A Hexagonal multiband fractal antenna using for wireless applications

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Abstract- **In this paper, a multiband Fractal antenna having the shape of hexagonal is proposed. This hexagonal antenna is used for different wireless applications. Three iterations of the hexagonal fractal multiband antenna are examined. With this structure it is possible to configure the multiband frequency at various bands and return loss to obtain high gain. The Computer Simulation Technology Microwave Studio (CST MWS) software was used to design and analyze the antenna for different wireless applications at range 1-6GHz.**

Keywords- fractal; gain; hexagonal fractal antenna; multiband frequency; return loss

I. INTRODUCTION

The most recent multi-band antenna development is the incorporation of fractal geometry into radiators and the Sierpinski gasket antenna is a prime example. Since the Sierpinski gasket has proven itself to be an excellent multi-band antenna, other multi-band antennas can similarly be constructed using fractal geometry [1, 2]. Fractal antenna's response differs obviously from traditional antenna designs. It is capable of operating optimally at many different frequency ranges simultaneously [3]. This makes the fractal antenna an excellent design for broadband applications. Due to the self-similar property of fractal antennas, microstrip fractal antennas demonstrate higher bandwidths than conventional microstrip antennas [4]. They are also considered in multi-frequency antenna designs. By connecting fractal shaped antennas, wideband coverage can be achieved [5]. Furthermore, the fractal antennas allow controlling of characteristics such as location of frequency bands, radiation pattern and entire bandwidth owing to feeding technique and antenna geometry variations [6]. This letter examines the input characteristics of one such fractal design based on the hexagon and evaluates its suitability for multiband [7]. Fractal's create from self-similar elements, iterating in various directions that increasing iterations, does not change their total form; because their small sections are reduced-size copy of the whole. Self-similarity of fractals causes multi-band and broadband properties of antennas [8]. Due to the concept of self-similarity and infinite complexities, the proposed geometry of an antenna is very versatile in term of polarization, radiation pattern, gain and bandwidth [9,10].

II. ANTENNA GEOMETRY

The hexagonal fractal microstrip antenna for three iterations has shown in Fig. 1. The hexagonal fractal is constructed by reducing a hexagon generator shape to one third its former size, and grouping six smaller hexagons together. This log periodic frequency behavior is the direct result of constructing the hexagonal fractal with a scale factor of one half. The triangles within the hexagonal fractal antenna are interconnected to maintain conductivity and to preserve electrical self-similarity. To design a Hexagonal Fractal antenna the dimension of substrate is 60mm × 80mm using FR4 material with dielectric constant 4.8, substrate thickness 1.59 and loss tangent 0.019. The first three iterations of the CPW fed hexagonal fractal are examined using the finite difference time domain (FDTD) method.

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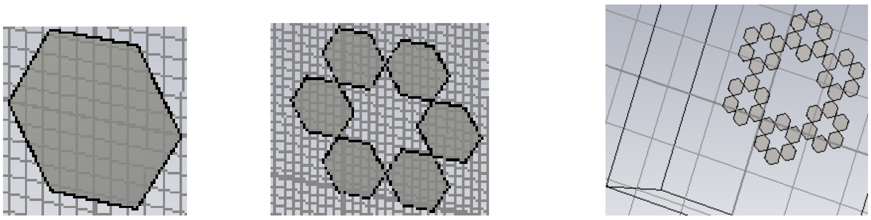
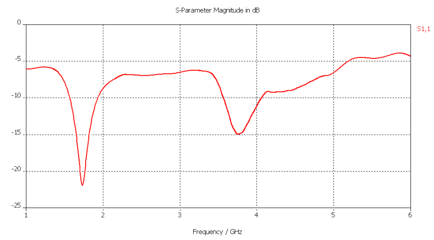


(a) (b) (c)

Figure1. shows Hexagonal antenna for different iterations, (a) shows Hexagonal fractal antenna for zero iteration, (b) shows Hexagonal antenna for one iteration, (c) shows Hexagonal antenna for two iteration.

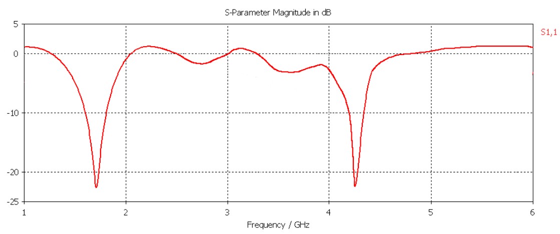
III. RESULTS AND DISCUSSION

The figure 2(a) shows the simulation results of zero iteration. The hexagonal patch resonates at the two frequency bands one is at 1.8GHz having bandwidth 345MHz with a return loss of -22.3dB and second at 3.7GHz having bandwidth 500MHz with return loss -15dB.



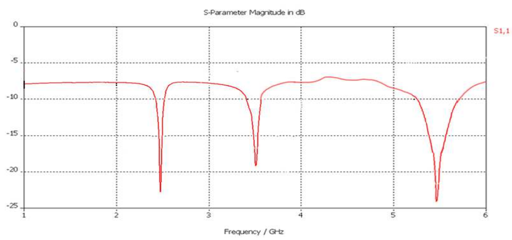
(a)

The figure 2(b) shows the simulation results of the first iteration. The hexagonal patch resonates at the two frequency bands one is at 1.8GHz having bandwidth 218MHz with a return loss of -23.1dB and second at 4.2GHz having bandwidth 121MHz with return loss -23.2dB.



(b)

The Return Loss S11 of the Hexagonal Fractal Antenna simulated using CST MWS software. Different iteration will produce a different amount of Return Loss, dB and bandwidth. The figure2(c) shows the simulation results of the second iteration. The hexagonal patch resonates at the various frequency bands i.e. at 2.3GHz having bandwidth 120MHz with a return loss of -23.2dB, -19.5GHz having bandwidth 138MHz with return loss -19.5dB and at 5.2GHz having bandwidth 385 with return loss -24.5 these bands are used for WIMAX applications.

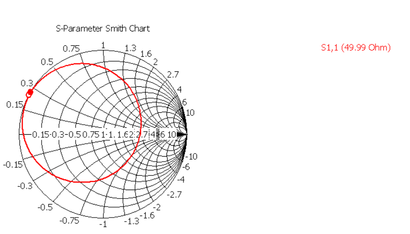


(c)

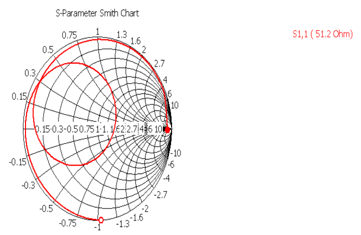
ISSN 2277-1956/V1N4-2107-2111

Figure 2. shows the return loss characteristics (a) For zero iteration (b) For first iteration (c) For second iteration.

The Smith Chart, invented by Phillip H. Smith (1905-1987), is a graphical aid specializing in radio frequency (RF) engineer to assist in solving problems with transmission lines and matching circuits. The Smith Chart is plotted on the complex reflection coefficient plane in two dimensions and is scaled in normalized impedance (the most common), normalized admittance or both, using different colors to distinguish between them. These are often known as the Z, Y and YZ Smith Charts respectively. Normalized scaling allows the Smith Chart to be used for problems involving any characteristic impedance or system impedance, although by far the most commonly used is 50 ohms. The Smith Chart plot represents that how the antenna impedance varies with frequency.



(a)



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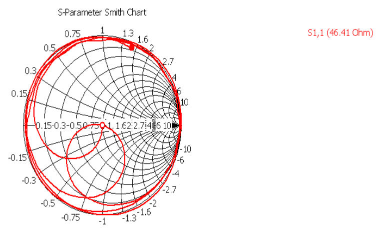
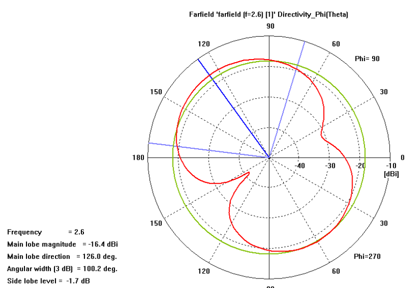


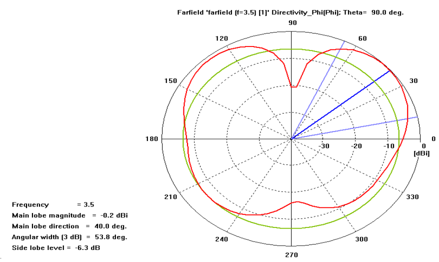
(c)

Figure 3 shows the smith chart of hexagonal fractal antenna (a) At 2.4GHz (b) At 3.4GHz (c) At 5.1GHz

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Antenna radiation patterns are taken at one frequency, one polarization, and one plane cut. The patterns are usually presented in polar or rectilinear form with a dB strength scale. Since a Microstrip patch antenna radiates normal to its patch surface, the elevation pattern for φ = 0 and φ = 90 degrees would be important. Figure 3.7 below shows the gain of the antenna at 2.438 GHz for φ = 0 and φ = 90 degrees. The maximum gain is obtained in the broadside direction and this is measured to be 6.8dBi for both, φ = 0 and φ = 90 degrees.

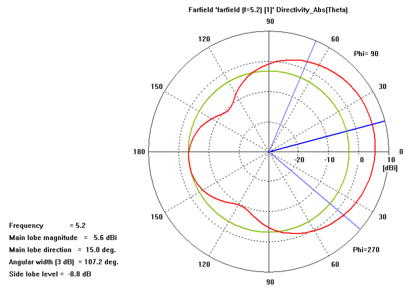


(a)



(b)

ISSN 2277-1956/V1N4-2107-2111



(c)

Figure 4 shows the radiation pattern of hexagonal fractal antenna (a) At 2.4GHz (b) At 3.4GHz (c) At 5.1GHz

Table 1. Resonant frequency, bandwidth and return loss at different iterations of hexagonal fractal antenna.

Type of iteration	Resonant Frequency (f_r) GHz	Bandwidth (MHz)	Return loss (dB)
Iteration 0	1.8	345	-23.1
	3.7	500	-15
Iteration 1	1.8	218	-23.1
	4.2	121	-23.2
Iteration 2	2.3	120	-23.2
	3.5	138	-19.5
	5.2	385	-24.5

IV. CONCLUSION

From result and discussion, it can be concluded that the self similarity in the structure for the 2nd iteration of hexagonal fractal antennas is observed to possess multiband behavior. These multiband hexagonal fractal antenna can cover the frequency bands of WLAN/WIMAX applications. Furthermore, as the no. of iterations increases number of resonant frequencies which gives a multiband performance to the designed antenna structures. The simulated results indicate that the antennas exhibit a good return loss, and multiband frequencies suitable for IEEE Bluetooth/WLAN (2.4-2.484 GHz), WiMAX (3.4-3.69 GHz) & WIFI (5.1-5.825 GHz) wireless communication applications. Since the area of fractal antenna engineering research is still in its infancy, there are many possibilities for future work on this topic. Fabrication can be done of these antennas. By using various feeding techniques on which one can extend our work to have a multiband antenna with sufficient bandwidth i.e. making the broadband. Other shapes of fractal antennas can also be designed for multiband/broadband antennas.

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ISSN 2277-1956/V1N4-2107-2111