



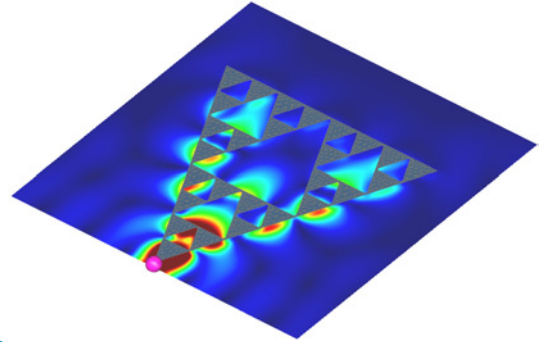
FRACTAL ANTENNAS SIMULATION

Introduction

This application demonstrates modeling of fractal antennas within EMC Studio / EMCoS Antenna VLab environment. The triangular shaped fractal, Sierpinski gasket monopole antenna is considered. Structure of this antenna is intended to be use for four discrete frequency bands.

Simulated resonance frequencies of the Sierpinski gasket monopole antenna are compared with analytical solution.

Fractal Antenna. Sierpinski Gasket Monopole



Simulation Model Description

Sierpinski gasket with largest side length (s) of 102.7683 mm or a height (h) of 88.9 mm is considered. The substrate thickness is 1.588 mm, and relative permittivity is 2.5.

Sierpinski Gasket Monopole Antenna

Parameter	Value
Side length, s, [mm]	102.7683
Height, h, [mm]	88.9
Substrate thickness, [mm]	1.588
Relative permittivity	2.5

Analytic Estimation of Resonance Frequencies:

$$fr = \begin{cases} (0.15345 + 0.34\rho x) \frac{c}{h_e} (\xi^{-1})^n & \text{for } n = 0 \\ 0.26 \frac{c}{h_e} \delta^n & \text{for } n > 0 \end{cases}$$

$$x = \begin{cases} 0, & k = 0 \\ 1, & k > 0 \end{cases}$$

$$h_e = \frac{\sqrt{3}s_e}{2}, \quad s_e = s + t(\epsilon_r)^{-0.5}$$

$\delta = 2$ is the scale factor of geometry

$$\xi = \frac{1}{\delta}$$

$\rho = \xi - 0.230735$

c is light speed

Sierpinski Gasket Monopole Antenna (Different Iterations)

1-st Iteration

2-nd Iteration

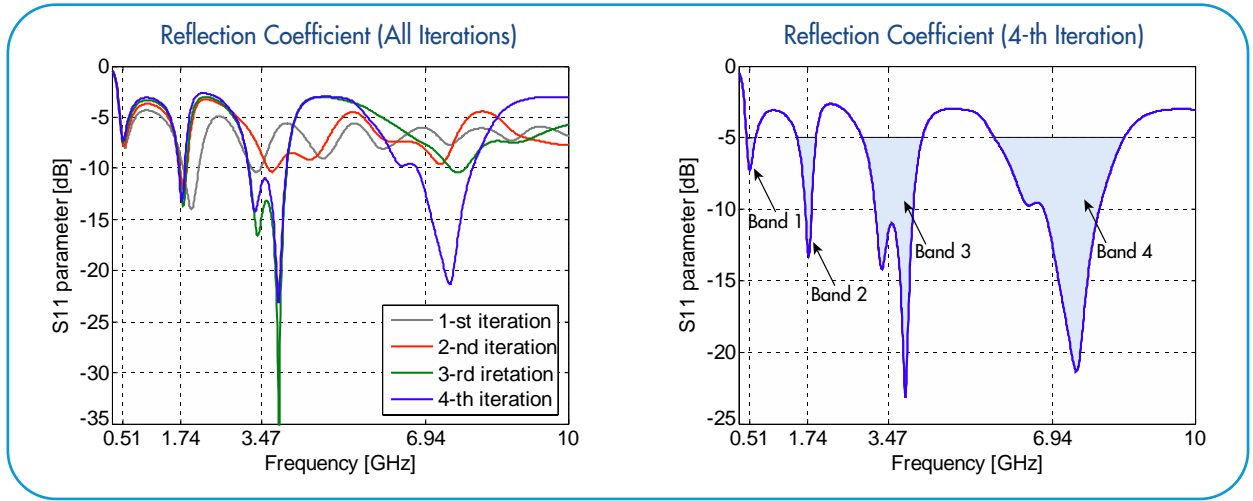
3-rd Iteration

4-th Iteration



FRACTAL ANTENNAS SIMULATION

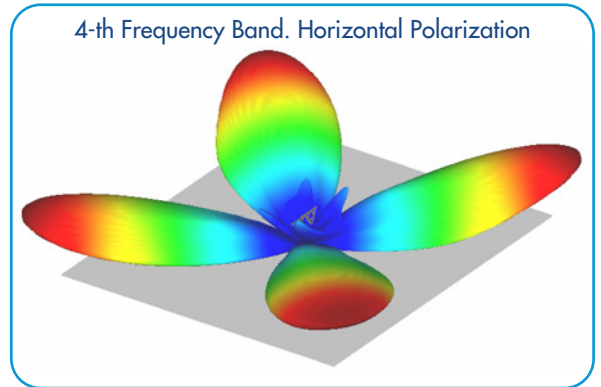
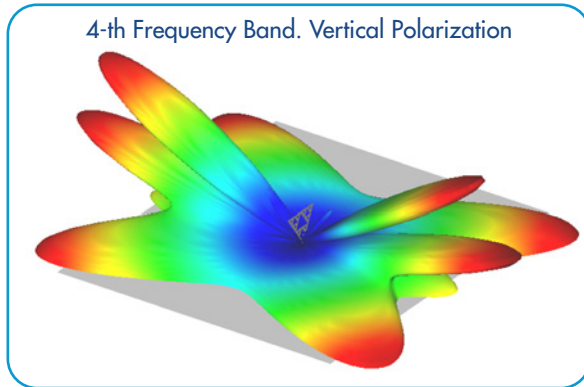
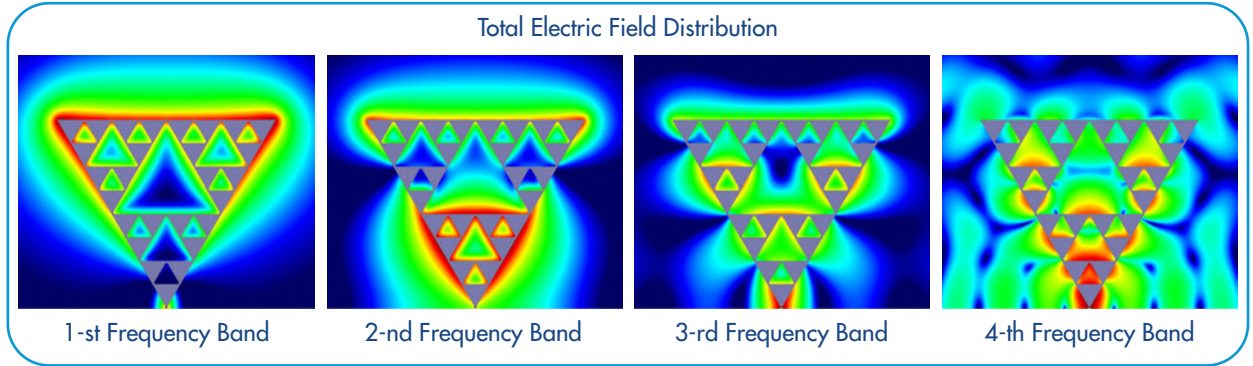
Results



The resonance frequencies of the Sierpinski gasket monopole antenna obtained from the analytical formulas and simulated in EMC Studio / EMCoS Antenna VLab are shown in table.

$$BW = 2 \frac{f_h - f_l}{f_h + f_l} \cdot 100\%$$

Band No.	Resonance frequency, [GHz]		Bandwidth, [%]
	Analytical Solution	EMC Studio	EMC Studio
0	0.51	0.54	35.6
1	1.74	1.72	23.7
2	3.47	3.54	36.1
3	6.94	7.09	38.9



Conclusions

- Fractal antenna simulations can be effectively done in EMC Studio and EMCoS Antenna VLab environment
- Simulated characteristics of Sierpinski gasket monopole antenna are in good agreement with analytical results

References

- R. K. Mishra, R. Ghatak, and D. R. Poddar, "Design formula for Sierpinski gasket pre-fractal planar-monopole antennas," IEEE Antennas Propag. Mag., vol. 50, no. 3, pp. 104-107, Jun. 2008.