DESIGN OF COMPOUND FRACTAL ANTENNA FOR MULTIBAND APPLICATION

Tarunjot Kaur
Electronics and communication engineering department
Yadavindra College of Engineering
Talwandi Sabo, Punjab, India
ertarunjot@gmail.com

Yadwinder Kumar
Electronics and communication engineering department
Yadavindra College of Engineering
Talwandi Sabo, Punjab, India
yaddi79@gmail.com

Abstract **This work is concerned with the investigation of two types of antenna elements that are to be used for multiband applications. The first antenna is the Fractal antenna while the second is the meander line antenna. The basic design is based on the self similarity principle of fractal profiles but uses different slot geometries. The behaviors of both type antennas are investigated such as return loss, number of iterations and radiation pattern. Compound fractal antennas have the potential to provide multi-band solution through the property of self similarity that the fractal shape poses. Compound fractal antenna is comprised of elements patterned after self similar designs. Self-similarity of the fractal shape can be translated into its electromagnetic behavior. Nowadays wireless communications systems require compact antennas which are capable of operating at different bands. Fractal geometry is being studied in order to answer those requirements.**

Keywords: *Fractals; antennas; antenna theory; self-similarity*

*****

I. INTRODUCTION

Fractal shaped antennas have already been proved to have some unique characteristics that are linked to the geometry properties of fractal. Benoit Mandelbrot, the pioneer of classifying this geometry, first coined the term 'fractal' in1975 from the Latin word *fractus*, which means broken. The field is quite extensive with many applications from statistical analyses, natural modeling, and compression and, of course, computer graphics. Soon after scientists discovered the practical aspect of fractal geometry, research began in the field of electrodynamics. These geometries have been used to characterize structures in nature that were difficult to define with Euclidean geometries. Examples include the length of a coastline, the density of clouds, and the branching of trees. Fractals are space filling contours, meaning electrically large features can be efficiently packed into small areas. Fractals can be used in two ways to enhance antenna designs. The first method is in the design of miniaturized antenna elements. These can lead to antenna elements which are more discrete for the end user. The second method is to use the self similarity in the geometry to blueprint antennas which are multiband or resonant over several frequency bands [3].

Meander line antenna is one type of the micro strip antennas. The meander line antenna was proposed by Rashed and Tai for reduce the resonant length. Meandering the patch increases the path over which the surface current flows and that eventually results in lowering of the resonant frequency than the straight wire antenna of same dimensions. The electrical small antenna defines as the largest dimension of the antenna is no more than one-tenth of a wavelength. Meander antenna is electrically small antenna .The design of meander line antenna is a set of horizontal and vertical lines. Combination of horizontal and vertical lines forms turns. Number of turns increases efficiency increases. In case of meander line if meander spacing is increase resonant frequency decreases. At the same meander separation increase resonant frequency decreases. A meander antenna is an extension of the basic folded antenna and frequencies much lower than resonances of a single element antenna of equal length [1].

II. ANTENNA DESIGN

Realizing the required design considerations is a fundamental procedure before the design of any antennas which is shown in figure 6.2.1. The size of antenna is 45ˣ30ˣ2.6 mm. The substrate used is FR4 and the dielectric used is 1.

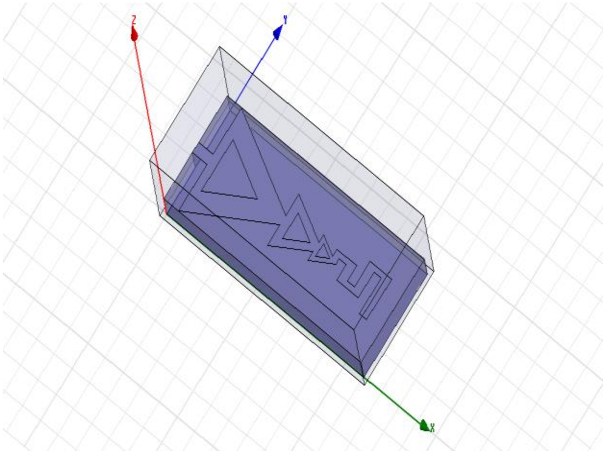

Figure 1 Geometry of antenna

III. DESIGN SPECIFICATIONS

The three essential parameters for the design of a Compound Fractal Antenna are:

• Frequency of operation (*fo*): The resonant frequency of the antenna must be selected appropriately. The antenna for various application uses the frequency range from 1400-6500 MHz. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 6.0 GHz.

• Dielectric constant of the substrate (*εr*): The dielectric material selected for my design is FR4 which has a dielectric constant of 4.7. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

• Height of dielectric substrate (*h*): For the compound fractal antenna to be used in various applications, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 2.6 mm.

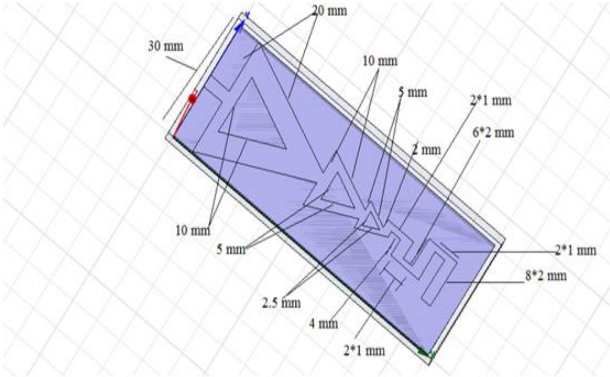

Figure 2 Top view of antenna

IV. RESULTS & SIMULATION

Given below in figure shows the combined result of triangular geometry and meander line antenna for the figure 3. The most commonly quoted parameter in regards to antennas is S11. S11 represents how much power is reflected from the antenna, and hence is known as the **reflection coefficient** or **return loss**. If S11=0 dB, then all the power is reflected from the antenna and nothing is radiated. If S11=-10 dB, this implies that if 3 dB of power is delivered to the antenna, -7 dB is the reflected power. The remainder of the power was "accepted by" or delivered to the antenna. This accepted power is either radiated or absorbed as losses within the antenna. Since antennas are typically designed to be low loss, ideally the majority of the power delivered to the antenna is radiated.

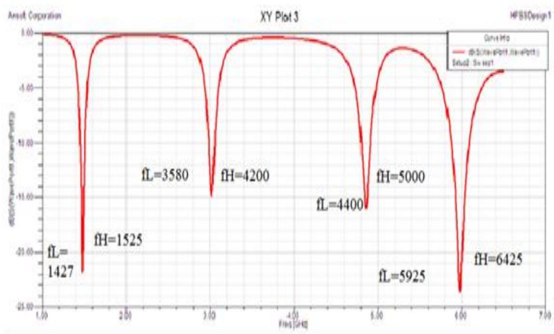

Figure 3 Return loss of antenna

Frequency Band Table

Bands	f_L	f_H	$(f_H+f_L/2)$	B.W.(f_H - f_L)
I	1427	1525	1476	98

II	3580	4200	3890	620
III	4400	5000	4600	600
IV	5925	6425	6175	500

VSWR - The parameter VSWR is a measure that numerically describes how well the antenna is impedance matched to the radio or transmission line it is connected to VSWR stands for Voltage standing Wave Ratio, and is also referred to as standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by Γ, then the VSWR is defined as:

$$\text{VSWR} = \frac{1+\Gamma}{1-\Gamma}$$

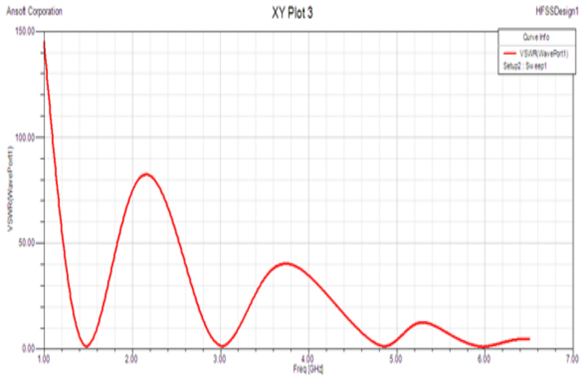

Figure 4 VAWR of antenna

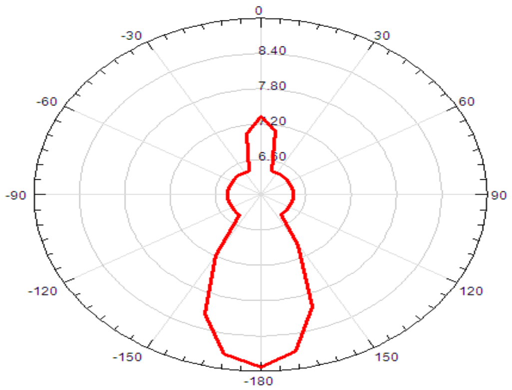

Figure 5 Radiation pattern of antenna

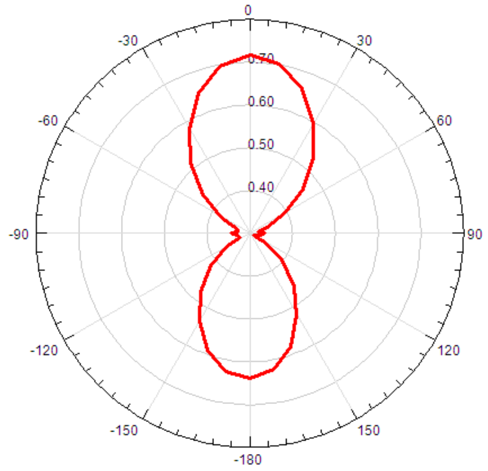

Figure 6 Radiation pattern of antenna

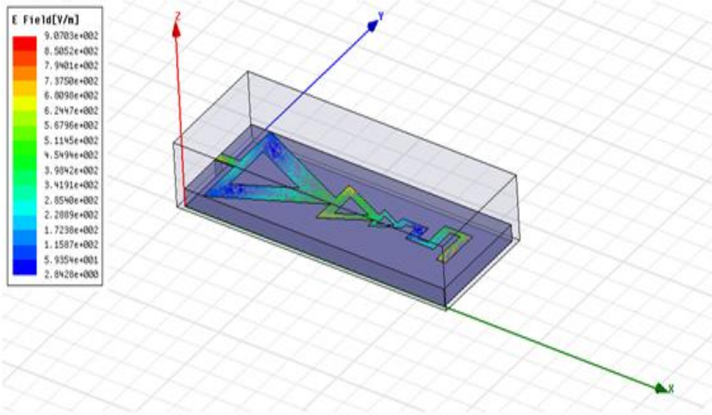

Figure 7 Gain of antenna

REFERENCES

1. C.C.Hsu, H.H.Song, "Design, Fabrication, and Characterization of a Dual-Band Electrically Small Meander-line Monopole Antenna for Wireless Communications" International Journal of Electromagnetics and Applications Issue-3, Volume-2, 2013

2. V.B. Ambhore & A.P.Dhande "An Overview on Properties, Parameter Consideration And Design of Meandering Antenna" International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN) ISSN No. 2248-9738, Issue-4 Volume-1, 2012

3. S. Suganthi, S. Raghavan, “Planar Fractal Antennas for Wireless Devices”, IEEE Antennas and Propagation, Issue-3, pp. 82-85, 2011

4. A. Ismahayati, P.J Soh, R.Hadibah, G.A.E Vandenbosch, “Design and Analysis of a Multiband Koch Fractal Monopole Antenna, IEEE, International RF and Microwave Confrence, Volume-2, pp. 58-62, 2011

5. Abolfazl Azari, “A New Fractal Antenna For Ultra Wide- And Multi-Band Applications”,17th Asia-Pacific Conference on Communications, Issue-8, Volume-75, pp. 389-392, 2011.

6. Kumar et.al, 2011, “Antenna Miniaturization Using Fractal Antenna and its Design”, International Journal of Enterprise Computing and Business Systems.

7. Arpan Mondal, Sandeep Chakraborty, Rajiv K Singh and Rowdra Ghatak, “Miniaturized and Dual Band Hybrid Koch Fractal Dipole Antenna Design”, International Conference on Computer, Communication and Electrical Technology – ICCCET 2011

8. Rao Shahid Aziz, Majeed A. Alkanhal, Abdel Fattah A, Shetta, “Dual Band Fractal Monopole” IEEE, Issue-4, Volume-51, pp. 1-5, 2011

9. Mr. Aneesh Kumar. S and Mrs. T. K. Sreeja, “A Modified Fractal Antenna for Multiband Applications”, IEEE, pp. 357-360, 2010

10. Werner Hodlmayr “Introduction to fractal technology and presentation of a fractal antenna\adaptable to any transmitting frequency - The “FRACTENT”.

11. Douglas H. Werner and Suman Ganguly, “An overview of Fractal Antenna Engineering Research”, IEEE Antenna and Propagation Magazine, Volume 45. Number 1, February 2003