A Design of Diamond Shape Sierpinski Fractal Patch Antenna for Multi Band Applications

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***Abstract*— All data and graph are presented in this dissertation which involved in the study. All measurement and simulation are based on the gives theory based on the Microstrip patch antenna and related formulas. In this dissertation two fractal geometries are simulated using IE3D software. I have designed two types of fractal antennas which are First diagonally triangular Slotted Fractal Patch Antennas is designed by the probe feed technique. The proposed antenna is resonating from 4 GHz to 12 GHz and second a diamond shape sierpinski fractal patch antennas is designed by the coaxial cable or probe feeding technique. This antenna is resonating from 1.5 GHz to 8 GHz. In this diamond shape sierpinski fractal patch antenna only simulated result included. The above both antennas have been designed by the use of The FR_4_epoxy material having dielectric constant of 4.4 with the thickness of 1.6 mm. As a result the Return loss, VSWR,Smith chart, Bandwidth, directivity and Gain are studied for different fractal geometries. When we increase the numbers of iterations than we obtained a Maximum return loss & VSWR and satisfactory gain, which are the desired goals of our antenna designs.**

***Index Terms*—About four key words or phrases in alphabetical order, separated by commas.**

I. INTRODUCTION

Fractal antennas have shown the possibility to miniaturize antenna and to improve input matching. Certain classes of Fractal antenna can be configured to operate effectively at various frequency bands. The IEEE standard definition of an antenna defines the antenna or aerial as "a means for radiating and receiving radio waves". In other words, an antenna is a transducer which converts the electrical power into the electromagnetic waves and vice versa. The Microstrip patch antennas are having many characteristics such as low profile, low weight and low manufacturing cost. So, the microstrip patch antenna can be used in Radars, missiles, spacecrafts, robots and mobiles, where size, weight and cost are the constraints. Conventional microstrip patch antennas have a conducting patch printed on a substrate. The shape of patch of the antenna may be square, rectangular, circular, triangular and elliptical or any other configurations. The patch has been fabricated using the photolithographic techniques. Recently, there are various other shapes of the patch that have been used to design antennas which are based on alphabets such as C-shape, U-shape, inverted U-shape, F-shaped, inverted F-shape, H- shape, ψ-shape, M-shape and E-shape. However, the microstrip patch antenna has many disadvantages such as low power, low efficiency, spurious feed radiation and very narrow bandwidth. There are many methods to enhance the bandwidth such as stacked layer, slotting techniques, shorting pins, multilayer, array design, partial ground, and parasitic patch etc.

II. PROPOSED ANTENNA DESIGN

I have proposed Diamond Shaped sierpinski fractal patch antennas in this thesis. These fractal antennas are basically microstrip patch antenna. For designing this microstrip fractal patch antenna IE3D simulation software is used.

In this work A diamond shaped sierpinski fractal patch antenna is designed for 4.56 GHz frequency. Basic dimension of all iteration in patch antenna is same (30 mm x 30 mm x 1.6mm).

A rectangle patch of length 30 mm and width 30 mm is chosen as base shaped as shown in figure. In the first iteration one diamond slot remove from center. The remove diamond slots have length and width of order of 10mm x 10mm of base shape as shown in figure4.22.In similar way, in second iteration total 4 diamond slot are cut in the four corner which are of 1/2 length of the first iteration as show in figure. , In third iteration total 16 diamond slots are cut at left, right, up and down of all the four diamond shape of second iteration which are of1/2 length as show in figure

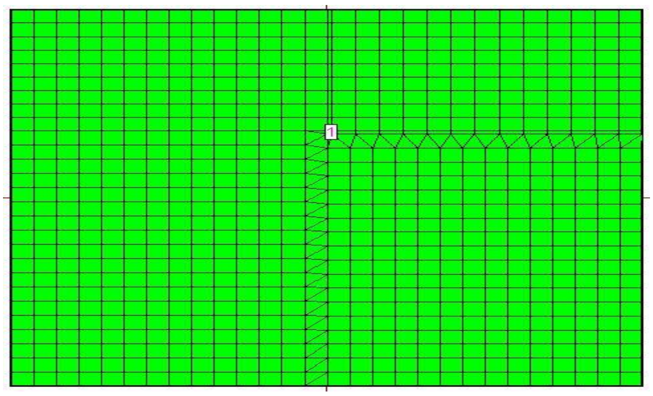

Figure 1- Base shape for D.S. fractal antenna

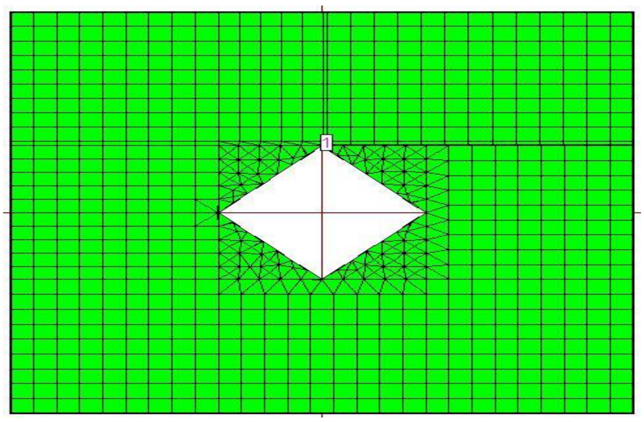

Figure 2- First iteration for D.S. fractal antenna

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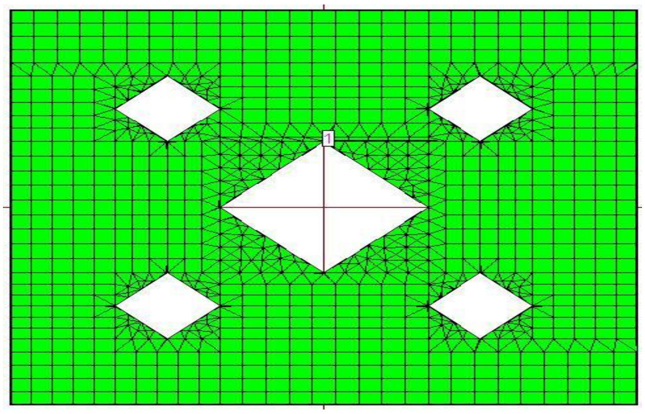


Figure 3- Second iteration for D.S. fractal antenna

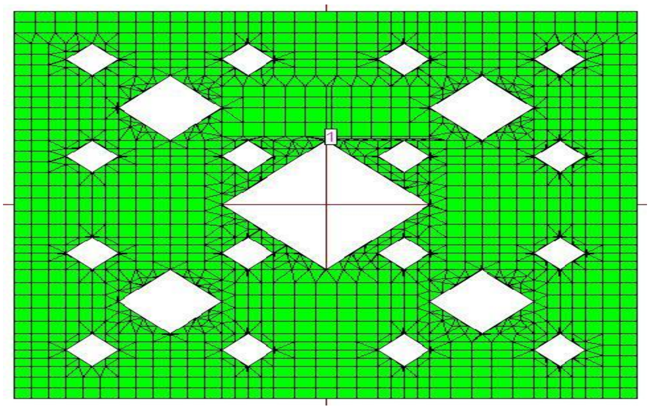


Figure 4- Third iteration for D.S. fractal antenna

This plus shaped sierpinski fractal patch antenna is stimulated at various resonant frequencies using following parameters.

- Dielectric Constant- Fr_4 is chosen as dielectric material $\varepsilon_r = 4.4$.
- Substrate Thickness- 1.6 mm.
- Resonant frequency- 4.56 GHz.
- Feed – Probe feed is used as a feed line with probe radius 0.16-mm. We are taken a common feed point for all iteration. The position of feed point is (0.15, 5.20) on x-y axis.

III. RESULTS AND DISCUSSION

The results of diamond sierpinski fractal patch antenna:

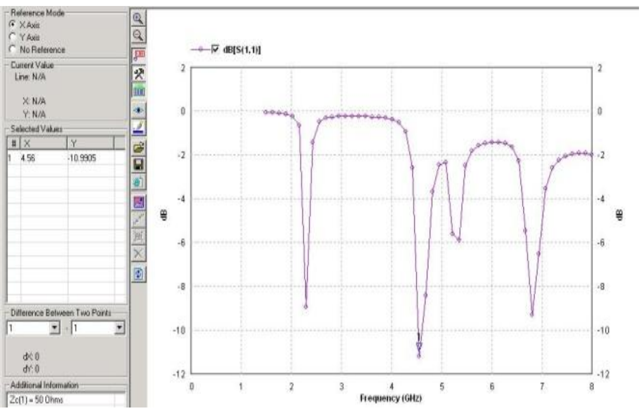


Figure 5- Return loss Vs frequency plot of base shape for D.S. fractal antenna

This figure shows a resonant frequency at 4.56 GHz with return loss -10.99 dB of base shape of a diamond sierpinski fractal patch antenna.

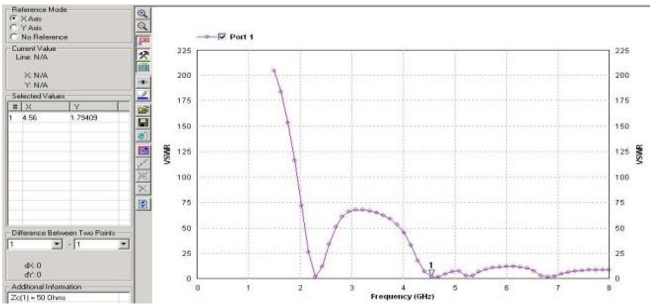


Figure 6- VSWR of base shape for D.S. fractal antenna

This figure shows that VSWR is 1.794 at 4.56 GHz is obtained.

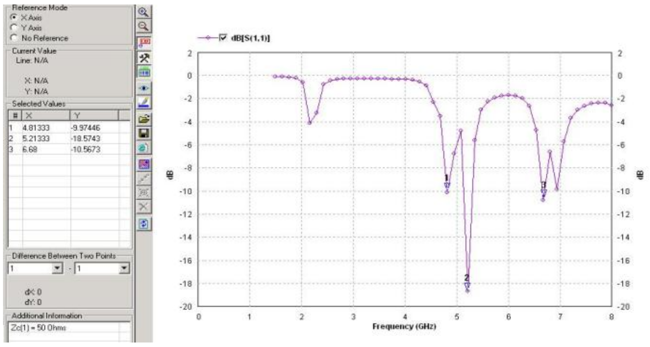


Figure 7- Return loss Vs frequency plot of first iteration for D.S. fractal antenna

This figure shows a resonant frequency at 5.2133 GHz and 6.68 GHz on return loss is -18.57 dB and -10.5673 dB respectively.

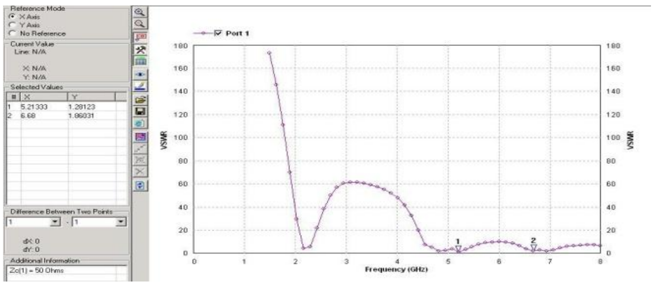


Figure 8 - VSWR of first iteration for D.S. fractal antenna

This figure shows that VSWR is 1.2812 and 1.8603 at 5.2133 GHz and 6.68 GHz respectively.

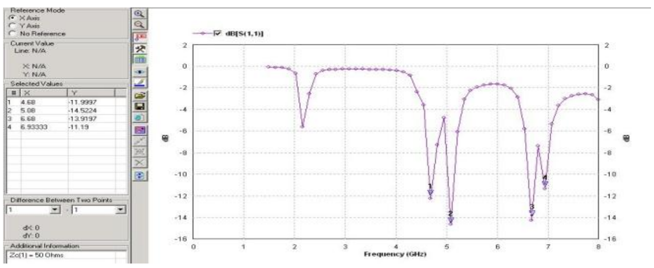


Figure 9- Return loss Vs frequency plat of second iteration for D.S. fractal antenna

This figure shows a multiband behavior of antenna with resonant frequency at 4.68 GHz,5.08 GHz,6.68 GHz and 6.933 GHz on return loss is -11.99 dB,-14.52dB ,-13.91 dB and -11.19 dB respectively.

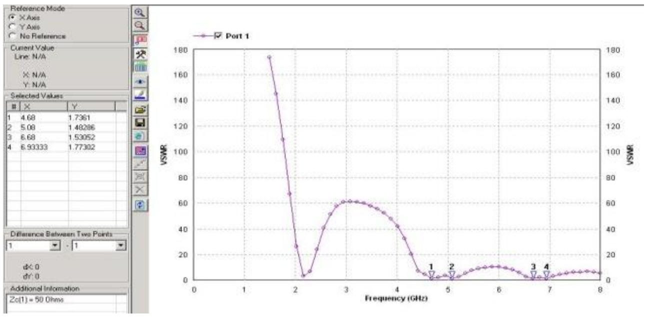


Figure 10- VSWR of second iteration for D.S. fractal antenna

This figure shows that VSWR is 1.736, 1.482, 1.530 and 1.773 at 4.68 GHz, 5.08 GHz,6.68 GHz and 6.933 GHz respectively.

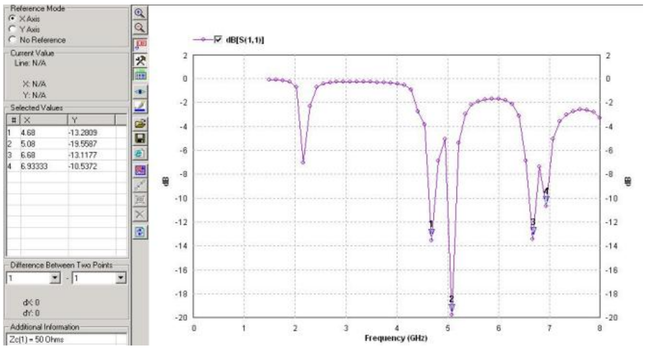


Figure 11 - Return loss Vs frequency plot of D.S.third iteration

This figure shows a multiband behavior of antenna with resonant frequency at 4.68 GHz, 5.08 GHz,6.68 GHz and 6.933 GHz on return loss is -13.280 dB,-19.558 dB,-13.117 dB and -10.537 dB respectively.

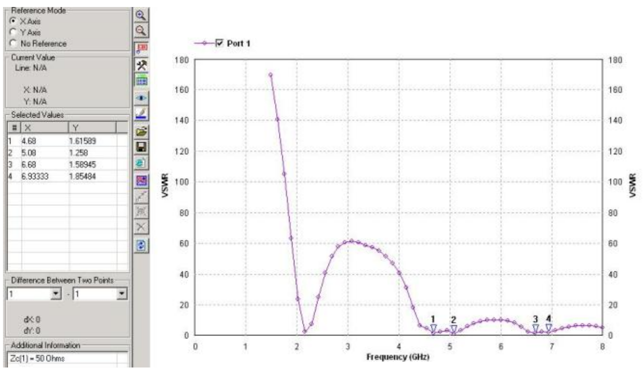
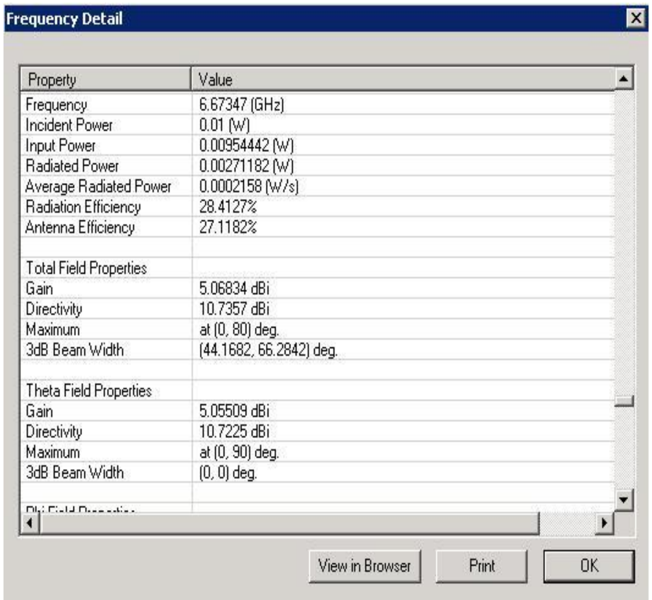


Figure 12 - VSWR of third iteration for D.S. fractal antenna

This figure shows that VSWR is 1.6158, 1.258, 1.589 and 1.855 at 4.68 GHz, 5.08 GHz,6.68 GHz and 6.933 GHz respectively.


Frequency Detail

Property	Value
Frequency	6.67347 (GHz)
Incident Power	0.01 (W)
Input Power	0.00954442 (W)
Radiated Power	0.00271182 (W)
Average Radiated Power	0.0002158 (W/s)
Radiation Efficiency	28.4127%
Antenna Efficiency	27.1182%
Total Field Properties	
Gain	5.06834 dBi
Directivity	10.7357 dBi
Maximum	at (0, 80) deg.
3dB Beam Width	(44.1682, 66.2842) deg.
Theta Field Properties	
Gain	5.05509 dBi
Directivity	10.7225 dBi
Maximum	at (0, 90) deg.
3dB Beam Width	(0, 0) deg.

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Frequency detail at 6.6734 GHz of third iteration for D.S. fractal antenna

IV. CONCLUSION

There exist a variety of fractal geometries that can be implemented as antennas. Several geometries have been simulated in this work. The miniaturization of the antennas has been explored for diagonal fractal patch antenna, Sierpinski diamond shape fractal patch antenna.

It is observed that A diamond Shaped sierpinski fractal patch antenna have good bandwidth of 3.67 % in third iteration and return loss of -19.558 dB in third iteration, which is finally well as compared to the fractal antenna geometry proposed in past.

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