Hexagonal Fractal Antenna for 1.6GHz GPS Application

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Abstract: *This paper presents dual band hexagon shaped fractal antenna. There are three iterations applied one by one on simple hexagonal patch which results in fractal patch antenna which resonates at 1.6 GHz , 2.1 GHz respectively .This antenna finds applications for GPS and Mobile communication. HFSS software is used for designing of proposed antenna.*

Keywords: Hexagon shape, Fractal, Patch antenna, Dual band.

1. Introduction

Fractal antennas are compact, multi- band antenna. These types of antennas are excellent alternative to traditional antenna system. The Fractal antenna can operate dual and triple band of frequency. Fractal antennas offers increase in bandwidth and gain at all multiband as well as the size of antenna gets reduced. Thus, in recent years fractal antennas have major demand in communication system.

A fractal is a rough or fragmented geometric shape that can be split into parts, each of which is a reduced-size copy of the whole. There are two properties of Fractals:
1. self-similarity
2. space-filling

The self-similarity property help to achieve multiband frequencies performance .The space-filling property of fractals leads to curves which have long electrical length but fit into a compact physical volume.

Key benefits of fractal antennas:
1. Reduced size and compactness.
2. It is capable of operating at many different frequency ranges simultaneously.

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. In this paper design of fractal antenna is based on hexagon Shape. From hexagonal geometry get more radiation on surface of patch since this provides better efficiency.

2. Design Procedure

The design of the proposed antenna is based on self-similarity property of fractal antenna. The Hexagonal Fractal antenna is designed for GPS application. So the band of interested is 1.6 GHz and below. This antenna design was divided into three stages. The first stage is operating at 1.6

GHz frequency. From the first iteration comes to second iteration and from second iteration, develop to third iteration.

The hexagonal fractal is constructed by reducing a hexagon generator shape to one third its former sizes, and grouping six smaller hexagons together. To design a Hexagonal Fractal antenna,

Parameters is been used.
• Dielectric constant, ϵr = 4.4
• Substrate height, h = 1.6 mm

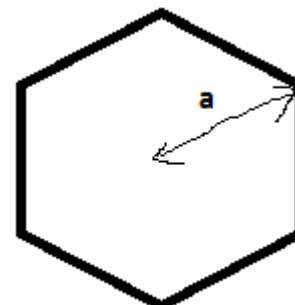Circular equation is used to calculate the actual radius, a of circular patch antenna to match at 1.6 GHz.

$$a = F / \{[1 + (2h / \pi \epsilon_r F][\ln (\pi F / 2h) + 1.7726]\}^{1/2}$$

Where,

$$F = \frac{8.791 \times 10^9}{fr\sqrt{\epsilon r}}$$

$$a = \frac{F}{\{1 + 2h/\pi \epsilon r F [\ln (\pi F/2h) + 1.7726]\}^{\frac{1}{2}}}$$

= 2.504cm @ 25mm

Substatate Caculations-
λ=c/f=187mm

Where c –velocity of light=3x10^8m/s2

Ground plane should be λ/2 i.e. 90mm

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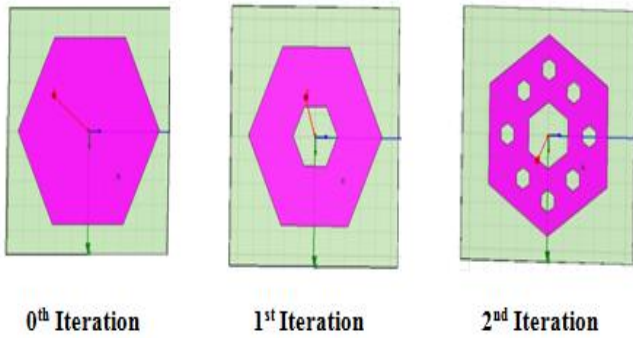
Figure 1: First three iterations of the hexagonal fractal

3. Simulation Results
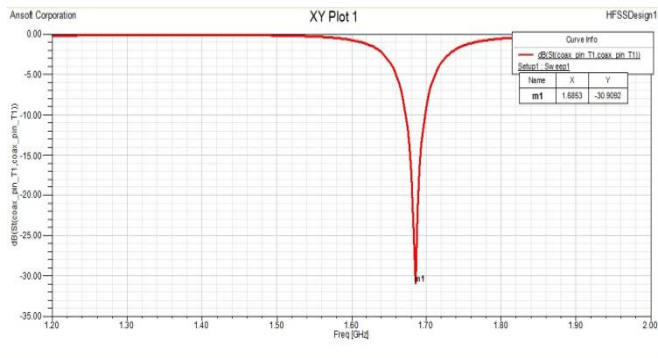
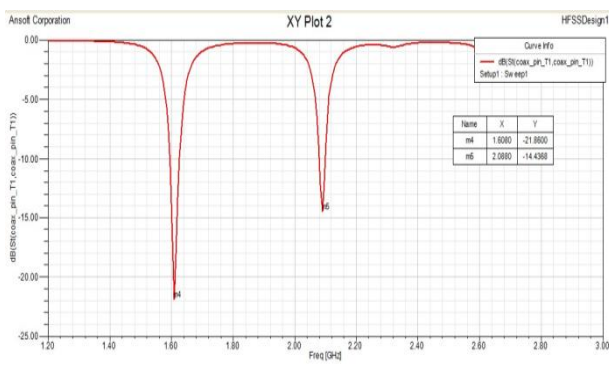**Figure 3:** Return Loss at Zeroth Iteration
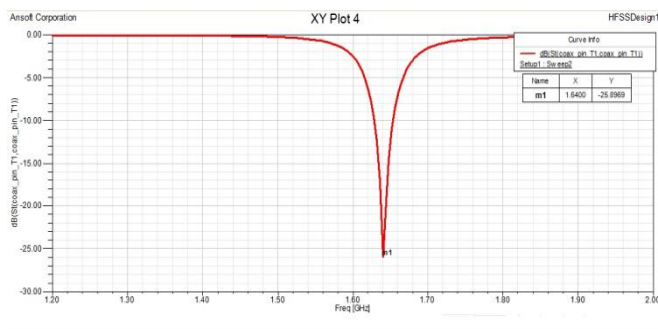

Figure 4: Return Loss at First Iteration

Figure 5: Return Loss at Second Iteration

Return losses ideally, should be bellow than -10db.As we increase number of iterations return losses gets excellent deep and excellent.


Figure 6: Current distribution First three iterations of the hexagonal fractal

Figure.2 shows that Current distribution of the proposed hexagonal fractal antenna is mainly along the circumference of the hexagoanal disc.

At 0th Iteration : The current density is low in the middle area of the hexagonal fractal antenna.Therefore, the current will not be affected if the middle area metallization of hexagonal fractal antenna is removed by hexagon or other geometrical pattern.At 1st Iteration and 2nd Iteration Removing some portion of metallization from hexagonal base shape increases the effective path of the surface current.
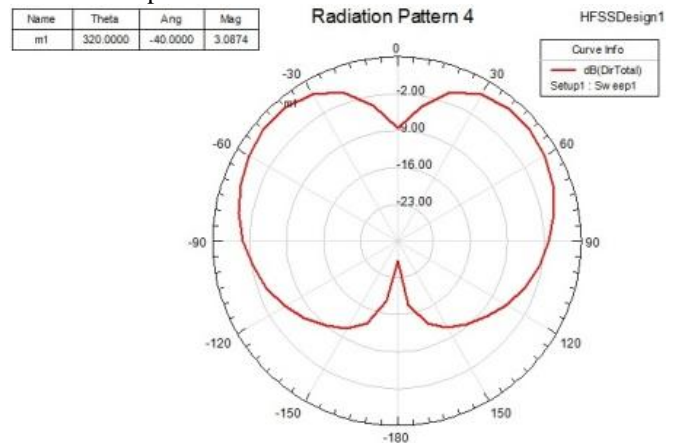
Figure 7: Radiation pattern

The antenna radiates more in a particular direction as shown in polar plot, as compared to the isotropic antenna which radiates equally in all directions.

Figure 8: Smith Chart

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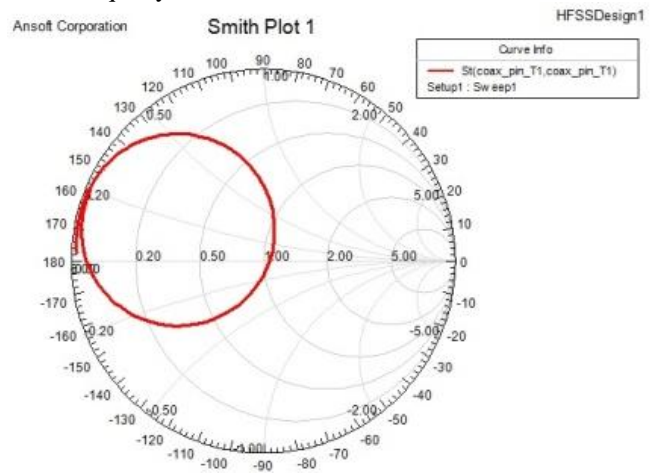
Figure 8 show the Smith Chart for the proposed antenna.

The Smith Chart plot represents that how the antenna impedance varies with frequency. The value of impedance is lie near about 50 ohms resistance value so perfectly match the port with the antenna.

4. Result

Table 1: Iteration wise Simulated Results

S.No	Iterations	Freq (GHz)	Return Loss	VSWR	Directivity (dB)
1.	0th iteration	1.68	-30.90	1.05	5.20
2.	1st iteration	1.64	-25.89	1.10	4.24
3.	2nd iteration	1.60	-23.64	1.17	3.90
		2.10	-14.43	1.46	

5. Conclusion

A simple hexagonal fractal patch antenna for 1.6GHz frequency has been simulated. At second iteration get 1.6GHZ and 2.1GHZ band of frequencies simultaneously. So, we can use this antenna for GPS and mobile communication application. The simulation result obtained by HFSS shows good results. The simulated results have shown a good radiation structure, which has high directivity and gain, when compared to a simple patch antenna. The return loss measurements show an excellent deep and suitable bandwidth.

References

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