

# Design Inset Fed Microstrip Patch Antenna for L-Band Applications



V.Saidulu

**Abstract:** Present paper focuses on design and simulation of an inset fed rectangular microstrip patch antenna for GPS applications. The proposed antenna is designed at frequency 1.9 GHz which comes in L-Band region and simulated using Electromagnetic Simulator such as HFSS simulation software with three different dielectric substrates and comparing their performance characteristics such as gain, bandwidth, beam width, VSWR and return loss. The simulation results shows that the maximum bandwidth is obtained with FR4 substrate and the minimum bandwidth is found with Arlon AD320 substrate, where as the maximum gain obtained with air (vacuum) substrate. The proposed antenna has been designed for the range of 1.9 GHz and which is highly suitable for GPS applications.

**Keywords:** Dielectric constant, return loss, Inset Fed and VSWR etc.

## I. INTRODUCTION

Microstrip patch antenna is an element can be used many applications. In wireless and mobile communication applications there are several types of antennas are used but the most popular type of antenna is Inset fed rectangular microstrip patch antenna [1-2]. The antenna can be easily mounted on rockets, satellite and missiles without major modifications. However, this antenna have some limitations over the conventional microwave antennas including narrow bandwidth (1-5%), gain is lower which is around (5dB)[2-3]. The advantages of inset fed technique over the conventional feeding technique is that easily fabricated, simplicity in modeling the process and also good impedance matching. The proposed rectangular patch with inset fed is designed with L-band frequency range of 1.9 GHz. The bandwidth of antenna can be improved by inset fed and 90 degree hybrid feed techniques [3-5]. The proposed microstrip antenna is designed with inset fed using three different dielectric constant and comparing the performance characteristics such as gain, return- loss, bandwidth and beam-width. It is observed practically that the bandwidth increases as increasing the thickness of the substrate [6]. The geometry of the patch antenna with radiating edges is shown in Fig. 1[7-8]. The designed frequency is same as operating frequency; antenna is operating on 1.9GHz which is used in GPS applications [8].

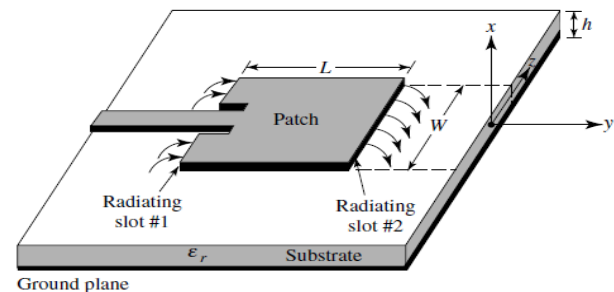
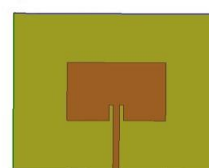


Fig 1 Patch antenna with Inset fed [8]

## II. MICROSTRIP ANTENNA DESIGN

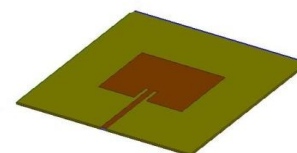
Antenna design is challenging task, any antenna to design, two things are most important one is selection of suitable substrate with dielectric constant value and other one is choosing frequency range selection [1-3]. The proposed inset fed rectangular microstrip patch antenna is designed at L-band frequency (1.9GHz) with three different dielectric substrate materials such as FR4, Arlon AD320 and Vacuum and which are having dielectric constant ( $\epsilon_r = 4.4, 3.2, 1.0$ ). The transmission line model is used for designing the antenna dimensions such as patch length, patch width, fed point location where the antenna is perfectly matched with free space impedance [9-11]. Design antenna dimensions with different dielectric constant which is shown in Table 1. The microstrip patch with inset fed is shown in Fig. 2. The designed frequency of antenna is same as operating frequency; antenna is operating on 1.9GHz which is used in GPS applications.



(a) FRONT VIEW



(b) BACK VIEW



(b) 3D VIEW STRUCTURE

Fig: 2 Patch antenna with inset fed technique

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V.Saidulu\*, Assistant Professor, Department of ECE, Mahatma Gandhi Institute of Technology, Email id: [saiduluvadtya@gmail.com](mailto:saiduluvadtya@gmail.com)

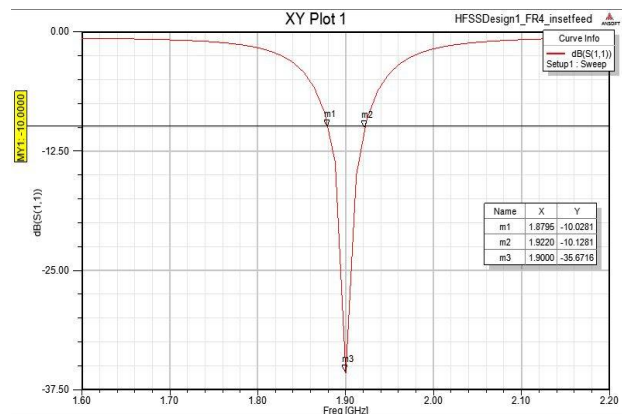
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**Table-1: Design dimensions of Inset fed rectangular microstrip patch antenna with different dielectric substrates**

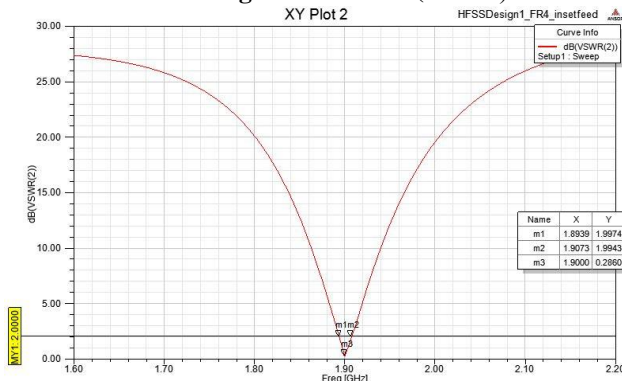
Design antenna dimensions	FR4 substrate ( $\epsilon_r=4.4$ )	Arlon AD320 substrate ( $\epsilon_r=3.2$ )	Vacuum (AIR) substrate ( $\epsilon_r=1.0$ )
Substrate ground width ( $W_g$ )	100 mm	100 mm	120 mm
Substrate ground length ( $L_g$ )	100 mm	100 mm	120 mm
Height of substrate (h)	1.6 mm	1.6 mm	3mm
Patch width ( $W_p$ )	48 mm	52 mm	84.5 mm
Patch length ( $L_p$ )	37.2 mm	44.3mm	74.5 mm
Relative permittivity	4.4	3.2	1

## III. RESULTS AND DISCUSSION

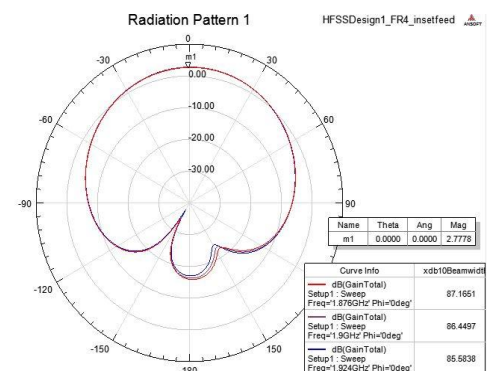
The antenna is designed at 1.9GHz which is same as antenna operating frequency. The results obtained from the three different dielectric constants which are shown in Table 2. The simulation result of patch with FR4 substrate found 40MHz maximum bandwidth, beam-width is 87.61 degree and 2dB gain is obtained from the radiation patterns which is shown in Fig. 5 and Fig.6 at which return loss (RL) = -35.67 dB. The VSWR plot is shown in Fig.3 and Fig. 4. From Fig.5 and 6, it is observed the gain of the antenna in elevation plane is 2.77dB and in azimuth plan is 2.77dB. The 3D radiation patterns with FR4 substrate is shown in Fig. 7. Antenna designed with Arlon AD320 substrate which obtained 6db gain, 25MHz bandwidth, 81.71 degree beam-width is calculated from the radiation patterns is shown in Fig. 10 and Fig.11. The return loss and VSWR plot is shown in Fig 8 and 9. From Fig. 10 and 11, observed the gain of antenna in elevation and azimuth plane is 6.37dB. The 3D radiation pattern is shown in Fig. 12. Whereas the antenna simulated with vacuum as substrate, observed that the maximum gain is 9.72dB, bandwidth is 39GHz and beam width is 58.41 degree is obtained from the radiation patterns is shown in Fig. 15 and Fig.16. The return-loss and VSWR plot is shown in Fig.13 and 14. From Fig. 15 and 16, it is found that the gain of antenna in elevation and azimuth plane is 9.72dB and 9.71dB. The comparison of simulation results of microstrip patch antenna with different dielectric constants is shown in Table 2,



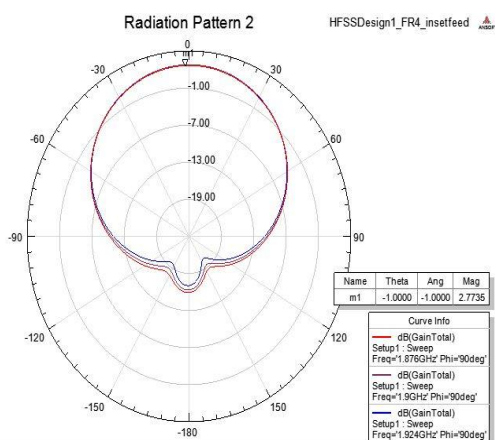
**Fig.3 Return loss ( $\epsilon_r = 4.4$ )**



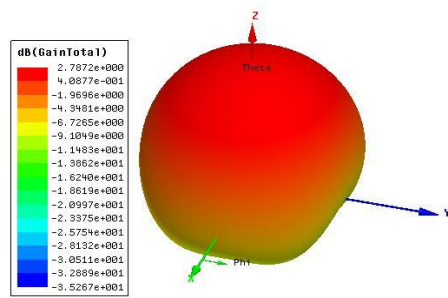
**Fig.4 VSWR ( $\epsilon_r = 4.4$ )**



**Fig. 5 Antenna radiation pattern at 0 deg. ( $\epsilon_r = 4.4$ )**



**Fig. 6 Antenna radiation pattern at 90 deg. ( $\epsilon_r = 4.4$ )**



A. Radiation pattern without Antenna

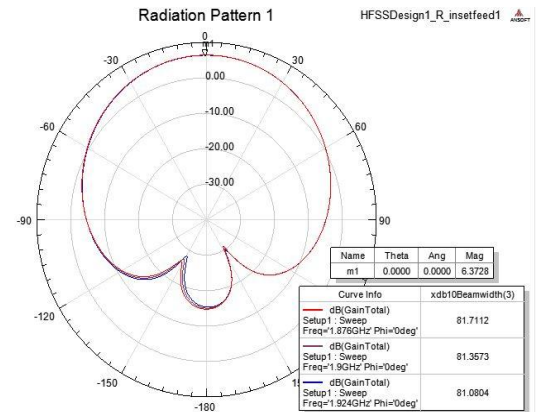
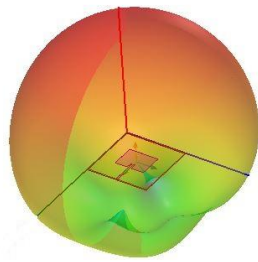


Fig. 10: Radiation pattern at 0 deg. ( $\epsilon_r=3.2$ )



B. Radiation pattern with Antenna

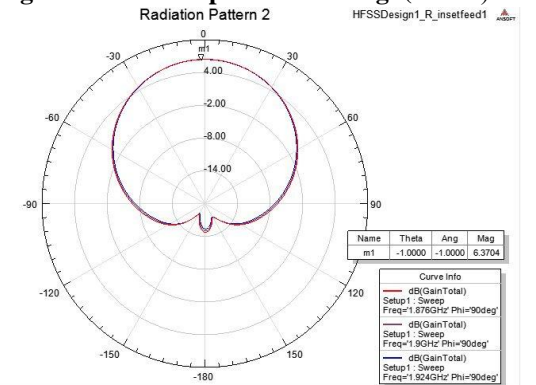


Fig. 11 Radiation pattern at 90 deg. ( $\epsilon_r=3.2$ )

Fig7: 3D radiation pattern of antenna ( $\epsilon_r=4.4$ )

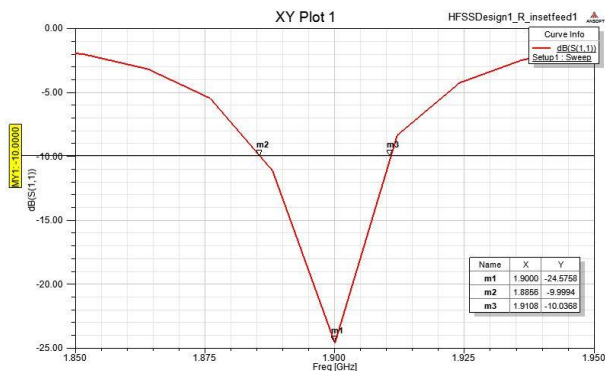


Fig. 8: Return loss of Antenna ( $\epsilon_r=3.2$ )

3.2.5 3D Radiation pattern with antenna

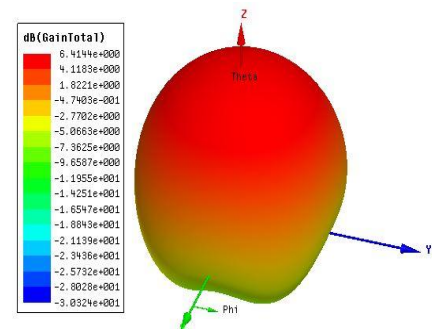


Fig. 12: 3D radiation pattern antenna ( $\epsilon_r=3.2$ )

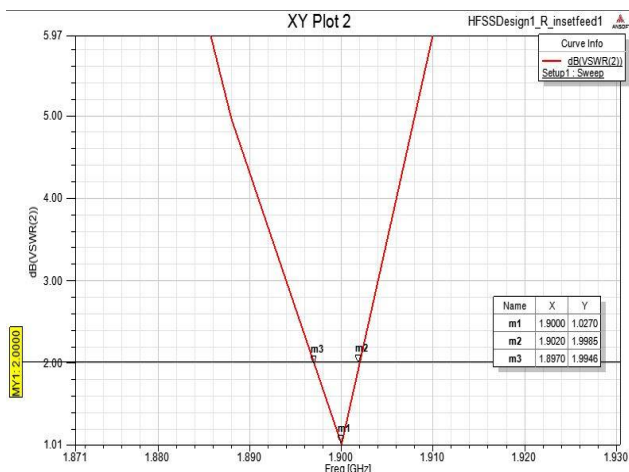


Fig. 9 VSWR of antenna ( $\epsilon_r=3.2$ )



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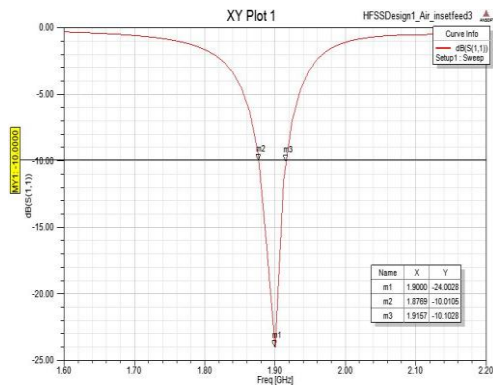


Fig. 13 Return loss ( $\epsilon_r=1.0$ )

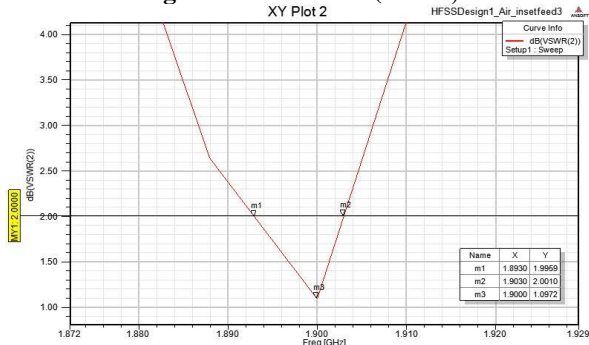


Fig. 14: VSWR of antenna with vaccum ( $\epsilon_r=1.0$ )

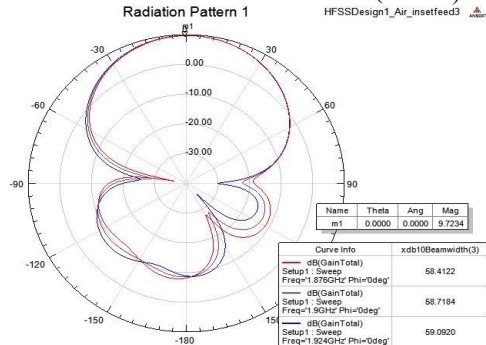


Fig. 15: Radiation pattern at 0 deg. ( $\epsilon_r=1.0$ )

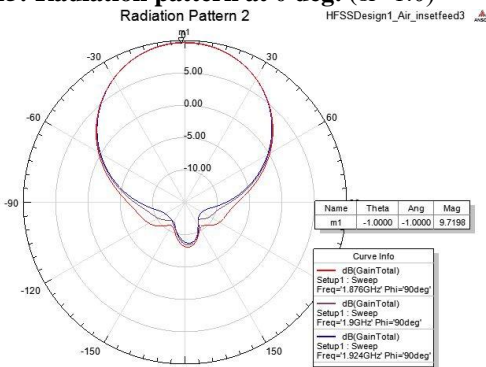


Fig. 16: Radiation pattern at 90 deg. ( $\epsilon_r=1.0$ )

Table 2: Simulation results of gain, band-width, beam-width and return-loss with different substrate materials

S.NO	Parameters	FR4 substrate ( $\epsilon_r=4.4$ )	Arlon AD320A ( $\epsilon_r=3.2$ )	Vacuum ( $\epsilon_r=1.0$ )
1	Gain (dB)	2	6	9.72
2	Bandwidth (MHz)	40	25	39

3	Return loss (dB)	-35.67	-24.57	-24
4	Beam width (Deg.)	87.61	81.71	58.41

## IV. CONCLUSION

The maximum bandwidth and low gain is obtained with dielectric constant ( $\epsilon_r=4.4$ ). The maximum gain is obtained with dielectric constant ( $\epsilon_r=1.0$ ). As the higher beam-width as the lower gain which is obtained at  $\epsilon_r=4.4$ . The better VSWR=1.9 ( $\leq 2$ ) is obtained ( $\epsilon_r=3.2$ ). As increasing beam width antenna gain is decreasing at  $\epsilon_r=4.4$ . The proposed antenna has been designed for the range of 1.9 GHz, this frequency range is highly suitable for GPS applications.

## ACKNOWLEDGMENT

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## REFERENCES

1. IJ Bhal and P Bhartia, "Microstrip antennas", Artech house, 1980
2. Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley & Sons.
3. T.A. Milligan, Modern Antenna Design, McGraw-Hill Book Co., New York 1885.
4. C.A. Balanis, Advanced Engineering Electromagnetics, John Wiley & Sons, New York, 1989.
5. A.G. Derneryd, "A Theoretical Investigation of the Microstrip Antenna Element, IEEE Trans. Antenna Propagat. Vol. AP-26, No.4, PP. 532-535, July 1978.
6. K.R. Carver and J.W. Mink, "Microstrip Antenna Technology, IEEE Trans. Antenna Propagat., Vol. AP-29, No.1, pp. 2-24, Jan 1981.
7. Nazish Irfan, Mustapha C.E. Yagoub and Khelifa Hettak, "Design of a Microstrip -Line-Feed Inset Patch Antenna for RFID Applications, IACSIT International Journal Engineering and Technology, Vol.4, No.5, Oct. 2012
8. Vinayak Samarthay, Swarna Pundir, Bansilal, "Designing and Optimization of Inset Feed Rectangular Microstrip Patch Antenna for Varying Inset Gap and Inset length" International Journal of Electronics and Electrical Engineering, Vol.7, No.9, 2014, pp. 1007-1013.
9. Sajina Pradhan, Dongyou Choi, "Inset Feed Microstrip Patch Antenna for wireless communications at 2.45GHz", Journal of Korea Institute of Information and Communication Engineering 18(8), pp. 178-1790, August 2014.
10. Jaget-Singh, "Inset Feed Microstrip Patch Antenna" International Journal of Computer Science and Mobile computing, Vol.5, Issue. 2, February 2016.
11. Pradeep HS, "Inset Feed Microstrip Patch Antenna for X-Band Applications, International Journal of Engineering Research in Electronics and Communication Engineering, Vol.5, Issue. 7 July 2018.
12. M Vinoth, Dr. R. Vallikannu, "A Compact Inset Fed Microstrip Patch Antenna with Defected Ground structure for Sub-6GHz/5G Applications" Solid State Technology, 2020.

## AUTHORS PROFILE



Assistant Prof. in ECE Department, MGIT, Hyderabad. His research area is antennas and mobile communications. He has more than 31 papers published to his credit.

**Dr. V. Saidulu**, was in Hyderabad, T.S, INDIA, in 1974. He received his B.Tech in ECE, in the year 1998 and M.Tech. in ECE in the year 2001 from Institute of Technology Banaras Hindu University, U.P He received his Ph.D degree from JNTUH, Hyderabad. Currently he is working as Sr.

