

Design, Simulation and Performance Analysis of Modified Sierpinski Fractal Antenna

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Abstract – The Abrupt advancement in wireless communication area has expanded the stipulation of compact integrated antennas. This paper depicts the architecture of modified sierpinski carpet fractal antenna up to 3rd iteration which reverberates over a frequency range of 2 to 5 GHz. Contrasting performance parameters like return loss, gain, directivity and VSWR are noticed for the frequencies. A FR-4 substrate with height of 1.6mm and permittivity of 4.4 is used. Microstrip line is used to feed the antenna and simulation is done using ie3d software

Key Words: Sierpinski Carpet, Rhombus Shape, Gain, Modified fractal, IE3D.

1.INTRODUCTION

Antenna is the foremost factor of wireless communication scheme used for imparting and receiving the electromagnetic signals. The antenna categories can be classified based on frequency of function, physical configuration and electrical layout. The prerequisites for modern wireless communication arrangement are small shape low profile multiband antenna, cheap price and large bandwidth. Researchers have advised the fractal pattern used in microstrip patch antenna to meet the above said conditions.

In contemporary years, exploration effort has been carried out for several antenna contour based on fractal geometries. These are low profile antennas with modest gain and can be regulated at numerous frequency bands and hence are multifunctional [1]. The style “fractal” measures cracked or erratic remnants. According to Mandelbrot, “a fractal is a pattern made of elements analogous to the whole in some manner”[2]. Self-resemblance tendency of fractal can be seen in its electromagnetic attitude [3]. Fractal based microstrip patch antenna are extensively used for broadband and multiband utilization in tremendous data rate schemes which are known as wide-band communication arrangement [4]. In order to attain the obligation of multiband antenna a modified Sierpinski carpet fractal antenna is created which displays broadband attributes and performance improvement [5]. The layout of modified Sierpinski fractal antenna consist of E pattern fractals up to 3rd iteration and can be used for wideband and ultra-wideband functions [6]. A compact Sierpinski carpet

fractal antenna is altered by introducing an extruded shape up to 2nd iteration for multiband attribute [7].

2. ANTENNA LAYOUT

Fractal antenna geometry is encouraged by nature i.e it retains appearance of fractals that endure naturally. Sierpinski carpet geometry has been used here to design modified Sierpinski carpet fractal antenna up to 3rd iteration. To attain above equitable, first rectangular microstrip patch antenna of L=39.43mm and W=50.72 mm is constructed as shown in figure 1, using equation (1) to (5).

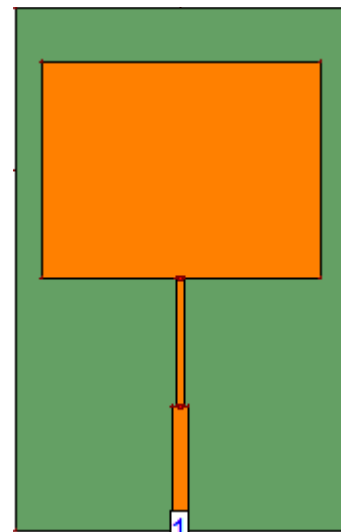


Fig -1: Design of RMPA.

$$w = \frac{c}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}} \tag{1}$$

$$L = L_{eff} + 2\Delta L \tag{2}$$

Where, L = Length of patch and L_{eff} = Effective Length

$$L_{eff} = \frac{c}{2f_0 \sqrt{\epsilon_{reff}}} \tag{3}$$

Where, ϵ_{reff} = Effective Dielectric Constant

$$\Delta L = 0.412h \frac{(\epsilon_{reff} + 0.3) \left(\frac{w}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258) \left(\frac{w}{h} + 0.8\right)} \tag{4}$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12 \frac{h}{w} \right]^{-1/2} \tag{5}$$

Next the rectangular patch antenna is cleft into 9 proportionate sub rectangles and center most sub rectangle has been modified to (1) rhombus shaped Sierpinski carpet and (2) rhombus inscribed in a rectangle Sierpinski carpet. Analogous steps have been carried out for iteration 2 and 3 for rhombus shaped Sierpinski carpet and rhombus inscribed in a rectangle Sierpinski carpet as shown in figure 2 and 3 respectively.

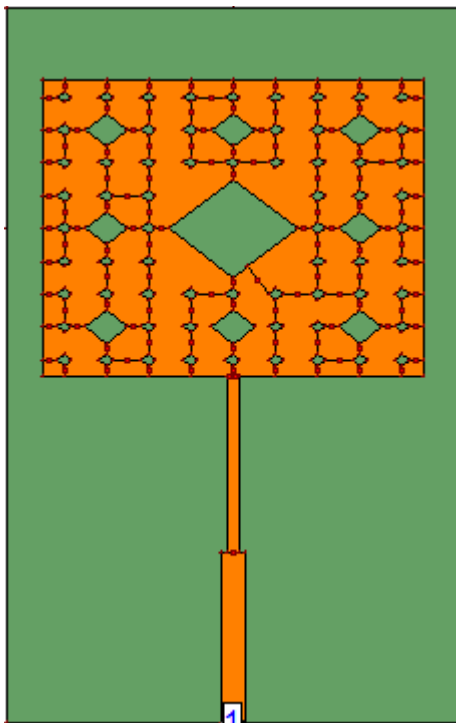


Fig 2-: Design of rhombus shaped SCFA

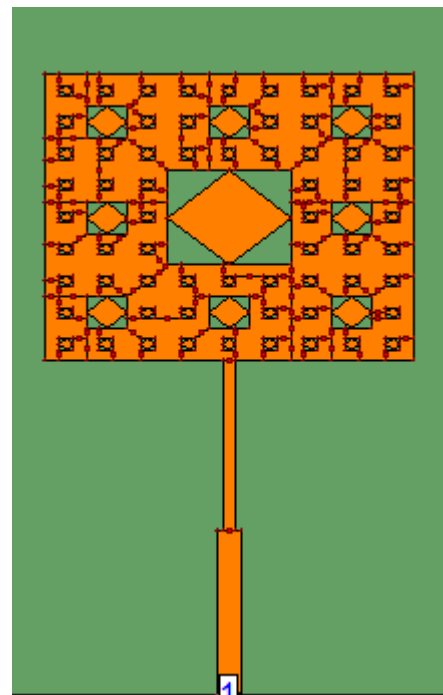


Fig 3-: Design of rhombus inscribed in rectangle SCFA

3. SIMULATION RESULTS

The RMPA antenna graph in Fig.4 gives a return loss of -12.042 dB at 1.8 GHz. The graph seen in Fig.5 gives a gain of 0.62 dBi at 1.8 GHz. The rhombus shaped SCFA and rhombus inscribed in a rectangle SCFA resonate over two frequencies. The graphs in Fig.6 and Fig.8 show the return loss of rhombus shaped SCFA and rhombus inscribed in a rectangle SCFA respectively. The graphs seen in Fig.7 and Fig.9 show the gain of rhombus shaped SCFA and rhombus inscribed in a rectangle SCFA respectively. The results of each antenna and their performance are outlined in Table 1.

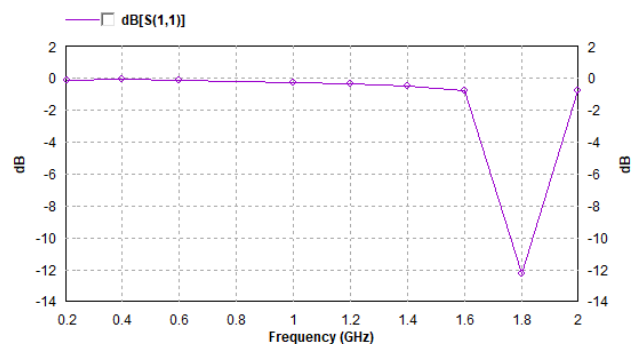


Fig 4-: S11 of RMPA

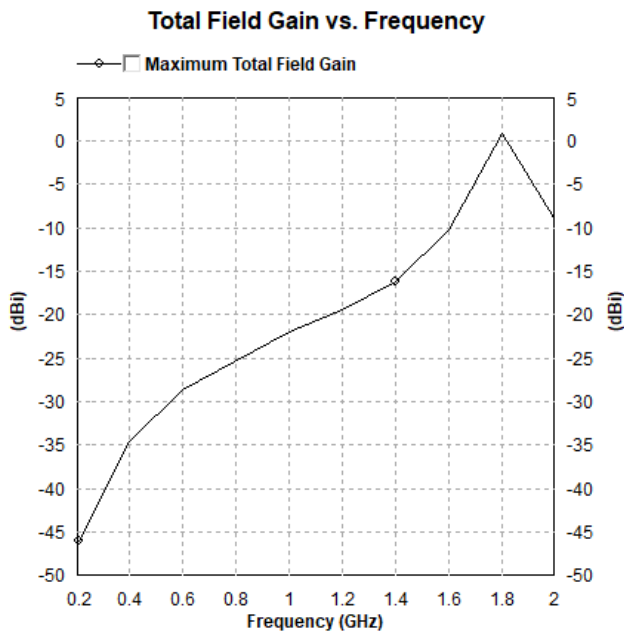


Fig 5:- Gain of RMPA

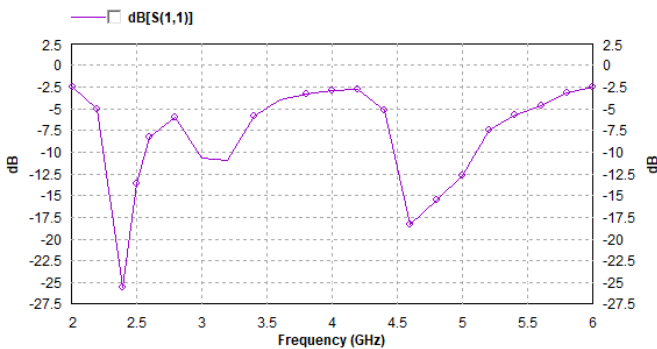


Fig 6:- S11 of rhombus shaped SCFA

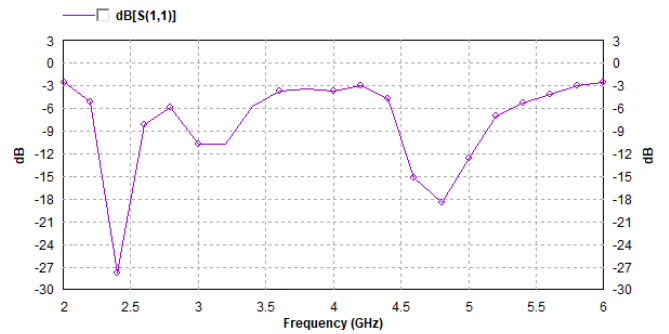


Fig 8:- S11 of rhombus inscribed in rectangle SCFA

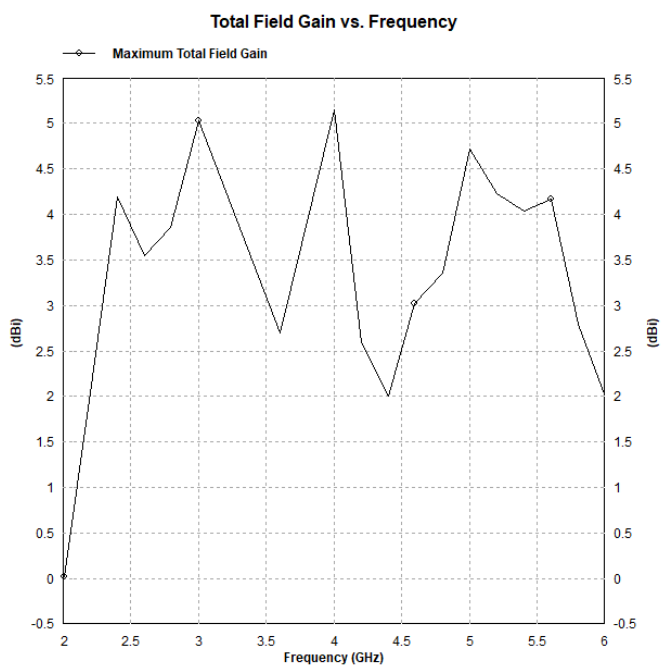


Fig 9:- Gain of rhombus inscribed in rectangle SCFA

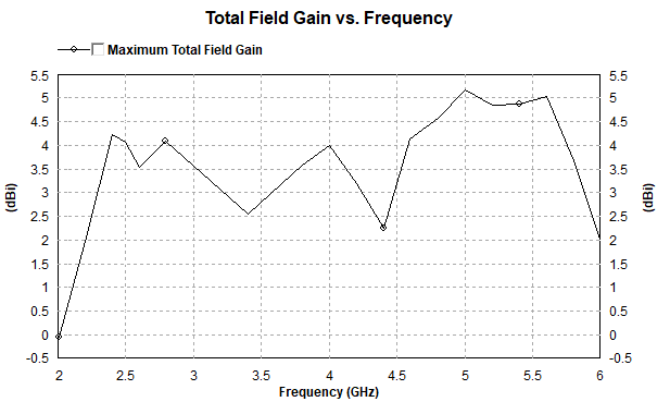


Fig 7:- Gain of rhombus shaped SCFA

Table -1: Optimized parameters

Parameters	Antenna				
	RMPA	Rhombus shaped SCFA		Rhombus inscribed in rectangle SCFA	
Resonant Frequency	1.8 GHz	2.4 GHz	4.6 GHz	2.4 GHz	4.8 GHz
Return loss (in dB)	-12.042	-25.4326	-18.3231	-27.7612	-18.548
Gain(in dBi)	0.62	4.22662	4.12625	4.18202	3.35355
VSWR	1.8	1.11526	1.27624	1.08533	1.26807
Directivity (in dBi)	6.22	4.28091	4.96988	4.2178	4.19826

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[8] Zealand IE3D software Inc. ver. 14.0.

4. CONCLUSIONS

A rhombus shaped sierpinski carpet and rhombus inscribed in a rectangle sierpinski carpet fractal antenna at 1.8 GHz has been created up to 3rd iteration in this paper using IE3D software. It has been investigated for parameters such as return loss, VSWR, gain and directivity. It can be achieved from above simulation outcomes that rhombus shaped and rhombus inscribed in a rectangle can be used over a range of 2-5 GHz.

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