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On the Investigation of Stacked Sierpinski 'S Gasket Antenna with Enhanced Bandwidth

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On the Investigation of Stacked Sierpinski 'S Gasket Antenna with Enhanced Bandwidth

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Abstract - The broadband behavior of the fractal Sierpinski's gasket antenna is described in this paper. A stacked microstrip gasket antenna at iterations level three for C-band application is designed and simulated on IE3D software. The feeding technique used is transformer feed. Simulated results shows that this antenna has three resonant frequencies of gain of order 5dBi with a bandwidth of 1.64GHz and percentage bandwidth of 48.2 which empower it as a broadband antenna.

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I. Introduction

The Sierpinski gasket is named after the Polish mathematician Sierpinski who described some of the main properties of this fractal shape in 1916. In recent years, the current trend in commercial and government communication system has been to develop low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies. This technological trend has focused much effort in to the design of microstrip antennas. Most fractal objects have self-similar shapes, which mean that some of their parts have the same shape as the whole object but at a different scale[1]. In multiple reduction copy machine (MRCM) algorithm, an initial structure called generator is replicated many times at different scales, positions and directions, to grow the final fractal structure. With the ever-increasing need for mobile communication and the emergence of many systems, it is important to design broadband antennas to cover a wide frequency range. Microstrip antenna suffers a major drawback of narrow bandwidth. This problem can be handled by three ways like lower the impedance of antenna, use of impedance matching and implementation of multiple resonances [2]. For lowering the impedance, mainly shape of radiator can be changed or thickness of substrate with lower dielectric constant and higher losses has to be chosen. As the shape of antenna is decided as per its requirements so a thick substrate with lower dielectric constant is a better option for reducing Q. Transformer feed provides impedance matching of antenna and microstrip line.

The matching network can be a quarter-wavelength impedance transformer, tuning stubs, active components or their variations,The advantage of this is that the radiator need not to be changed, which simplifies the design by allowing the impedance matching and radiation performance to be controlled independently.

Some of the major antenna properties discussed in this paper are

a) Bandwidth[2]

The term bandwidth simply defines the frequency range over which an antenna meets a certain set of specification performance criteria. The important issue to consider regarding bandwidth is the performance tradeoffs between all of the performance properties described above. There are two methods for computing an antenna bandwidth. An antenna is considered broadband if $fH/fL \geq 2$.

Narrowband by %

$$BWp = \frac{fh - fl}{fo} \times 100$$

Broadband by ratio

$$BWp = \frac{fh}{fl}$$

where $f_o \equiv$ operating frequency
$f_H \equiv$ higher cut-off frequency
$f_L \equiv$ lower cut-off frequency

b) Gain

The gain of an antenna is essentially a measure of the antenna's overall efficiency. If an antenna is 100% efficient, it would have a gain equal to its directivity. There are many factors that affect and reduce at the overall efficiency of an antenna. Some of the most significant factors that impact antenna gain include impedance, matching network losses, material losses and random losses.

$$Gain = \frac{|S12|\left(\frac{4\pi d}{\lambda o}\right)}{\sqrt{(1-|S11|^2)(1-|S22|^2)}}$$

where d is distance between the transmitting and receiving antenna. Gain also can be simply defined as the product of the directivity and efficiency given by

$$G = \eta D$$

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II. Antenna Design And Specifications

The original gasket is constructed by subtracting a central inverted triangle from a main triangle shape (Fig. 2.1). After the subtraction, three equal triangles remain on the structure, each one being half of the size of the original one. One can iterate the same subtraction procedure on the remaining triangles and if the iteration is carried out an infinite number of times, the ideal fractal Sierpinski gasket is obtained. In such an ideal structure, each one of its three main parts is exactly equal to the whole object, but scaled by a factor of two and so each of the three gaskets that compose any of those parts. Due to this particular similarity properties, shared with many other fractal shapes, it is said that the Sierpinski gasket is a self-similar structure.

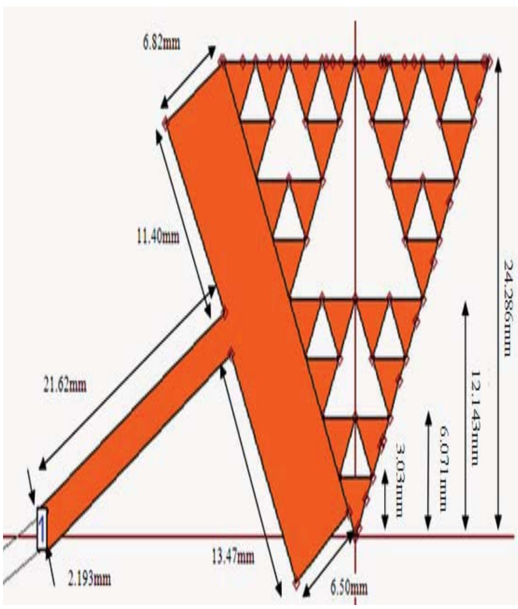

Figure 2.1 : Design of Antenna

The Sierpinski gasket (also Sierpinski triangle) was chosen as the first candidate for a fractal antenna due to its resemblance to the triangular or bow-tie antenna. As shown in Fig. 1, the height of gasket is 24.286mm. Stacking of two substrates of thicknesses 1.588mm and dielectric constant of 4.4 is done for the design. The antenna design starts with frequency is 3.4GHz and proposed antenna has got three resonance frequency at 6.18 GHz,6.942 GHz & 7.442 GHz with enhanced band width up to 1 GHz. Which indicates that this antenna is a broadband antenna.

The formulae for determining the length of each side of gasket is

$$a = \frac{2c}{3fr\sqrt{\varepsilon r}}$$

The 3D view of antenna (fig. 2.2) clearly shows the stacking and feed structure.

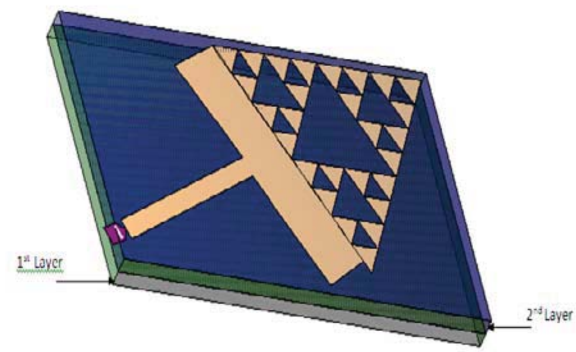

Figure 2.2 : 3D view of Design

III. Simulation Results

The proposed antenna is simulated on IE3D software and the results are shown below.

a) Return Loss

Return loss is the difference, in dB, between forward and reflected power measured at any given point in an RF system. It is a convenient way to characterize the output of signal sources. The return loss of antenna is displayed in fig 3.1.1 and its values are displayed in table 3.1.1.

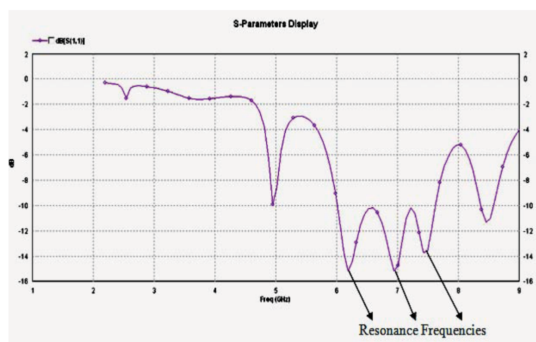

Figure 3.1.1 : Return Loss

Frequencies(GHz)	Return Loss(dB)
6.18	-15.104
6.942	-15.142
7.442	-13.682

Table 3.1.1 : Return Loss

The overall bandwidth of antenna is 1.64 GHz from 5.997GHz to 7.637 GHz with a bandwidth percentage of 48.2.

b) VSWR Result

Simulated results show that the antenna has VSWR of approximately 1 at three working frequencies. The VSWR of the antenna is shown in the figure 3.2.1.

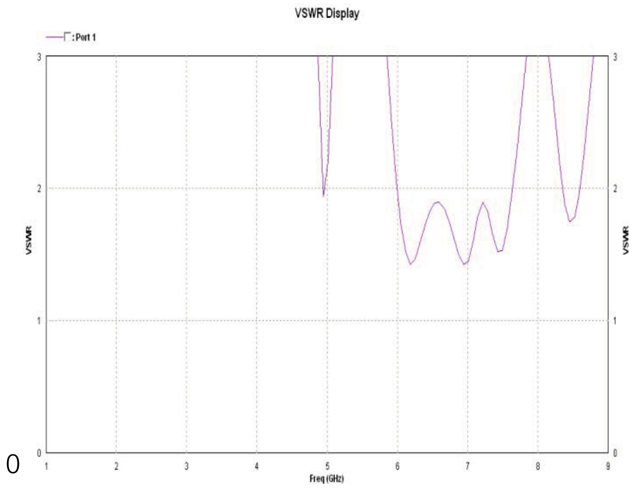

Figure 3.2.1 : VSWR

c) Radiation Pattern

The 3D radiation pattern of the antenna at the frequency of 6.52GHz is shown in the figure 3.3.1.The 2D radiation pattern(polar plot) of antenna for phi=0°,90°,170° is shown in the figure 3.3.2. It can be observed from the 3D radiation pattern that the antenna has a gain of 6.64dbi at the above frequency.

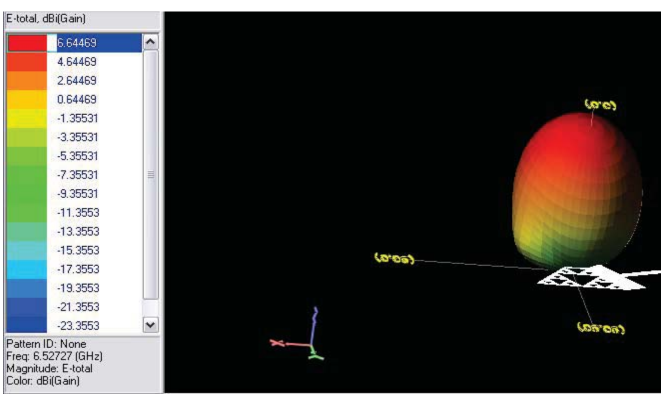

Figure 3.3.1 : 3D gain

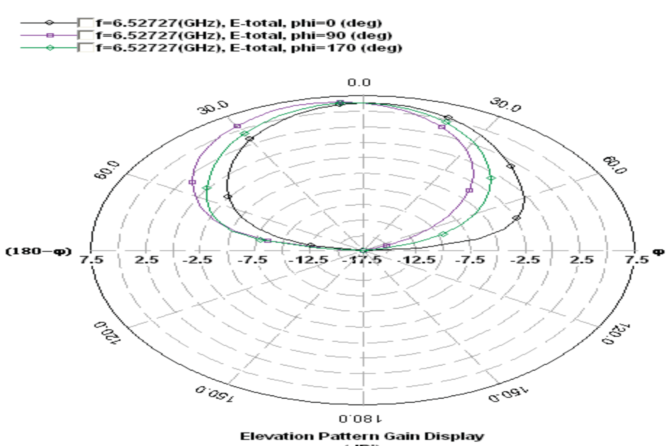

Figure 3.3.2 : Polar plot at 6.52 GHz

IV. Conclusion

From the simulated results, it can be inferred that the designed antenna can operate at three resonance frequencies and has bandwidth of 1.64 GHz and enhancement in bandwidth is 42.8% with a gain of 6dBi.Result shows that designed antenna has broadband behaviour. This is the overcome of the narrow banding behaviour of microstrip antenna. .

References Références Referencias

1. "On the Behavior of the Sierpinski Multiband Fractal Antenna" by Carles Puente-Baliarda and Rafael Pous, IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 46, NO. 4, APRIL 1998, PP: 517-524
2. "Broadband Planar Antennas" by "Ning Chen and Michael Y. W. Chia,University of Infocom research, Singapore", YOP: 2005, Publisher: John Wiley and Son
3. David M. Pozar, "*Microwave Engineering"*, Second Edition, YOP: 1998, Publisher: John Wiley and Sons, PP: 655- 672.