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Design Inset Fed Microstrip Patch Antenna for L-Band Applications

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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 (vaccum) 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].

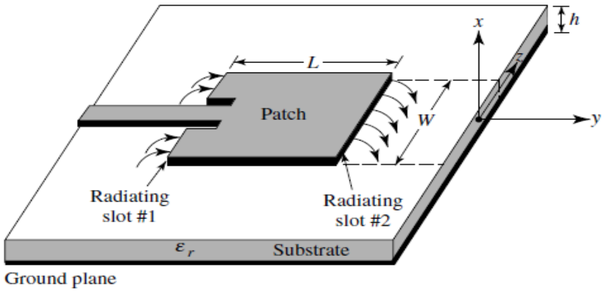
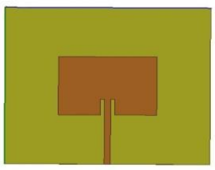


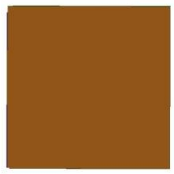
Fig 1 Patch antenna with Inset fed [8]

II. MICROSTRIP ANTENNADESIGN

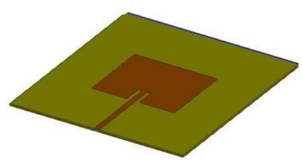
Antenna design is challenging task, any antenna to design, two things are most important one is selection of suitable substrate with dielectric constant value and other one is choosing frequency range selection [1-3]. The proposed inset fed rectangular microstrip patch antenna is designed at L-band frequency (1.9GHz) with three different dielectric substrate materials such as FR4, Arlon AD320 and Vaccum and which are having dielectric constant (εr= 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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Table-1: Design dimensions of Inset fed rectangular microstrip patch antenna with different dielectric substrates

Design antenna dimensions	FR4 substrate (εr=4.4)	Arlon AD320 substrate (εr=3.2)	Vaccum (AIR) substrate (εr=1.0)
Substrate ground width (W_g)	**100 mm**	**100 mm**	**120 mm**
Substrate ground length (L_g)	**100 mm**	**100 mm**	**120 mm**
Heighty 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 vaccum 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,

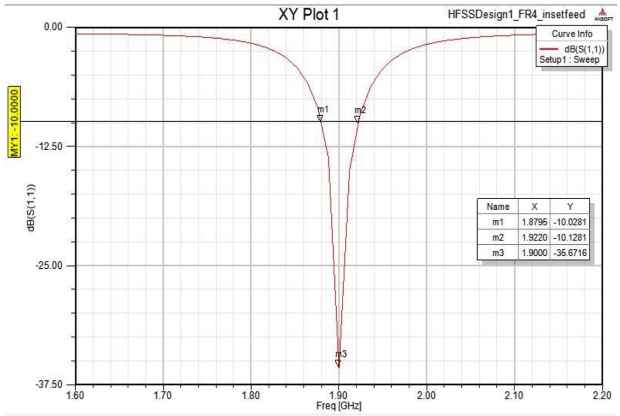

Fig.3 Return loss (εr =4.4)

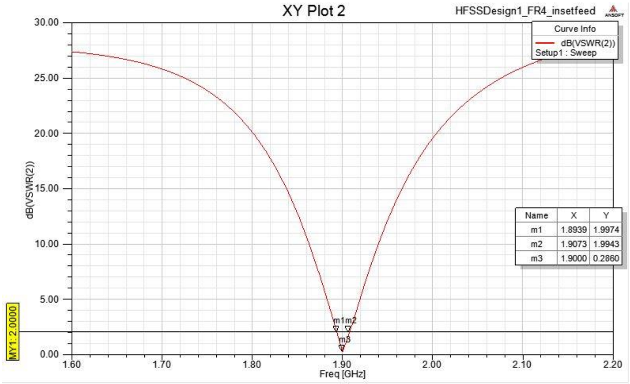

Fig.4 VSWR (εr =4.4)

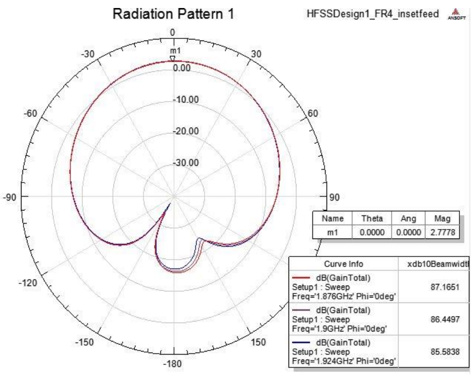

Fig. 5 Antenna radiation pattern at 0 deg. (εr =4.4)

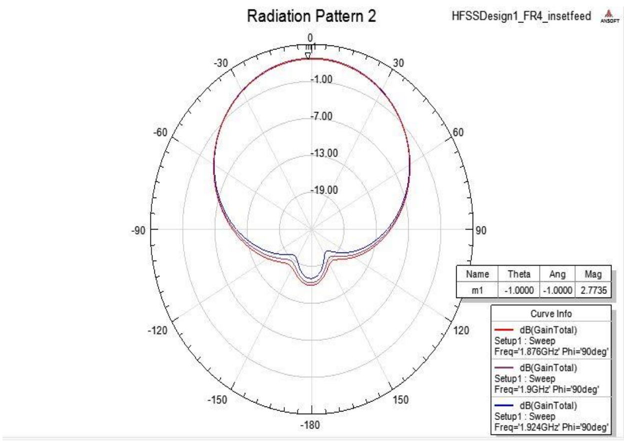

Fig. 6 Antenna radiation pattern at 90 deg. (εr =4.4)

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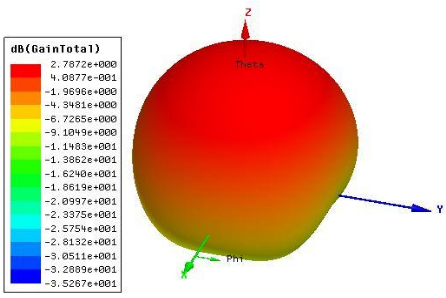
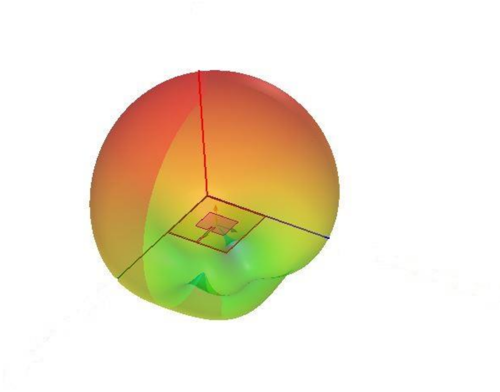


A. Radiation pattern without Antenna



B. Radiation pattern with Antenna

Fig7: 3D radiation pattern of antenna (εr =4.4)

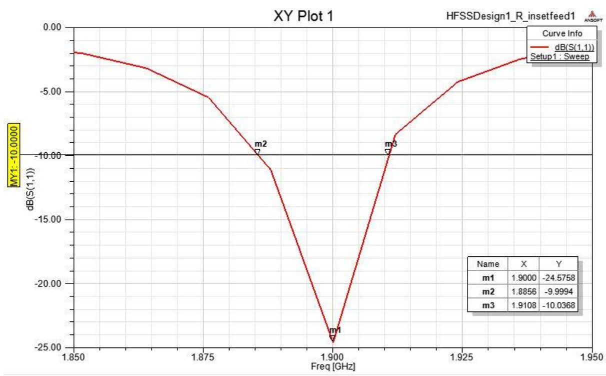


Fig. 8: Return loss of Antenna (εr =3.2)

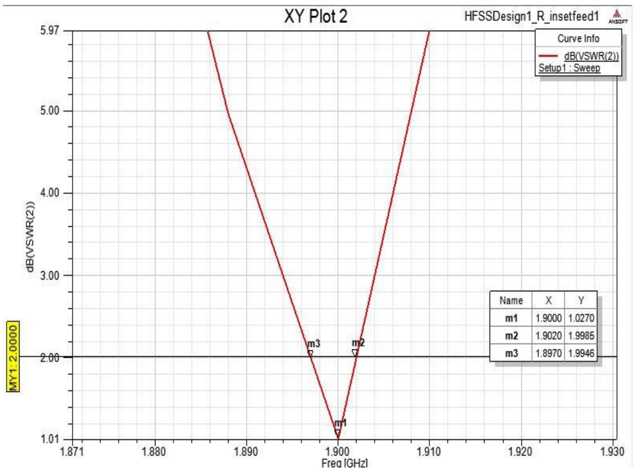


Fig. 9 VSWR of antenna (εr =3.2)

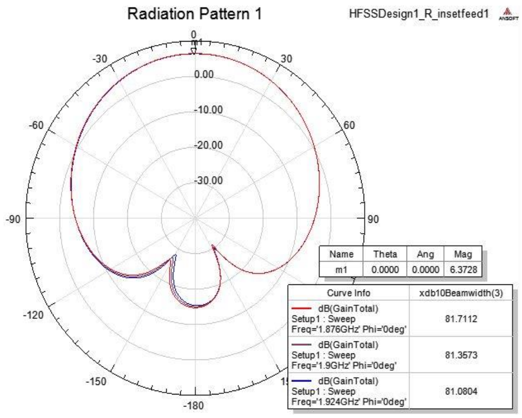


Fig. 10: Radiation pattern at 0 deg. (εr=3.2)

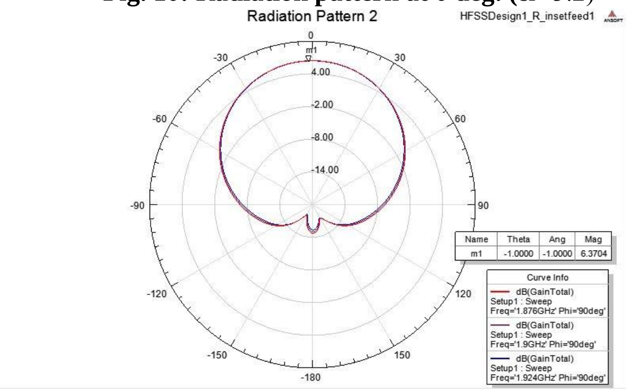
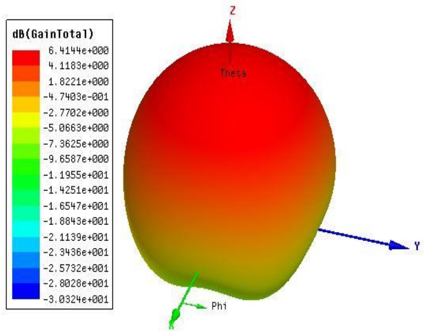
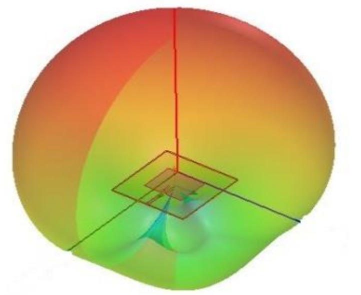


Fig. 11 Radiation pattern at 90 deg.(εr=3.2)



3D Radiation pattern without Antenna

3.2.5 3D Radiation pattern with antenna



3D Radiation pattern with Antenna

Fig. 12: 3D radiation pattern antenna (εr=3.2)

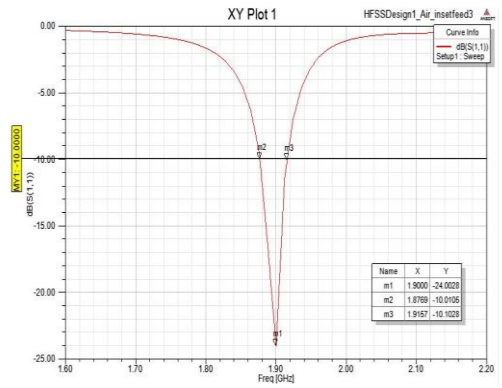


Fig 13 Return loss (εr=1.0)

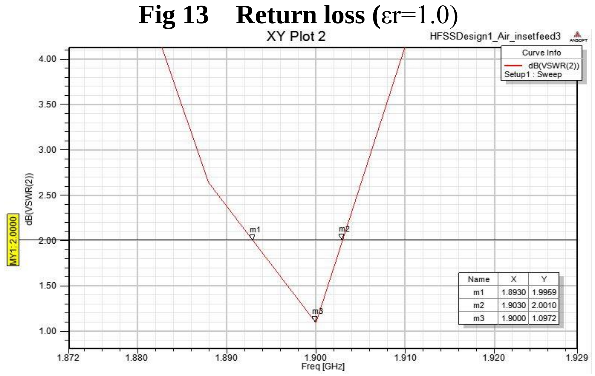


Fig. 14: VSWR of antenna with vaccum (εr=1.0)

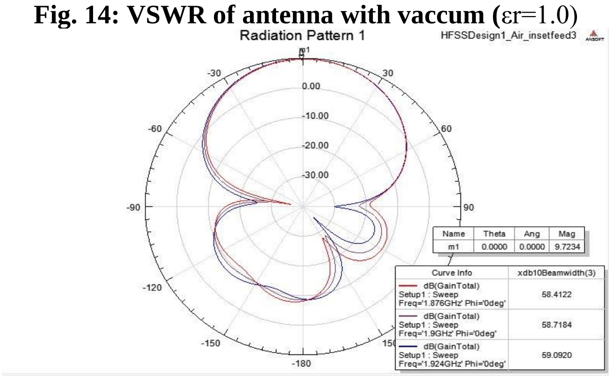


Fig. 15: Radiation pattern at 0 deg. (εr=1.0)

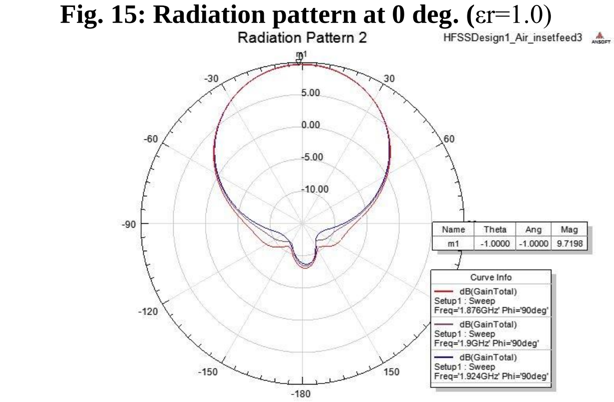


Fig. 16: Radiation pattern at 90 deg.(εr=1.0)

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

S.NO	Parameters	FR4 substrate (εr=4.4)	Arlon AD320A (εr=3.2)	Vaccum (εr=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 (εr=4.4). The maximum gain is obtained with dielectric constant (εr=1.0). As the higher beam-width as the lower gain which is obtained at εr=4.4 The better VSWR=1.9 (≤ 2) is obtained (εr =3.2). As increasing beam width antenna gain is decreasing at εr=4.4. The proposed antenna has been designed for the range of 1.9 GHz, this frequency range is highly suitable for GPS applications.

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