Volume 5, Issue 5, May 2015 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Design and Development of Square Fractal Antenna for Wireless Application

Rahul Tyagi[1], Saurabh Kohli[2]

[1]M.Tech Student, [2]Asstt. Prof.

[1, 2,] Department of Electronics and Communication Engineering, Shree Siddhi Vinayak Engineering College, Kurukshetra University, Kurukshetra, Haryana, India

Abstract: This paper present the analysis and design of a small size, low profile, single-band square shape sierpinski fractal antenna. The proposed antenna design, analysis and characterization have been performed using the method of moments (MoM) technique. The use of fractal pattern in this paper provides a simple and efficient method for obtaining the compactness. A square shape sierpinski based fractal antenna is designed for 5.09 GHz. The FR-4 epoxy/glass material is used as substrate. The radiation pattern shows the gain of the antenna which is 3.87 dBi at 5.09 GHz. The directivity of the antenna satisfies present need and the VSWR is minimum. The bandwidth of the antenna is 30 MHz. In term of wavelength (λ), the length of the antenna is .50λ.

Keywords-Microstrip, Fractal, Sierpinski.

I. INTRODUCTION

Modern telecommunication systems require antennas with wider bandwidths and smaller dimensions than conventionally possible. This has initiated antenna research in various directions, one of which is by using fractal shaped antenna elements. In recent years several fractal geometries have been introduced for antenna applications with varying degrees of success in improving antenna characteristics. Some of these geometries have been particularly useful in reducing the size of the antenna, while other designs aim at incorporating multi-band characteristics. Yet no significant progress has been made in corroborating fractal properties of these geometries with characteristics of antennas. Fractal represents a class of geometry with very unique properties. Fractals are space-filling contours, meaning electrically large features can be efficiently packed into small area so that space filling property is used for size reduction of the antenna.

Fractal geometry is self similar in some portion of the geometry that has been the same shape as the overall geometry, only at the reduce scale. The self similarity property of fractals results in a multiband behaviour. Using self similar properties a fractal antenna can transmit and receive over a wide range of frequencies.

In this paper Sierpinski based square patch fractal antenna. The advantage of Sierpinski square patch fractal antenna is that a Sierpinski square patch fractal antenna manifests a useful resonance at a lower frequency in comparison to a non-fractal square antenna of the same physical area.

II. ANTENNA DESIGN

The square patch fractal antenna is based on sierpinski square shaped. For designing this fractal antenna IE3D software is used which is based on method of moment (MoM). The FR-4 epoxy material is used as substrate. The thickness of the substrate is 1.575 mm. The dielectric constant (ε_r) of the antenna is 4.3. The sierpinski fractal shape is used in this paper with second iteration. In decomposition algorithm for square shape is cut down from the centre of the square patch antenna which shows the 1st iteration and give one resonance frequency. For second iteration, again square shape is cut down from the some portion of 1st iteration. Finally resonant frequency find at 2nd iteration. To design the fractal antenna a square shape structure is designed on the simulator.. Fig. 1 shows the square patch antenna without iteration and fig. 2 shows the fractal with 1st iteration of the square patch antenna. Fig. 3 shows the square patch antenna with 2nd iteration.The side length of square patch fractal antenna is 30 mm (without iteration) and after 1st iteration 'indentation' size is 10 mm×10 mm and each square side is 10 mm. This square patch fractal antenna has scale factor

$$\delta = \frac{h_n}{h_{n+1}} \qquad (1)$$

Where h represents the side length of the square patch fractal antenna and n is a natural number represents the number of iteration.

The resonant frequency selected in this design is 5.09 GHz. The dimension of the patch form is obtained from the following equation.

L=W=0.5□d

Where L is the dimension of the square,

λ_d is the wavelength in the dielectric, where

$$\lambda_d = \frac{\lambda}{\sqrt{\varepsilon_r}}$$

The side length of the square shape antenna is 30 mm.

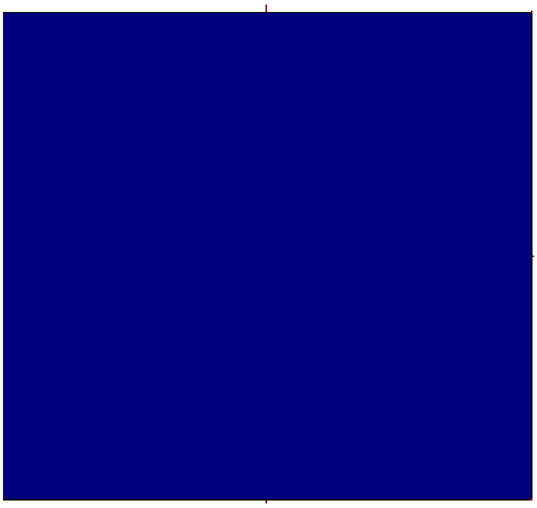

Fig. 1 Proposed antenna with zero iteration

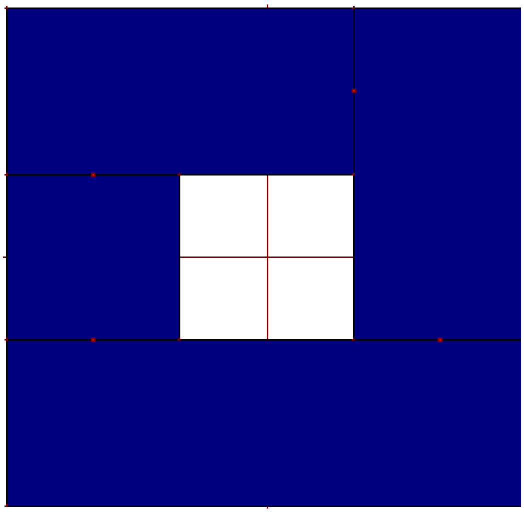

Fig.2 Proposed antenna with first iteration

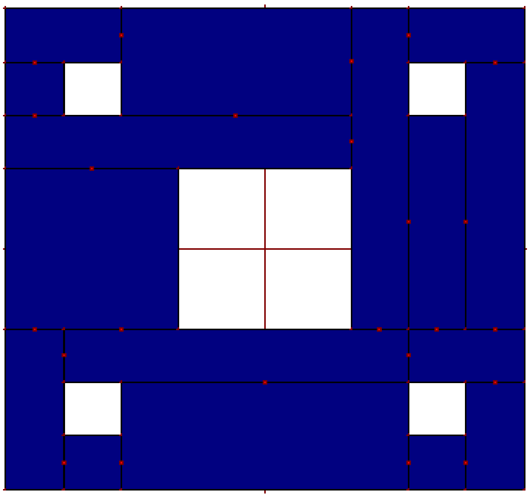

Fig 3 Proposed antenna with second iteration

III. RESULT AND DISCUSSION

The simulated results of return loss are shown in fig. 4. The return losses -27.31 dBi for the resonant frequency 5.09 GHz. The bandwidth of the antenna is 30 MHz.

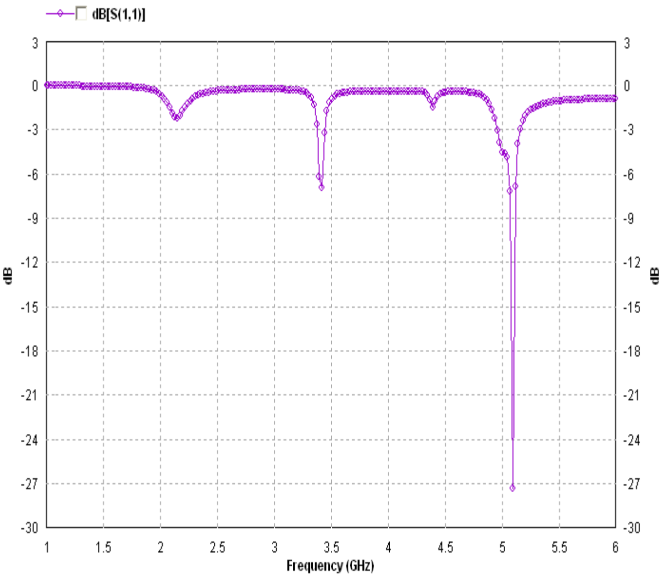

Fig.4 Return loss (S_{11}) Characteristics of the antenna

The gain of the antenna is 3.87 dBi at resonant frequency 5.09. The characteristics of the gain are shown in fig.5.

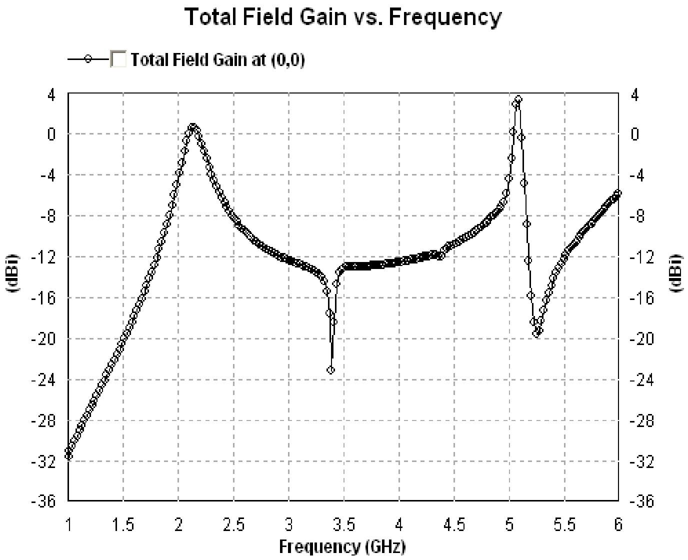

Fig.5 Gain characteristic of the antenna

The radiation pattern shows the gain of the antenna which should be positive. Fig. 6 show the gain of the antenna which is 3.87 dBi, which is suitable for radiation for resonant frequency 5.09 GHz .

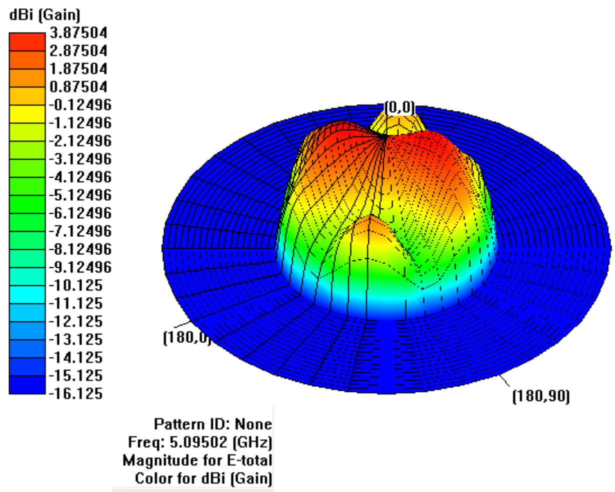

Fig 6. 3D radiation pattern

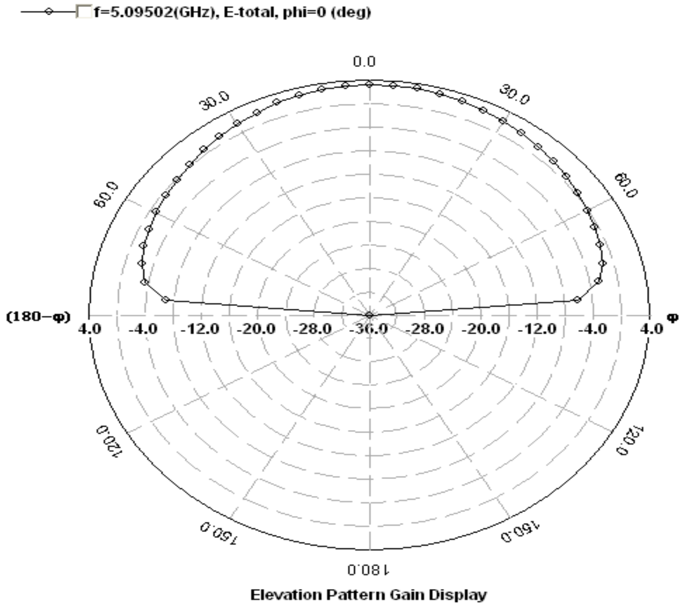

Fig.7 Elevation radiation pattern in polar form for 5.09 GHz.

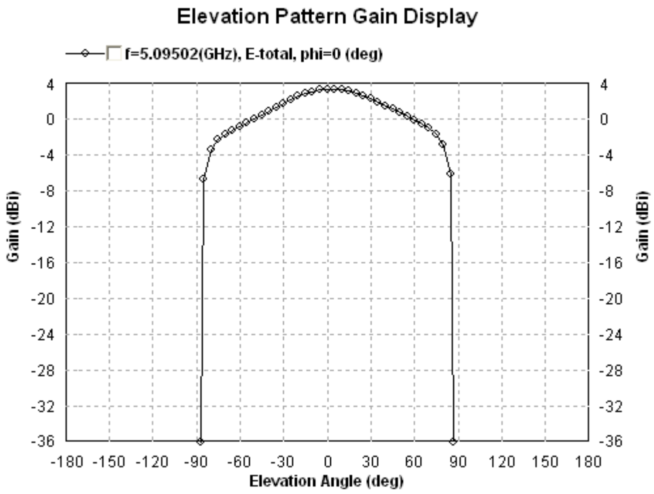

Fig.8 Elevation radiation pattern in Cartesian form for 5.09 GHz

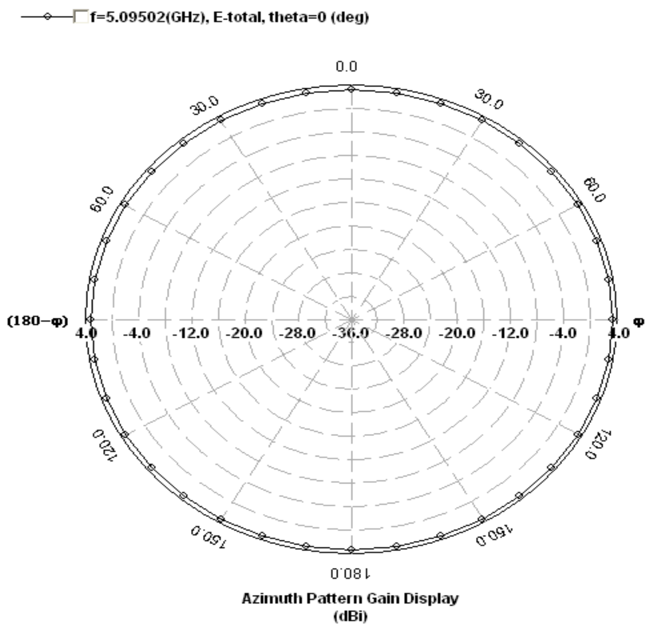

Fig.9 Azimuth Radiation pattern in polar form for 5.09 GHz.

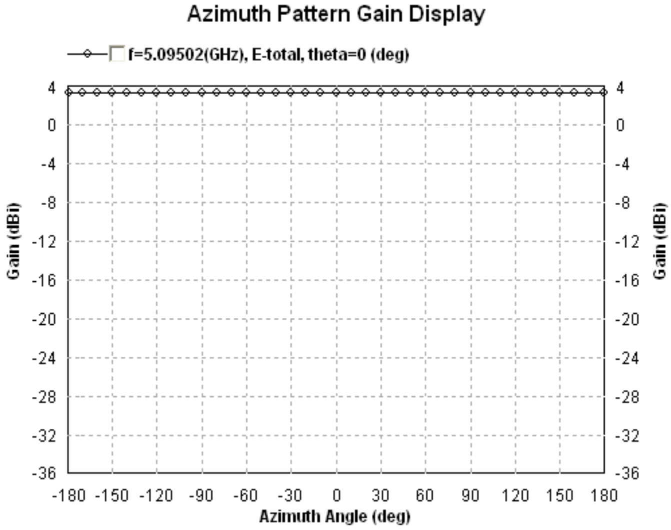

Fig.10 Azimuth Radiation pattern in Cartesian form at 5.09 GHz

The directivity of the antenna is related to gain as

$$G = kD \quad (5)$$

Where G is the gain of antenna, k is efficiency coefficient and D is the Directivity of the antenna. The value of k is always less than 1 so that D is always greater than G.

The VSWR is the voltage standing wave ratio and should be lies between 1.2 to 2.
The VSWR is between 1 & 2 for both resonance frequencies.

$$VSWR = \frac{1+S_{11}}{1-S_{11}} \quad (6)$$

The VSWR value for resonant freq. 5.09 GHz is 1.43.

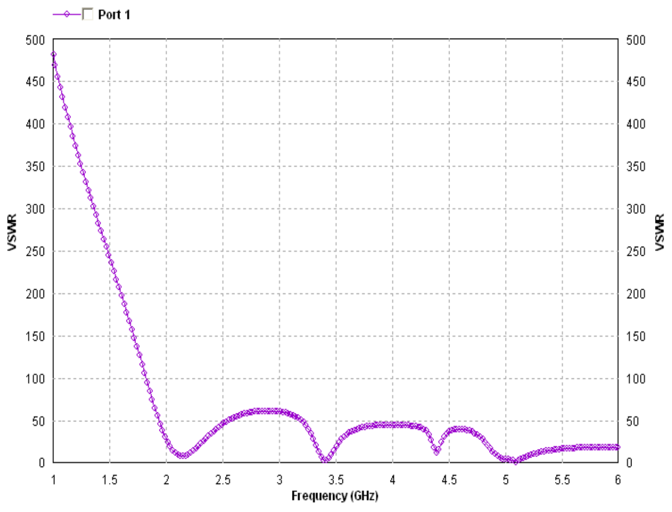

Fig. 11 VSWR characteristics of the antenna

IV. CONCLUSION

The resonance behaviour and space filling capabilities of the sierpinski based square patch fractal antenna have been investigated. It is found that this structure with an indentation in the border length offers considerable miniaturisation compared with a conventional square patch antenna (0 iteration). For this iteration the resonance frequencies decrease to lower side which indicates size reduction. The frequency bands of the antenna lies between 4-8 GHz (wi-max) .

REFERENCES

[1] Mahdi Naghshvarian-Jahromi " Novel Wideband Planar Fractal Monopole Antenna" IEEE Transaction on antennas an propagation, vol. 56, no. 12, 2008.

[2] M. Comisso "Theoretical and Numerical Analysis of the Resonant behaviour of the Minkoviski Fractal Dipole Antenna" IET Microwave, antenna &propagation, vol. 3. PP. 456-464, 2008.

[3] Dau-Chyrh chang "CPW-Fed circular fractal slot antenna design for dual-band applications" IEE Transaction on antennas & propagation, vol.56, no.12 2008.

[4] John P. Gianvittorrio and Yahya Rahmat-samii "Fractal Antennas: A novel Antenna Miniaturization Technichue and Applications" IEEE Antenna and Propagation Magazine, vol 44, no. 1, 2002.

[5] Weixia Wu, Bing-Zong Wang, Xue song"A Pattern Reconfigurable Planner Fractal Antenna and its Characteristic-mode Analysis"IEEE antennas and propagation magazine, vol. 49. no. 3,2007.

[6] Leo cao, Shu yan and Hanhua Yang "Study and Design of a Modified Fractal Antenna for RFID Applications" ISECS international colloquial on computing, communication, control, and management, IEEE 2009.

[7] Abas sabouni, Sima Noghanian, M.S.Abrishamian "Analysis of Microstrip Fractal Patch Antenna by 3-D FDTD Method" IEEE international workshop on antenna technology, 2005.

[8] C.puente *et.al*. "On The Behaviour of the Sierpinski Multiband Fractal Antenna' ,IEEE AP-46 PP.517-24.1998.

[9] C. Puente- Baliarda, J. Romeu, R. Pous, and A. Cardama, "Perturbation of the Sierpinski Antenna to Allocate Operating Bands, "*Electron Lett.*,vol.32,pp.2186-2188.1996.

