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Research Article

Design and Simulation of Square Shape Fractal Antenna

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Abstract

This paper describes the design and simulation of novel square shape fractal antenna using Hfss11.1 electromagnetic simulation software. The fractal structure is advantageous in generating multiple frequencies or enhancing bandwidth. Square shape fractal antenna gives better performance in return loss, efficiency and directivity. This fractal antenna can be used in the Wi-Fi. Fractal antenna are very odd in concept and very new in design for broadband applications, many discontinues in the structure add in radiating higher frequencies. This paper proposes the design and simulation of three stages of antenna and the performance characteristics of this three antenna reported in this paper

Keywords: *Multiband, Fractal Antenna, Simulation, Return loss.*

1. Introduction

Fractal antennas (J. Gianvittorio,2000) can be utilized in a variety of applications, especially where space is limited. An example of exploiting the benefits of fractal in antenna systems is the phased arrays, where fractals can reduce mutual coupling and allow for lower scan angles, mobile phone handsets and satellite communications (J. Gianvittorio,2000)Since the first fractal antenna was introduced, fractal geometries have been applied to the design of antennas especially for multiband antennas because of its self-similarity. If an antenna is much smaller than the operating wavelength, its efficiency deteriorates drastically, since its radiation resistance decreases and the reactive energy stored in its near field increases. Antenna geometries and dimensions are the main factors determining their operating frequencies .Fractal antennas (A.J. Crilly, R.A. Earnsshaw, and H.Jones, Eds,1990), have very good features like small size and multiband characteristics. Most fractal objects have self similar shape, with different scale . Fractal antennas have shown the possibility to miniaturize antenna structures and to improve the input matching. Certain classes of fractal antennas can be configured to operate effectively at various frequency bands . As a part of an effort to further improve modern communication system technology, researchers are now studying many different approaches for creating new and innovative antennas. One technique that has a received much recent attention involves combining aspects of the modern theory of fractal geometry(J. Gianvittorio,2000) with antenna design .In this letter examine a novel antenna design which is based on the fix shape of the square , which gives some desirable result for many wireless applications (Douglas H. Werner and Suman Ganguly,2002)

2. Antenna Design

In this model, the proposed antennas were designed using FR4 EPOXY substrate (Y. Yorozu, M. Hirano, K. Oka,1987). In this fractal antenna height and substrate are same that is h = 1.53 and ε_r = 4.4 respectively. For feeding, Probe feeding method is used. In all iteration feeding point is different and radius of feeding point is 0.63mm.In the present work, a square slot is cut and another slot of square shape is cut from it. Same procedure is repeated inside that geometry and the result of simulation studies(John P. Gianvittori and Yahya Rahmat-Samii,2002) is presented up to second iteration. In the base shape a rectangle slot of length 38 mm and width 38 mm as shown in figure 1.

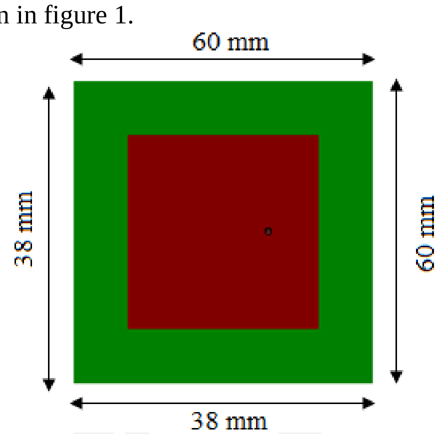

Figure 1 Base shape

For the first iteration one square shape slot is cut inside the geometry as shown in figure 2. In the second iteration four

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unsemitric square shape slots cut as shown in figure 3. In the first iteration, the total length and the width are 38 mm and 38 mm respectively. The square shape cut inside the geometry of the same length and width i.e 2mm shapes for all iteration. VSWR for base shape ,first iteration and second iteration is 1.2917,1.1094,1.1094 respectively.

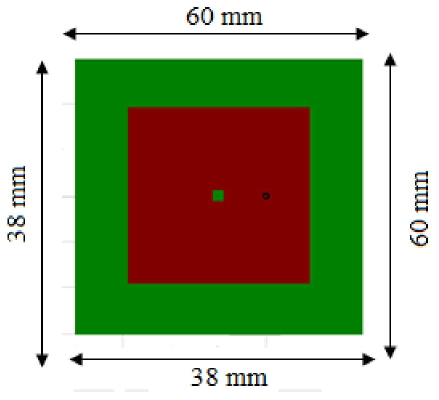

Figure 2 First Iteration

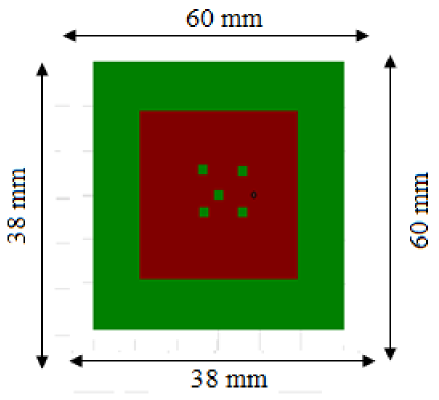

Figure 3 Second Iteration

3. Computer Simulation and Results

For the simulation of RF component design, there exist many types of software, such as HFSS, CST, Fidelity, Super NEC etc. The structure is designed and simulated using HFSS simulation software. There resonant frequency for which minimum return loss occurs for various bands with increase in number of fractal since successive iterations. Figure 4 shows the Return loss versus frequency for base shape. Figure 5 shows the variation of VSWR versus frequency for base shape. Similar results for successive iterations are shown in figure 6 to figure 9. It its observed that as the number of iterations are increased; number frequency bands also increase. (.O.Peitgen, H. Jurgens, and D. Saupe, Chaos,1992)

For the base shape, resonant frequency occur at 1.700GHz and return loss is-17.88 and bandwidth percentage is 5.586 . For first iteration also resonate frequency occurs at 1.700GHz but their bandwidth percentage and return loss increases to 7.83% and -25.9257 respectively.. Similarly for second iteration resonant frequency occurs at 1.700GHz . But return loss increases to ,-35.07db and band width increases to 9.01825.

i) Base Shape

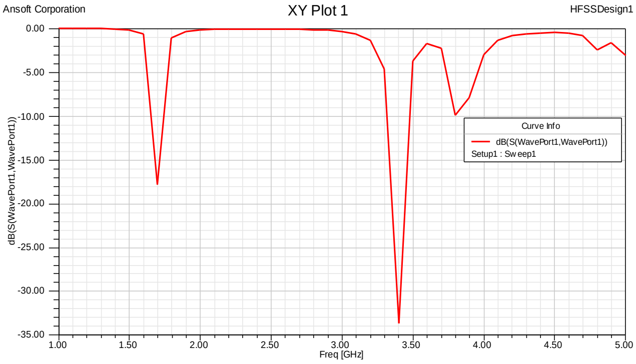

Figure 4 Return loss for base shape

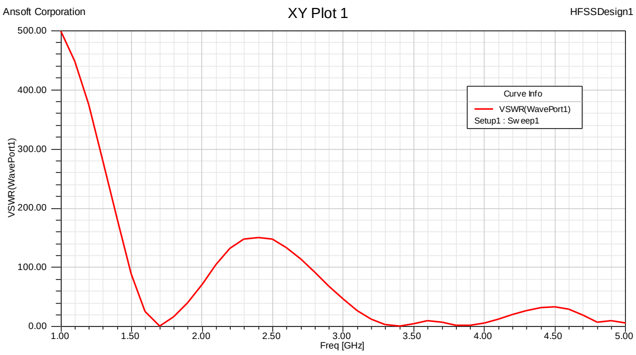

Figure5(a) Variation of VSWR with frequency for base shape

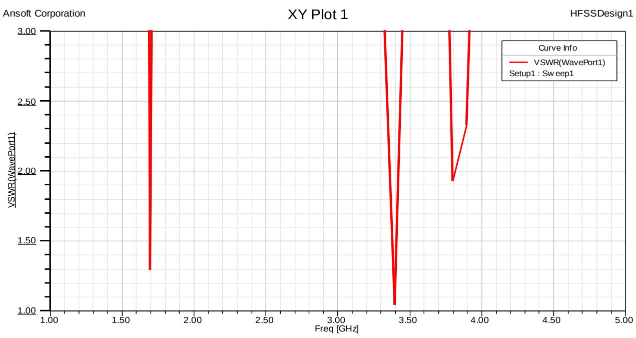

Figure5 (b) Variation of VSWR with frequency for base shape

ii) First Iteration

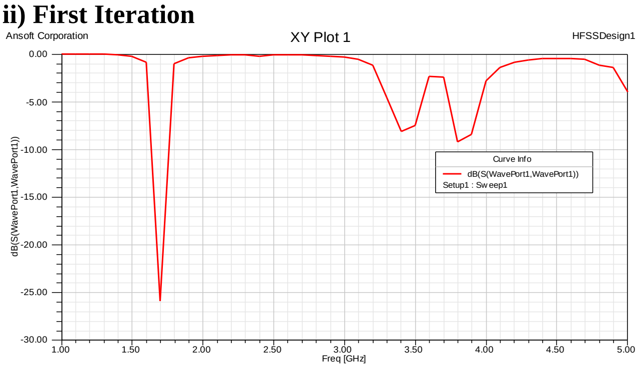

Figure 5 (c) Return loss for first iteration

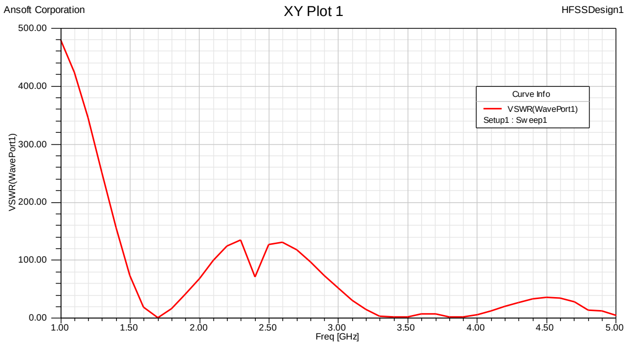

Figure 6(a) Variation of VSWR with frequency for first iteration

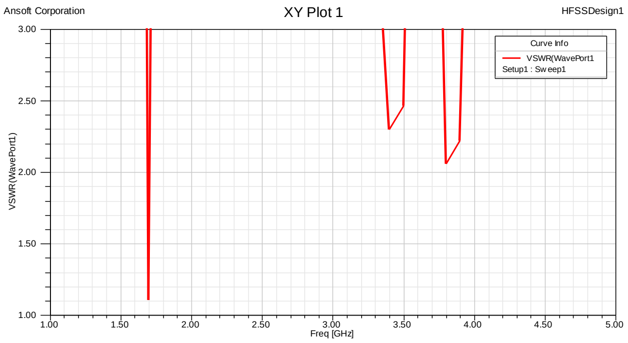

Figure 6(b) Variation of VSWR with frequency for first iteration

iii) Second Iteration

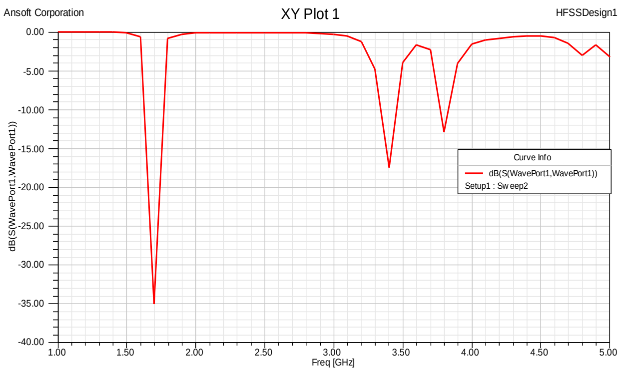

Figure 7 Return loss for Second iteration

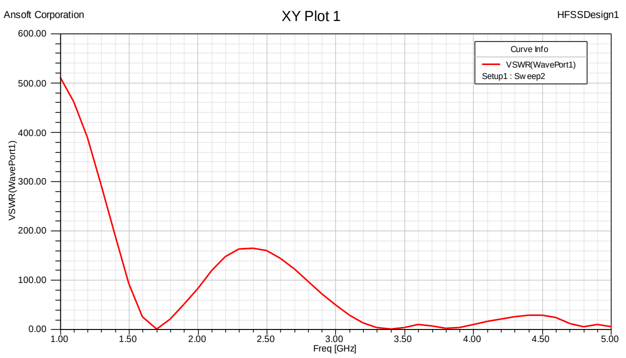

Figure 7(a) Variation of VSWR with frequency for second iteration

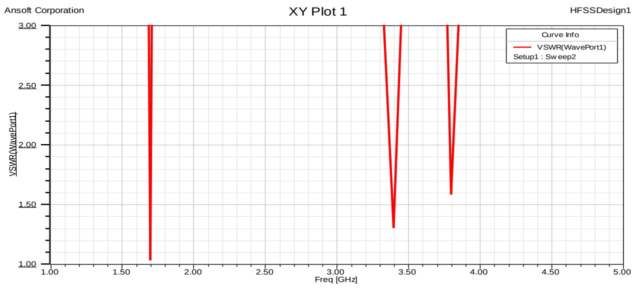

Figure 7(b) Variation of VSWR with frequency for second iteration

4. Result Analysis of Proposed Work

Comparative Table of Sierpinski Square Fractal Patch Antenna

S. No.	Shape	Resonant Freq. (GHz)	Return Loss	Band width (%)	VSWR
1.	Base Shape	F =1.700GHz	-17.88db	5.586%	1.2917
2.	1st Iteration	F =1.700GHz	-25.92db	7.83%	1.1094
3.	2nd Iteration	F =1.700GHz	-35.07db	9.01%	1.0365

Conclusion

The proposed fractal antenna seems to be an interesting configuration for use in application where a large frequency separation is required. The bandwidth effect changes with the change in resonant frequencies and VSWR is within the accepted level. The second iteration in this paper presents the best performance at resonant frequency 1.700 GHz with band width percentage also increases continuously as 5.586,7.83,9.01 respectively. For the last iteration at Resonant frequency 1.700GHz return loss increases -17.88 to -35dB and bandwidth 5.586 9.01 % and VSWR 1.2917 to 1.023 . This antenna has best performance as comparison with other conventional antennas.

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