STUDYAND SIMULATION OF NOVEL H-SHAPE FRACTAL ANTENNA

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ABSTRACT

This paper describes the design and simulation of novel H-Shape fractal antenna usingCST Microwave Studio simulation software. The H shape fractal structure is advantageous in generating multiple frequencies. It gives better performance in return loss, VSWR and directivity and can be used in the Wi-Fi. Fractal antenna is very odd in concept and very new in design for broadband applications, many discontinuities in the structure add in radiating higher frequencies. This paper proposes the design and simulation of four stages of antenna and the performance characteristics of these four antennas are reported in this paper. The micro strip patch antennas are widely used in mobile communication, satellite communication and GPS. The antenna parameters such as far field pattern, return loss, VSWR play an important role in applications. Here, the Far filed pattern, return loss and VSWR are calculated for the antenna at frequencies 6.83 GHz, 7.22 GHZ respectively.

Keywords:- Antenna, far field pattern, return loss, fractal antenna, simulation, VSWR.

1. INTRODUCTION

Fractal antennas 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 [1-3].

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 [4-7]. Antenna geometries and dimensions are the main factors determining their operating frequencies [8-10].

Fractal antennas [9-11], have very good features like small size and multiband characteristics. Most fractal objects have self similar shape, with different scale [5, 6]. 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 [12]. 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 received much recent attention involves combining aspects of the modern theory of fractal geometry with antenna design [13-15]. In this paper, a novel antenna design is considered which is based on the fix shape of the H alphabet, which gives some desirable result for many wireless applications.

2. ANTENNA DESIGN

In this model, the proposed antennas were designed using ground plane & patch of material copper annealed substrate is of FR4 lossy. In this fractal antenna height h=3mm. Wave guide port feeding method is used. In all iterations feeding point is same and thickness of feeding point is 0.5mm on X axis and the feeding is given in Y direction. For feeding Nickel is used.

In the present work, a rectangular slot of length 80mm & width 40mm is cut for ground plane & and a square patches of length 30mm & width 30mm is cut from it. For the first iteration, two H shape slots are cut inside the geometry. It is shown in Fig.1 and the results of first iteration in shown in Fig.2, 3 and 4 for return loss, VSWR and Far field pattern respectively. For the second iteration, four H shape slots are cut that is one small H in the bottom portion of first H and another small H in the bottom portion of second H is cut as shown in Fig.5 and the results of second iteration are shown in Figs.6, 7 and 8 for return loss, VSWR and Far field pattern respectively. For the third iteration, four H shape slots are cut, that is one small H in the top portion of first H and another small H in the top portion of second H is cut as shown in Fig.9 and the results of third iteration are shown in Figs.10, 11 and 12 for return loss, VSWR and Far field pattern respectively. For the fourth iteration, six H shape slots are cut that is both in the top and bottom portion of first H and another small H in the top and bottom portion of second H is cut as shown in Fig.13 and the results of fourth iteration are shown in Figs.14-17.Fig.14 & 15 represents return loss for two different frequencies, Fig. 16 represents VSWR and Fig.17 represents Far field pattern. The results of simulation studies are presented upto four iterations in the next section.

3. DESIGN PROCEDURE FOR NOVEL H SHAPE FRACTAL ANTENNA& ITS FORMULATIONS

Height (h)=3mm; width(w)=40mm; length(l)=40mm; relative permeability(ε_r)=4.5

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\left(\frac{h}{w}\right)\right]^{\frac{-1}{2}} \tag{1}$$

By substituting the values of h,w,l of the Novel H Shape Fractal Antenna

$$\varepsilon_{reff} = 4.02, \quad L_{eff} = L + 2\Delta L = 80 + 2(1.36) = 82.72 \tag{2}$$

$\Delta L =$

$$0.412 * h \frac{(\varepsilon_{reff} + 0.3)}{(\varepsilon_{reff} - 0.258)} \frac{\left[\frac{w}{h} + 0.264\right]}{\left[\frac{w}{h} + 0.8\right]} = 1.36 \tag{3}$$

$$f_r = \frac{1}{2L_{eff}\sqrt{\varepsilon_{eff}\sqrt{\mu_o \varepsilon_o}}} \quad \text{and} \quad f_r = 1GHZ \tag{4}$$

after fractal dimensions for Microstrip it's resonant frequency varies between fr = 8 to 10 GHz.

4. Simulation Results

The simulation is carried out for four iterations and the results are shown below in Figs.1-17.

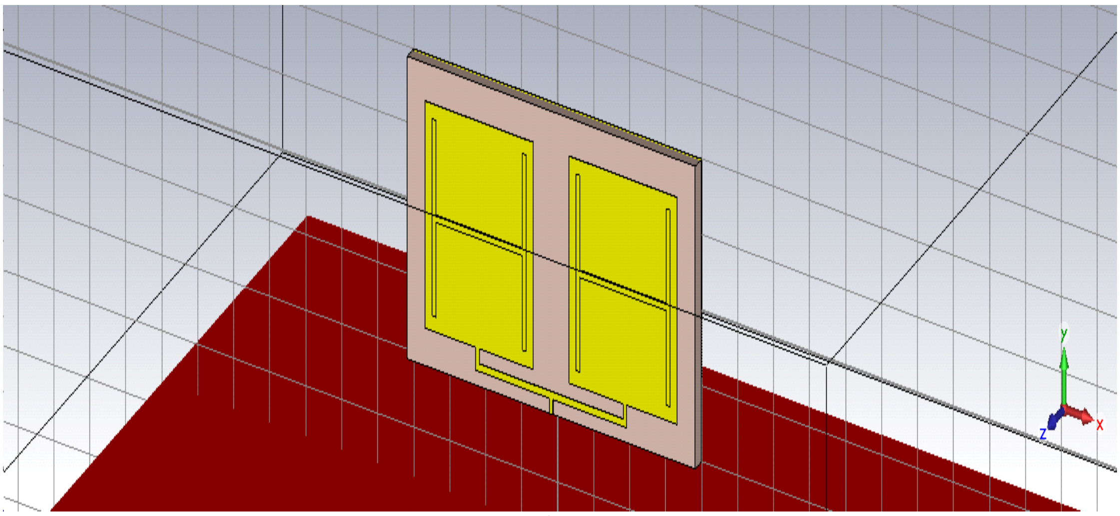

Fig.1 1st Iteration

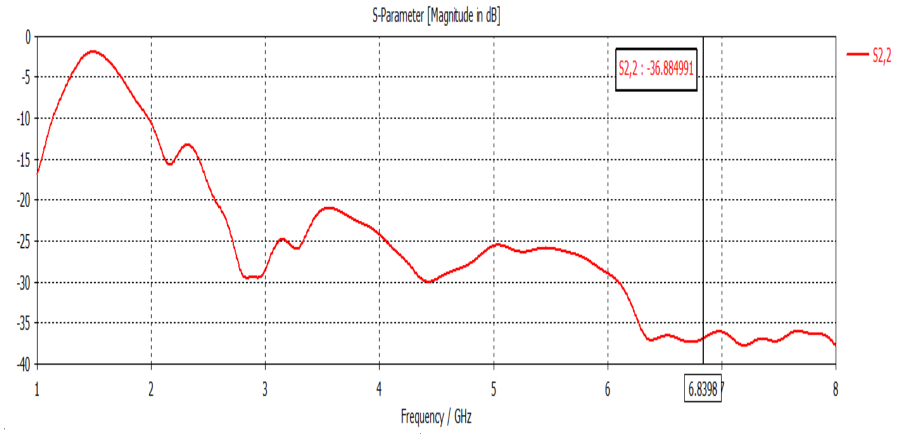

Fig.2 Return Loss in dB for1st Iteration at a frequency = 6.83GHz

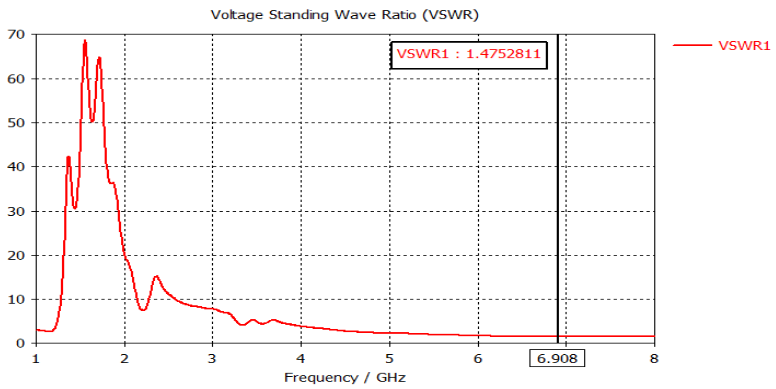

Fig.3 VSWR for 1st Iteration at a frequency= 6.9GHz

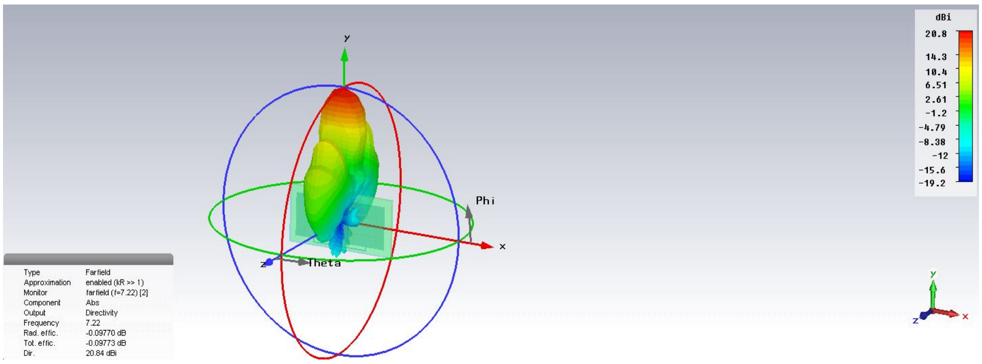

Fig.4 Far field pattern for 1st Iteration at a frequency =7.22GHz and Directivity= 20.84dBi

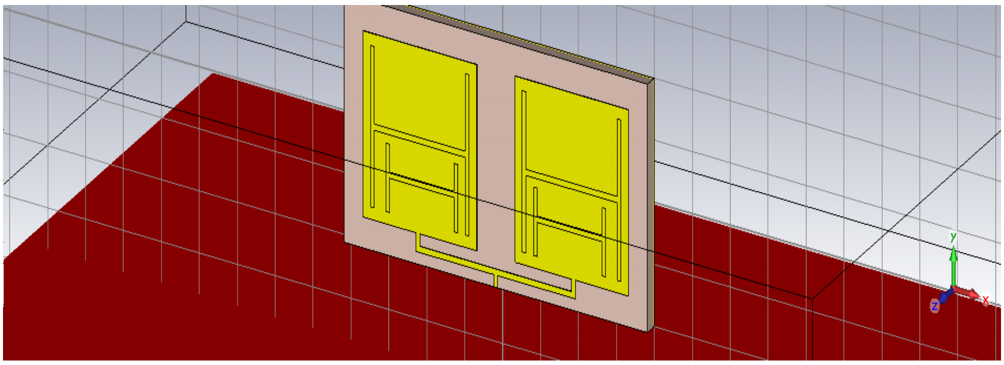

Fig.5 2nd Iteration

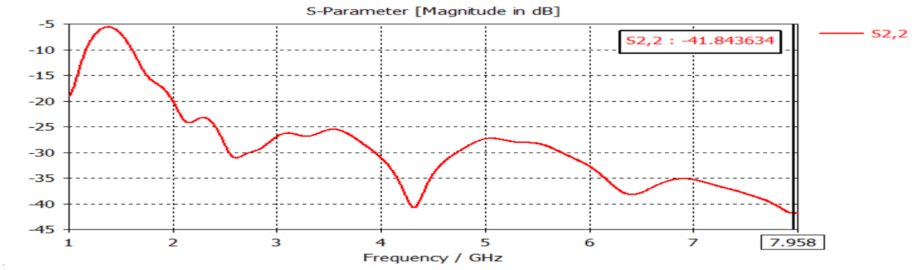

Fig.6 Return Loss in dB for 2nd Iteration at a frequency =6.83GHz

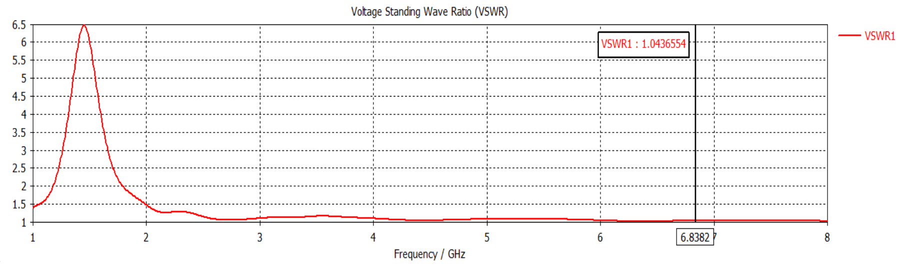

Fig.7 VSWR for 2nd Iteration at a frequency = 6.83GHz

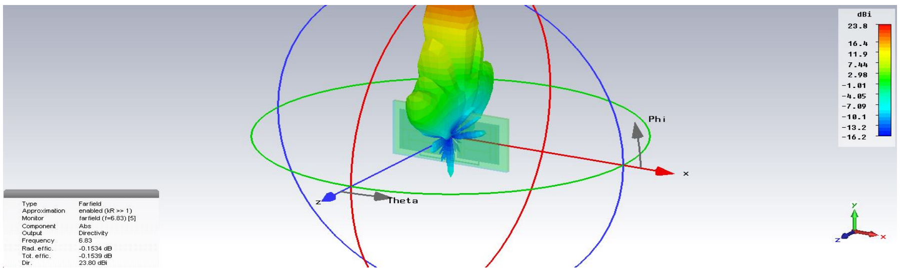

Fig.8 Far field pattern for 2nd Iteration at a frequency = 6.83GHz and Directivity =23.80dBi

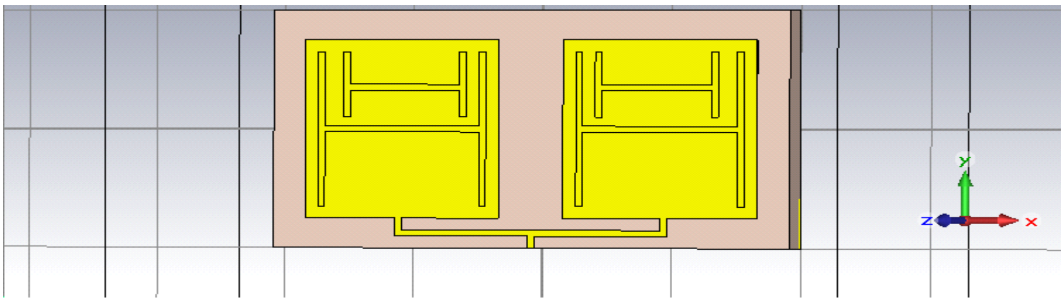

Fig.9 3rd Iteration

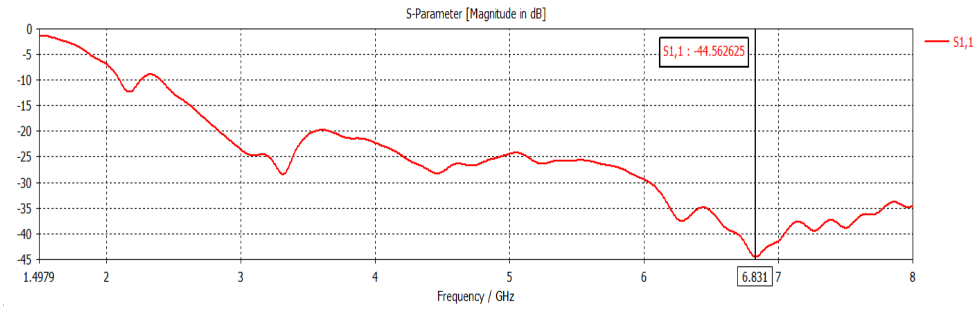

Fig.10 Return Loss in dB for 3rd Iteration at a frequency = 6.83GHz

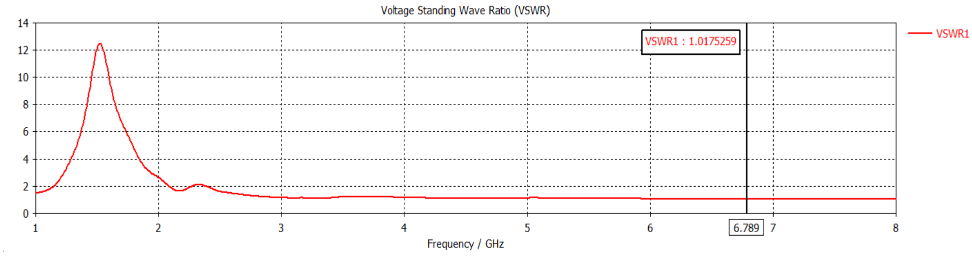

Fig.11 VSWR for 3rd Iteration at a frequency= 6.8GHz

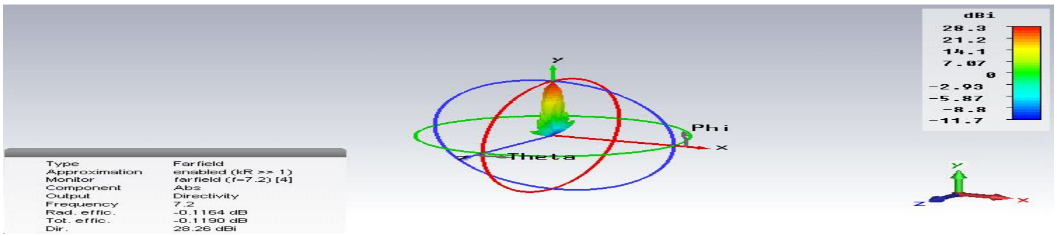

Fig.12 Far field pattern for 3rd Iteration at a frequency= 6.83GHz and Directivity = 28.26dBi

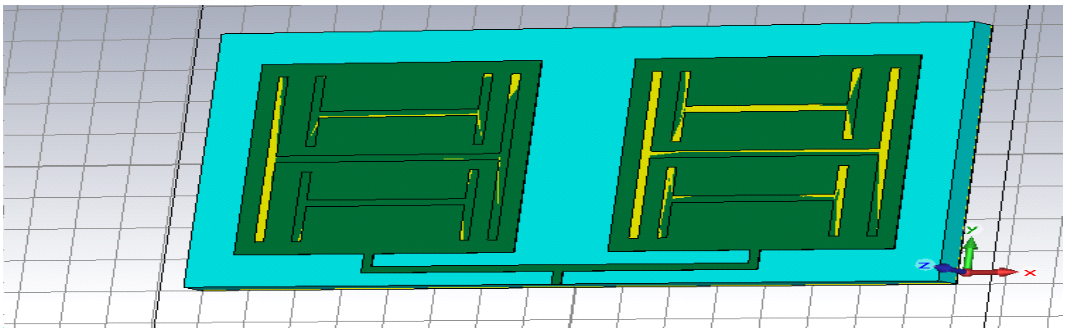

Fig.13 4th Iteration

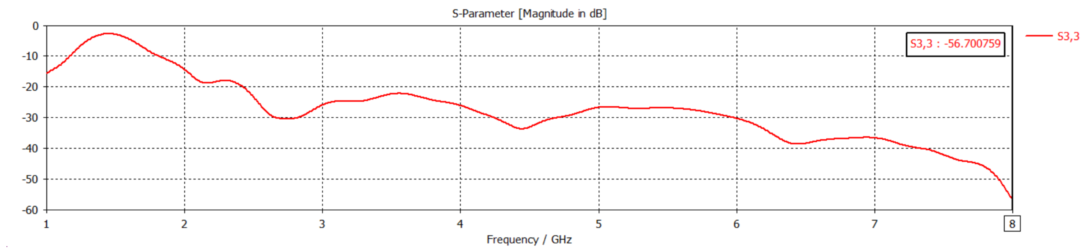

Fig.14 Return Loss in dB for 4th Iteration at a frequency of 8GHz

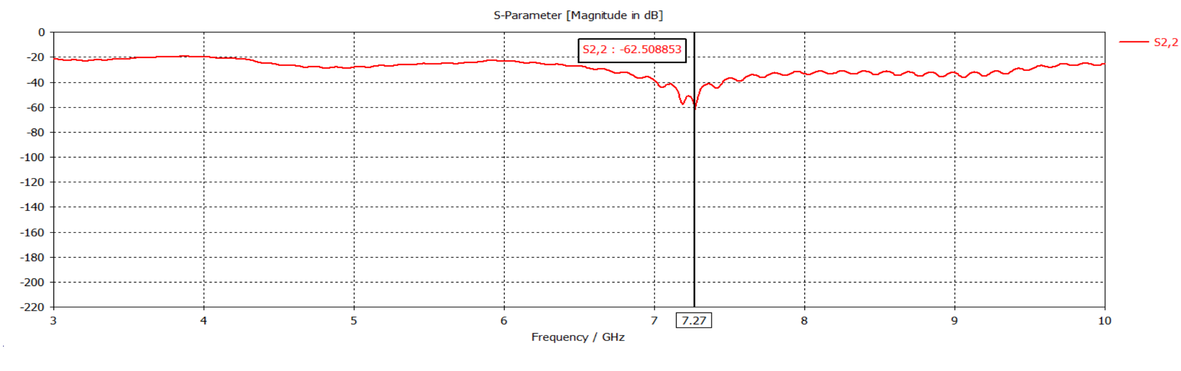

Fig.15 Return Loss in dB for 4th Iteration at a frequency of 7.2GHz

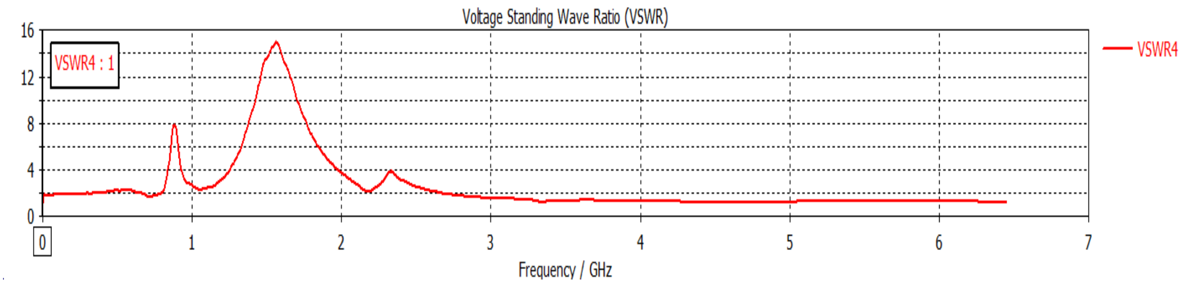

Fig.16 VSWR for 4th Iteration at a frequency of 6.8GHz

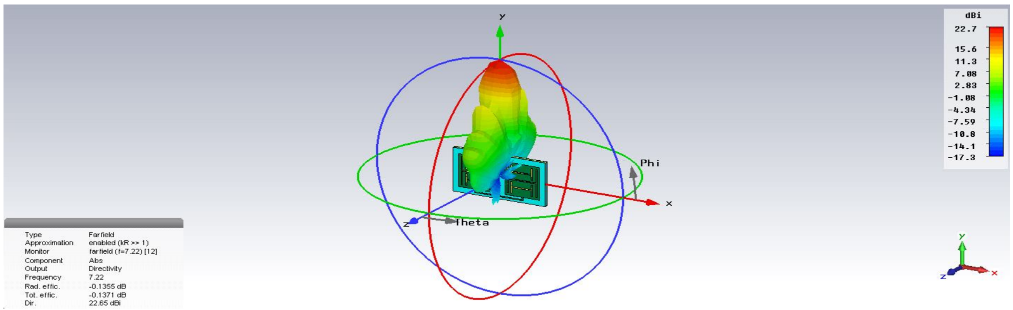

Fig.17 Far field pattern for 4th Iteration at a frequency = 7.22GHz and Directivity= 22.65dBi

Table 1: Four iterations for Return Loss VSWR and Directivity

Iteration	Frequency	Return Loss in dB	VSWR	Directivity in dBi
1st Iteration	6.83GHz 7.22GHz	-36.88 dB	1.52	20.84 dBi
2nd Iteration	7.9GHz 6.83 GHz	-41.84 dB	1.043	23.80 dBi
3rd Iteration	6.83 GHz 7.2 GHz	-44.56 dB	1.01	28.26 dBi
4th Iteration	7.2 GHz 6.5 GHz	-62.5 dB	1	22.65 dBi
	8GHz	-56.7 dB	1.001	

5.Conclusion

The proposed fractal antenna seems to be an interesting configuration as the number of iterations increases even though the circuit complexity increases the noise reduced because the return loss reduced to the maximum possible level so that the signal can travel more efficiently. In this paper a Novel H shaped Fractal Patch Antenna is proposed with 6.83GHz&7.22GHz &other frequencies. The third iteration in this paper presents the best directivity of 28.26dBi at frequency 6.83 GHz. This antenna has best performance as comparison with other conventional antennas. The final or fourth iteration provides voltage standing wave ratio of unity. The minimum return loss of -62.5dB so that the electromagnetic interference &noise is reduced to maximum extent. The entire simulation is done using CST Microwave Studio.

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