and G.M.V. Prasad, "Implementation of printed microstrip apollonian gasket fracxtal antenna for multiband wireless applications," IEEE, International Conference on SPACES, pp.200-204,2015

[12] Z.H. feng and M.C. Liang, "The study of Koch fractal applied to isosceles triangle patch antenna," Proceedings of IASP, pp. 229-230,2014

[13] Y. Kumar and S. Singh, "A Quad band hybrid fractal antenna for wireless applications," IEEE, International Advance Computing Conference (IACC), pp. 730-733, 2015.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY