MICROSTRIP SIERPINSKI CARPET ANTENNA USING TRANSMISSION LINE FEEDING

Mohamad Kamal A. Rahim, Mohamad Zoinol Abidin Abd Aziz and Noorsaliza Abdullah

Wireless Communication Centre,
Faculty of Electrical Engineering, Universiti Teknologi Malaysia,
Skudai Johor
Email: mkamal@fke.utm.my, matjoin@yahoo.com, Saliza@yahoo.com

Abstract: Low cost of fabrication and low profile features of microstrip antennas, attract many researchers to investigate the performance of this antenna in various ways. Today, fractal antenna become popular among the researcher because they have a peculiar properties that make them suitable for multiband applications. Microstrip Sierpinski carpet antenna using transmission line feed is proposed for a multiband operation. Bandwidth up to 47% is being obtained at frequency 7.93 GHz. Thee cross polar isolation is between 10 to 15 dB.

Key Words: microstrip, fractal antenna, sierpenski carpet

I. INTRODUCTION

Fractal technology allowed us to design miniature antennas and integrate multiple band into a single device. Fractals are objects, which display self-similarity on all scales [1]. Two basic characteristics of a fractal are self-similarity and the fractal dimension. An object is said to be self-similar if it look roughly the same on any scale. The estimated length, L, of an object equals the length of the ruler, r, multiplied by a number, N, of such rules needed to cover the measured object. If we reduce an object in Euclidian dimension D and reduce its linear size $\frac{1}{r}$ in each spatial direction its measure would increase to $N = r^D$. Solving for D, the equation become:

$$D = \frac{\log N}{\log r} \qquad (1)$$

This is known as the Hausdorff dimension [2].
Fractal antennas are antennas that have the shaped of fractal structures. The fractal antennas consist of geometrical shapes that are repeated. Each one of the shapes has unique attributes. By careful selection. Fractal antennas can be design in many shapes such as Sierpinski gasket, Sierpinski carpet, Koch island, Hilbert curve and Miskowsi. In this paper a microstrip sierpinski carpet antenna has been designed and analyzed. The performance of the antenna has been investigated in term of the return loss and the radiation pattern.. The co and cross polar isolation was also investigated from the radiation pattern

II. ANTENNA CONFIGURATION

The square patch microstrip antenna was selected for the initial design. The dimension of the antenna was determined from the equation of the microstrip patch antenna design equation. For the fractal design, a microstrip sierpinski carpet antenna using transmission line feeding was selected. This antenna was design until second iteration. Figure 1 shows the iteration of the microstrip Sierpenski Carpet fractal antenna up to 3rd iteration.

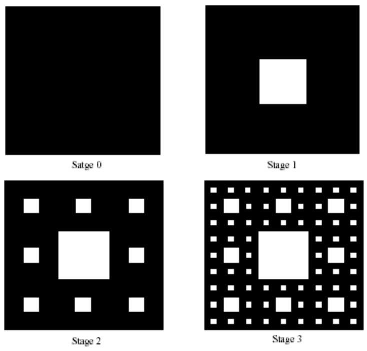


Figure 1 Sierpinski carpet square antenna with third iteration

For the fractal design this procedure has to be followed [3]

Let N_n be the number of black boxes,

L_n the ratio for the length,

A_n the ratio for the fractional area after the nth iteration and

d_n is the capacity dimension.

Then

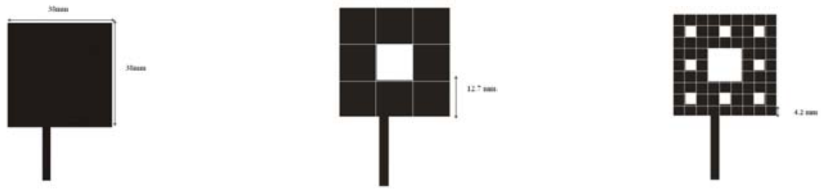
$$N_n = 8^n \tag{2}$$

$$L_n = \left(\frac{1}{3}\right)^n \tag{3}$$

$$A_n = \left(\frac{8}{9}\right)^n \tag{4}$$

$$d_n = -\lim_{n-->\infty}\left(\frac{\ln N_n}{\ln L_n}\right) = 1.89 \tag{5}$$

The radiating elements were printed on a copper clad material FR-4. The design of the antenna starts with the basic square of a single element patch operating at 1.8 GHz. The element size of the square patch antenna was obtained from the calculation. The simulation for the basic square structure with transmission line feeding resulted in antenna size of 38 mm x 38 mm. Figure 2 shows the step of producing microstrip Sierpinski Carpet antenna with transmission line feed.



(a) (b) (c)

Figure 2 Microstrip Sierpinski Carpet antenna with transmission line feeding of (a) zero iteration, (b) first iteration,(c) second iteration.

Table 1 Fractal antenna properties

	Zero Iteration	1^{st} iteration	2^{nd} iteration
N_n	1	8	64
L_n	1	0.33	0.111
A_n	1	0.889	0.791

III. Experimental Results

(a) Return Loss Measurement result

The measurement and simulation result of input return loss for sierpenski carpet with second iteration is shown in Figure 3. The bandwidth for the 1^{st} band up to the third band is between 2 to 5 %. At frequency 5.2 GHz the fourth band the bandwidth is 13% and at band five for frequency 7.93 GHz the bandwidth has been increased to 47%

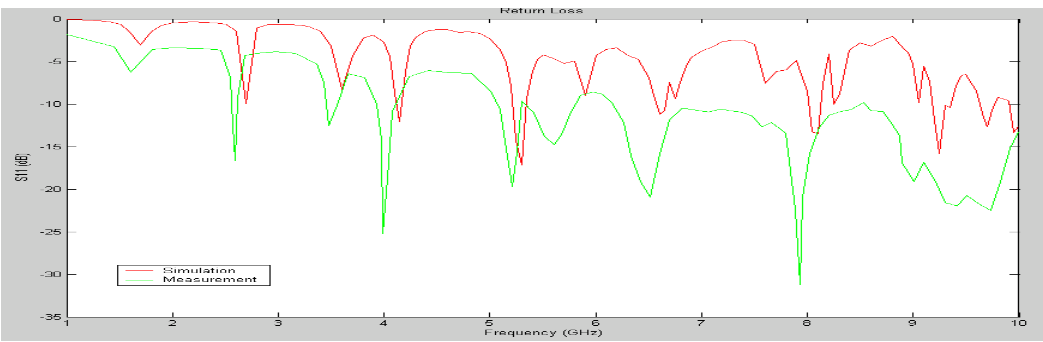


Figure 3 Measurement and simulation of return loss for fractal antenna

(b) Radiation pattern

The far-field radiation pattern has been measured in an anechoic chamber. The typical measured co-polar and cross-polar radiation pattern at the first and four band are illustrated in Figure 4. The multiple lobes of the radiation pattern at a higher band are due to the geometrical asymmetry of the fractal structure in the E-plane with respect to the feed point.

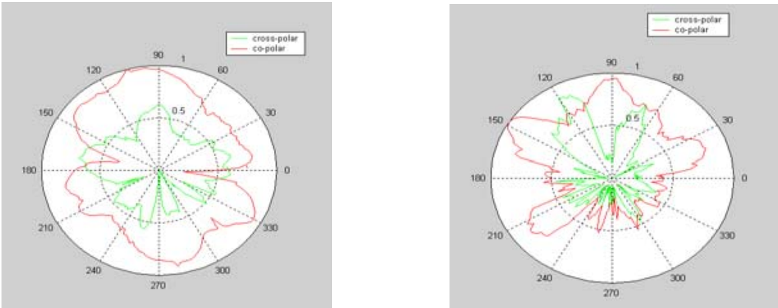


Figure 4 Co and cross polar radiation pattern for Microstrip Sierpinski Carpet antenna for (a) 2.59 GHz (b) 5.2 GHz

IV. DISCUSSIONS

From the result of the return loss it shows that the measurement of the return loss follows the trend from the simulation process. The simulation was carried out using momentum simulation from the microwave office software. It shows that this antenna gives a multiband frequency for the two iterations. The resonance frequencies start from 2.59 GHz with a return loss of –16.65 dB. The next higher frequency is at 3.48 GHz with a return loss of –12.9 dB. At higher frequency the percentage of bandwidth is increased up to 47%. The radiation pattern shows the E plane for two different frequencies. The cross polar isolation frequency at 2.59 is 15 dB and at frequency 5.2 GHz the cross polar isolation is 10 dB.

V. CONCLUSION

A square microstrip Sierpinski Carpet antenna was constructed using fractal geometry for multiband operation. The measured results indicate that the antenna exhibits a good radiation and input return loss. This type of antenna is the best candidate for wireless communications for multiband operation.

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