Effect of ground slotting and substrate slotting on Sierpinski Carpet Fractal Antenna

Mr. Nitin Kumar Sharma[1], Dr. Rakesh Kumar Joon[2]

[1] M.Tech scholar, Deptt. Of ECE, GITAM, Kablana, Jhajjar,
[2] Associate Professor, Deptt. Of ECE, GITAM, Kablana, Jhajjar.

In this paper we design the Sierpinski carpet fractal antenna with substrate and ground slotting. The proposed antenna is designed on FR4 epoxy substrate with dielectric constant of 4.4 and fed with 50 ohms micro strip line. In our work there is a comparison between the result of slotting in ground as well as slotting in substrate. The Dimensions for the sierpinski Carpet are 16mm*18mm*1.6mm. The antenna structure is simulated using An Soft HFSS software. The antennas characteristics such as return loss, radiation pattern and VSWR of the antenna are analyzed and presented. The proposed fractal antenna can be used in the frequency range from 2-20 GHz. In our purposed work the simulated result of sierpinski carpet fractal antenna with ground as well as substrate slotting is much better than the slotting in ground.

Keywords - Micro strip Antenna, Fractal, Sierpinski Carpet Fractal Antenna (SCFA)

I. Introduction

The fractal antenna plays a most important role in the field of wireless communications due to its multiband and wideband characteristics. This is the reason, that the use of microstrip fractal antenna geometry has been a recent topic for the researchers in the world [1].The fractal means the irregular fragments, which are the set of complex geometries that possess the self-similarity structures [2]. Fractal geometries of antenna also reduce the overall size of antenna and produce the multiple resonant bands [3].Fractal antenna concept was given by Nathen Cohen in 1995. The self-similarity and space filling properties of fractal antennas make it possible to use for UWB applications [4]. To increase the radiation efficiency of antennas, discontinuities introduced in the patch of fractal antenna geometry [5]. Partial ground planes are used in antennas to increase the relative bandwidth of antennas [4].

II.The Purposed Antenna Configuration

The square patch was selected for initial design. Fig1 shows the sirpinski carpet fractal antenna and patch antennas with ground and substrate slotting. Fig 1 (a) shows sierpinski carpet fractal antennas third iteration with slotting in ground and fig 1 (b) shows that the designed antenna with slotting in ground as well as slotting in substrate.

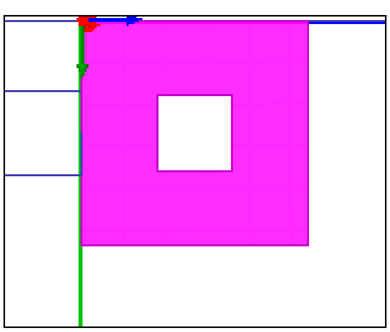
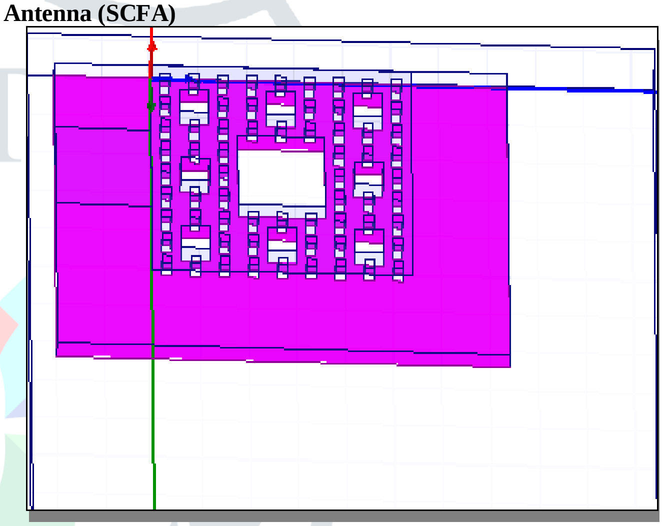


Fig 1 (a) shows sierpinski carpet fractal antennas third iteration with slotting in ground



1 (b) shows that the designed antenna with slotting in ground as well as slotting in substrate

III ANTENNA DESIGN

A. SIERPINSKI CARPET FRACTAL GEOMETRY

The design starts with Sierpinski Carpet Planar Antenna. The first basic rectangular patch is designed. In the first iteration the basic square patch is segmented by removing the middle square from it, by taking scale factor 1/3. For second iteration segments are done on remaining eight squares following the scale factor of 1/3. The same procedure is used for further iterations with same scale factor. By using this method we have designed four iterations as shown in Figure 1(a). This basic rectangular patch is designed on a FR4 substrate of thickness 1.6 mm and relative permittivity of 4.4.

B. PATCH ANTENNAS GEOMETRY

In this section the steps under taken for designing the antenna are discussed. The first practical step in antenna design is substrate selection. For our design FR4 substrate is selected. It is one of the most commonly available as well as cheap substrate. It has a dielectric constant of 4.4 and a loss tangent of 0.02. then the no of slots in patch are equal no of slots in substrate.

The geometry of the proposed antenna is shown in figure 1(a). The antenna is designed on 27×27×1.6 mm3 substrate. The dimensions of the antenna are shown in table 1. All the dimensions are obtained after optimization using HFSS software. The antenna structure is shown in figures 1(a) and 1(b).

IV Return Loss

Return loss is the important parameter of antenna it is the difference between forward and reflected power in dB. The acceptable value of return loss is less than -10dB for the antenna to work efficiently. Figure 2 (a) shows the simulated return loss v/s frequency plot of antenna with ground slotting. The curve shows that the 3rd iteration has -26.91 at 5.53GHz frequency. Figure 2 (a) shows the simulated return loss v/s frequency plot of antenna with ground & substrate slotting. The curve shows that the 3rd iteration has -26.91 at 5.53GHz

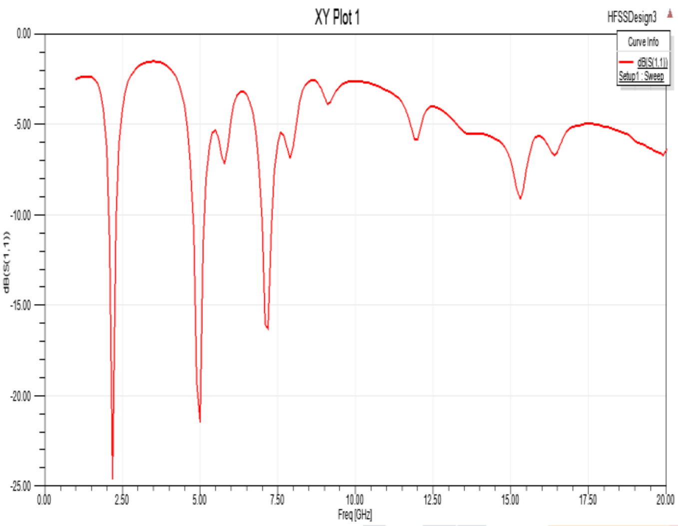


Fig 2(a) return loss for sierpinski carpet fractal antenna

The return loss for patch antenna is given in fig 2(b).

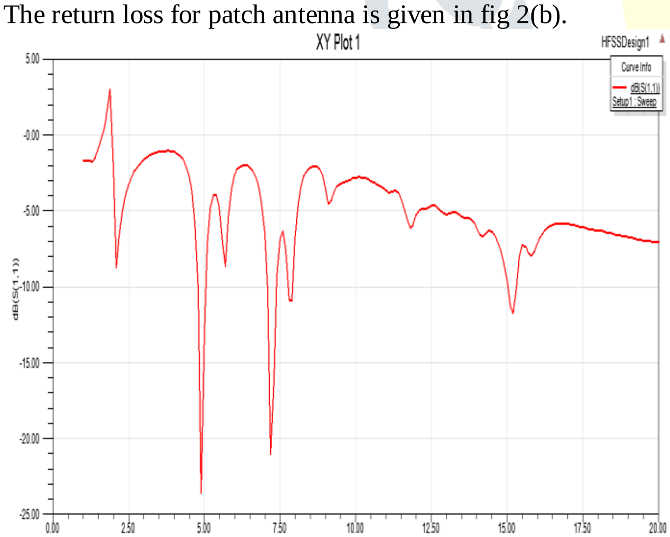


Fig2 (b) return loss for patch antenna

V. VSWR

The VSWR for the sierpinski carpet fractal antenna is given in fig 3(a).

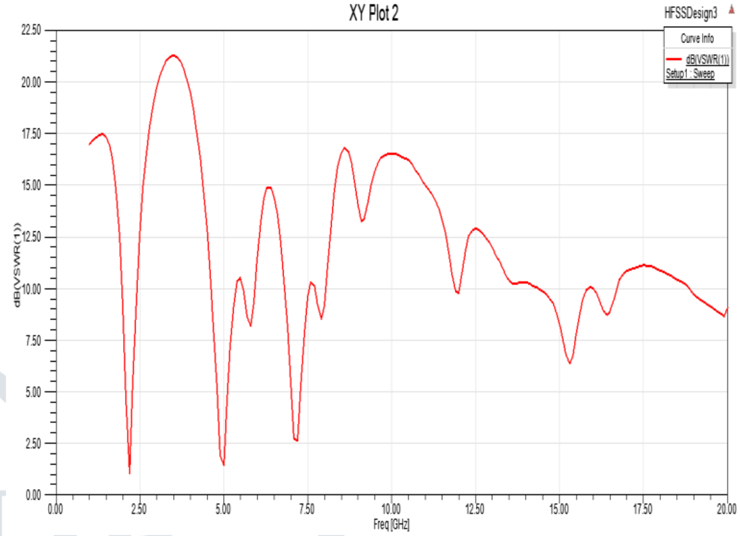


Fig3 (a) VSWR for sierpinski carpet antenna

The VSWR for patch antenna is given in fig3 (b).

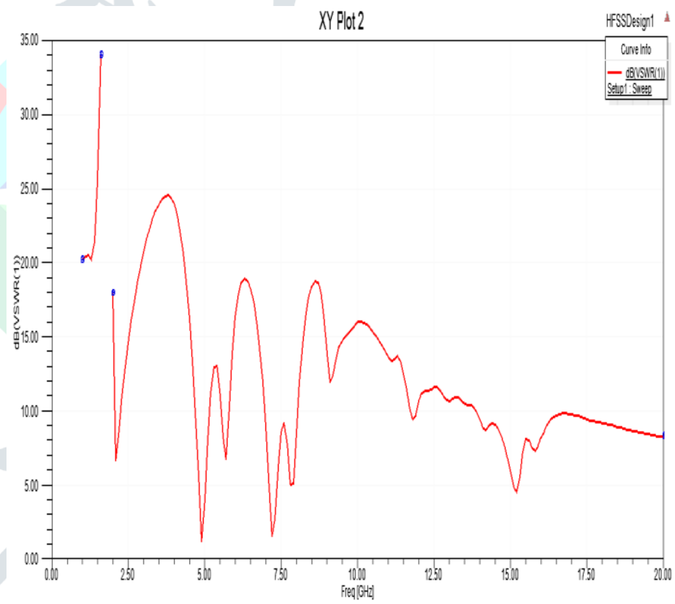


Fig 3 (b) VSWR for patch antennas

The measured values of the return loss and the VSWR are given in table 1 and 2 which are given below

Table 1 for sierpinski carpet fractal (proposed) antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Gain(db)
1	2.4	-25	0.9	7
2	4.9	-22	1	4
3	7	-17	1.1	2
4	14	-19	1.8	2

Table 2 for patch (reference) antenna

Ref. no.	Resonating Frequency(GHz)	Return Loss(db)	VSWR(db)	Gain(db)
1	2.4	-9	4	4
2	4.9	-21	1	1
3	7	-24	1.1	2
4	14	-10	4.8	-2

VI. Radiation pattern

The radiation pattern for sierpinski carpet antenna is given in fig4 (a).

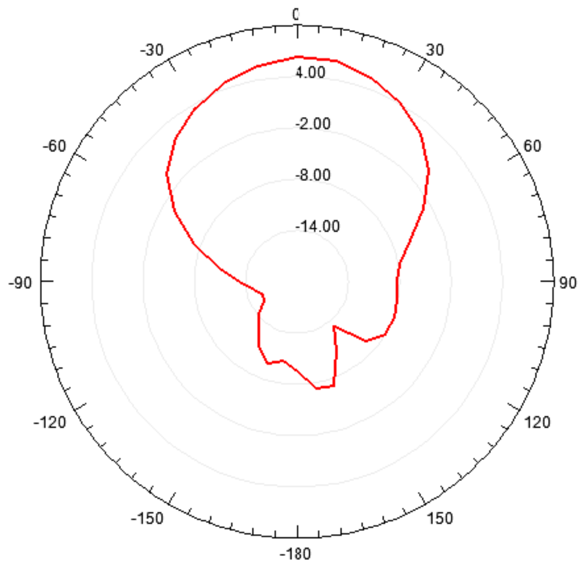


Fig 4(a) simulated radiation pattern for sierpinski carpet antenna

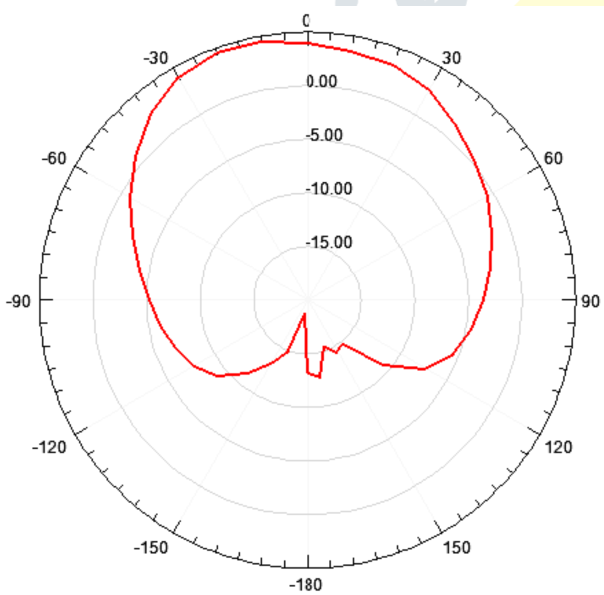


Fig4 (b) simulated radiation pattern for patch antenna

Fig4 (a) and 4(b) shows radiation patterns of sierpinski carpet fractal antenna and patch antenna. It is observed that the E-field pattern is Omni directional with low cross polarization level less than -25db for sierpinski carpet and for patch antenna E-field pattern is near Omni directional with polarization level less than -21db

VII. Conclusion

The sierpinski carpet and patch antennas are designed and its performance characterstics are analysed. The minimum return loss for proposed antenna is -25db at VSWR is 0.9 which is bettere than that the reference antenna. The simulated result of the sierpinski carpet fractal antenna exhibit minimum return loss,omini directional radiation pattern, wide impedence bandwidth, VSWR<2, which is much better then the simulated result of the patch antenna.

Acknowledgment

I would like to thanks Dr.Rakesh Joon (HOD,ECE) and entire team of GITAM in supporting me to carry out this activity.

REFRENCES

[1] B.A. Floyad, C. Hung, and K.K.O," Intra-chip wireless interconnect for clock distribution implemented with integrated antennas, receivers and transmitters," IEEE j solid- state circuits,pp.543-552, may 2002

[2] A.B.M.H. Rashid,W. watanabe and T. Kikkawa," High transmission gain integrated antenna on extremely high resistivity on Si for USI wireless inter connect,"IEEE Electron device Lett.,pp. 731-733,nov 2002

[3] J. Gianvittorio and Y. R. Samii,"Fractal patch antenna,"Deprtment of electrical engineering, university of caalifornia, Los Angeles,2001.

[4]K.J. Vinoy, Fractal shaped antenna elements for wide and multiband wireless applications,PhD Thesis,Pennsylvania State University,2002.

[5] M. K. A .M. Z. A. Rahim , A. Aziz, and N. Abdullah,"Wideband sierpinski carpet monopole antenna,"2005 Asia-pacific Conference on Applied Electromagnetics Proceedings, IEEE, 2005.

[6] T.W. Hee , P.S. Hall, and K.Y. Liew," Wideband stacked sierpinski dipole antenna,"IEEE Transaction on Antenna and propagation , pp. 242-245, 2003.

7. Leon, G., R. R. Boix, and F. Medina, "A comparison among different reduced-size resonant microstrip patches," *Microwave and Optical Technology Letters*, Vol. 29, No. 3, 143–146, 2001.

8. Kim, I.-K., J.-G. Yook, and H.-K. Park, "Fractal-shape small size micro strip antenna," *Microwave and Optical Technology Letters*, Vol. 34, No. 1, 15–17, 2002.

9. Guterman, J., A. A. Moreira, and C. Peixeiro, "Microstrip fractal antennas for multistandard terminals," *IEEE Antennas and Wireless Propagation Letters*, Vol. 3, 351–354, 2004.

10. Gianviffwb, J. P. and R.-S. Yahya, "Fractal antennas: A novel antenna miniaturization technique and applications," *IEEE Antennas and Propagation Magazine*, Vol. 44, No. 1, 20–36, 2002.

11. Rahim, M. K. A., N. Abdullah, and M. Z. A. Aziz, "Micro strip Sierpinski carpet antenna design," *2005 Asia-Pacific Conference on Applied Electromagnetics Proceedings*, 58–61, 2005.

12. Ooi, B.-L., "A modified contour integral analysis for Sierpinski fractal carpet antennas with and without electromagnetic band gap ground plane," *IEEE Trans. Antennas and Propagation*, Vol. 52, No. 5, 1286–1293, 2004.