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Research paper

Design of octagonal fractal antenna for ultra wide band communication

Resmi Raj .U. R [1] *, Prof. Heera Karunakaran [1]

[1] Dept. of Ece Tkmce, Kollam, India
**Corresponding author E-mail: resmirajur@gmail.com*

Abstract

This paper presents an octagonal fractal antenna for ultra wide band communication. This antenna have small size, lower fabrication cost and multiband characteristics. The antenna is simulated by using HFSS software. It has dimension 32x30mm2.Defected ground plane is used which improves gain. Here.FR4 (εr=4.4) having thickness 1.6mm is used as the substrate. The proposed antenna is operating in the frequency range 2.1-12GHz. The resonance frequencies are 2.2GHz, 3.3GHz, 5.6GHz, 9.6GHz and 12GHz.where VSWR ≤ 2. It has radiation efficiency of 89.08% and peak gain 10.2dBi .The proposed antenna is applicable in UWB, S, and C and X bands.

Keywords: *Micro Strip Line Feeding; Fractal; Patch Antenna Multiband Antenna; Octagonal Geometry; HFSS.*

1. Introduction

Now a day's ultra wide band have much more attention because of its wide range of applications. So that studies regarding ultra wideband antennas are conducting by researchers. But the problem facing in such design is in the miniaturization and multiband properties of antenna. Another factor is the gain of antenna. It should be large in order to deliver maximum antenna power efficiently.

There are different feeding mechanisms such as probe feeding; aperture coupled feeding, and micro strip line feeding, where microstrip line feeding is commonly used. Among them micro strip line feed is preferred because of it's ease of fabrication. The antenna has to work in multiple frequency bands, also compact, low profile, low cost, and high gain. These antenna structures can be made using fractal geometries, which provide wide band and multi band characteristics [1].

Fractal antennas provide compact, high gain, multiband and wideband characteristics. The two important properties of fractal antenna are self similarity and space filling property.

Similarity in geometry is useful for multiband characteristics and space filling property leads to over all compact of antenna [2], [3].For an antenna radiate efficiently, its size should be less than quarter wavelength.

Fractal antennas over come such limitations by applying a number of iterations. The iteration procedure leads to multi band and miniaturized antenna structure. Further miniaturization can be achieved by introducing slots in the patch [4].

A wheel shaped fractal antenna has been proposed [5] to achieve ultra wide band applications. The proposed antenna have dimension 32x36mm^{2}which operate in UWB, S, C and X band .FR4 is used as the substrate with defected ground plane. A comparison is carried out according to the antenna dimension with previous UWB antennas.

Octagonal fractal circular PIFA for mobile phone applications [6] has been proposed. Fractal PIFA antennas have multiple bands Octagonal shape and slotted structures in the circular patch helps in increasing bandwidth.The results show that the proposed antenna can be used for integrating telecommunication services such as GSM, 3G, HiperLAN, UMTS and WLAN.

In this paper, an octagonal fractal antenna is analysed. This antenna structure supports multiple bands with wide bandwidth. It can be used for UWB, S, and C and X band applications. The aerial have bandwidth ranging from 2.1-12GHz with resonance frequencies 2.2GHz, 3.3GHz, 5.6GHz and 9.6GHz.The antenna shows 10.2dBi peak gain and maximum efficiency of 89.08%.

2. Mathematical modelling

The circular patch can be designed using following equation

$$a=\frac{F}{\{1+\frac{2h}{\pi\varepsilon r a}[\ln(\frac{\pi a}{2h})+1.7726]\}1/2}$$

$$F=\frac{8.791X10^2}{fr\sqrt{\varepsilon r}} \quad (1)$$

Here a is radius of circular patch; h=substrate thickness; εr =dielectric constant of the material. Patch length is increased due to fringing, so effective radius of patch is

$$Ae=a\ \{1+\frac{2h}{\pi\varepsilon r a}\ [\ln(\frac{\pi a}{2h})+1.7726]\}^{1/2} \quad (2)$$

Resonant frequency

$$(Fr)_{110}=\frac{1.8412v0}{2\pi ae\sqrt{\varepsilon r}}$$

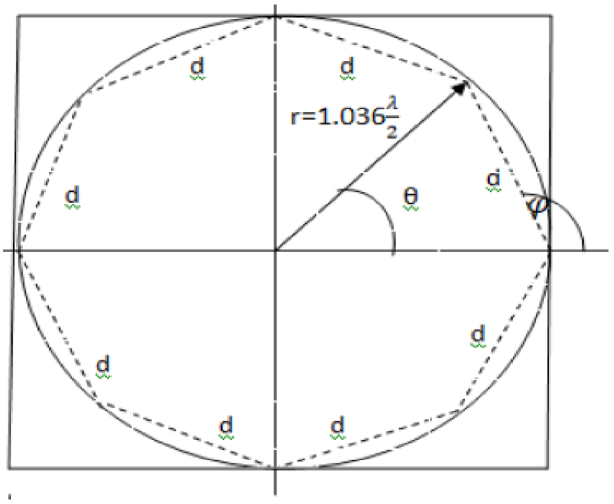

Fig. 1: Octagonal Geometry Formation.

Since octagonal shape is similar to circular shape it ia possible to obtain side length of octagon from radius of circle. Side length of octagon is given by the equation

$$\cos\left(\frac{135^0}{2}\right)=\frac{\frac{d}{2}}{r}\rightarrow r=1.306\left(d or \frac{\lambda}{2}\right)$$

3. Proposed antenna structure

An octagonal fractal antenna for ultra wide band communication is proposed in this paper. Here octagonal shapes is used as fractal shape. Also rectangular slots are introduced in the octagonal shape. Since octagonal shape is similar to circular shape, it offers wide bandwidth. The structure of proposed antenna is shown in the figure 1. Micro strip line feed is used for excitation. The octagonal fractal patch is printed on FR4 (ε_r=4.4 and tan δ= 0.002) substrate material. The height of the substrate is 1.6mm. The size of proposed antenna is 32x30mm^2(LXW).Here defected ground plane is used which results reduction in antenna size and band width enhancement. The length of ground plane, L_g is 30mm and it's width W_g is 7.5mm. The dimensions are depicted in the table I.

As the first iteration an octagon with outer side length S_1 equal to 7.6mm and inner side length S_2 equal to 6.12 is designed. Then second octagon with outer side length (S_3) 6.12mm and inner side length (S_4)3.06mm designed .Rectangular slots are added to the octagonal shape then proceed the iteration till the desired bandwidth is obtained. Microstrip line feed having feed length L_f=9.4mm is used for excitation, which gives 50Ω impedance match. The slots in the ground plane provide wide band width High frequency structure simulator (HFSS) software is used for simulation of the proposed antenna.

Table 1: Dimensions of Antenna in Mm

L	32
W	30
L_f	9.4
L_g	30
W_g	7.5
S_1	7.6
S_2	6.12
S_3	5
S_4	3.06

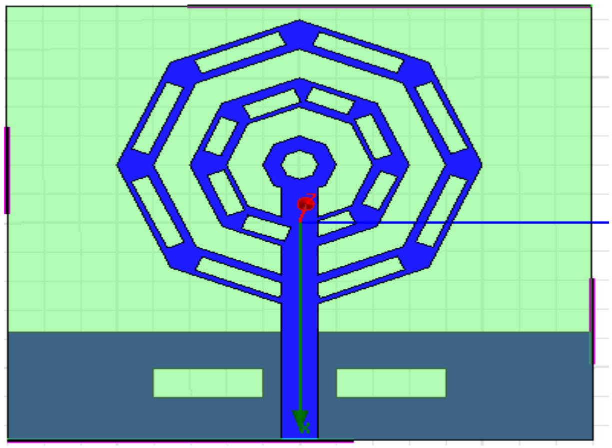

Fig. 2: Proposed Structure.

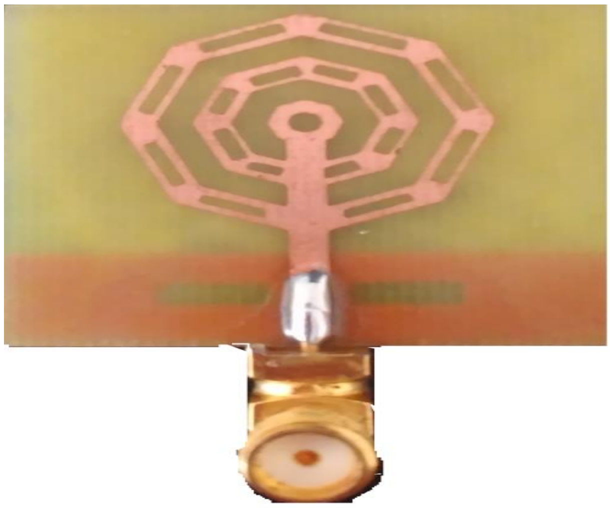

Fig. 3: Fabricated Antenna.

4. Measured results and discussion

The figure shows simulated reflection coefficient, S11 of proposed antenna. From the result resonance frequencies are 2.2GHz, 3.3GHz, 5.6GHz and 9.6GHz. Where s11 is less than -10dB.The band width is 9.9GHz starts from 2.1-12GHz.

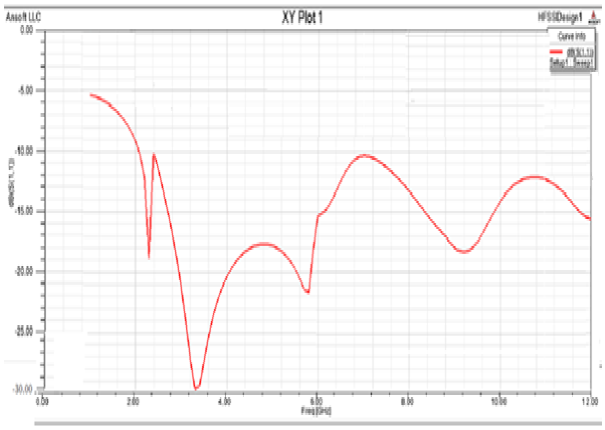

Fig. 3: Simulated Reflection Coefficient.

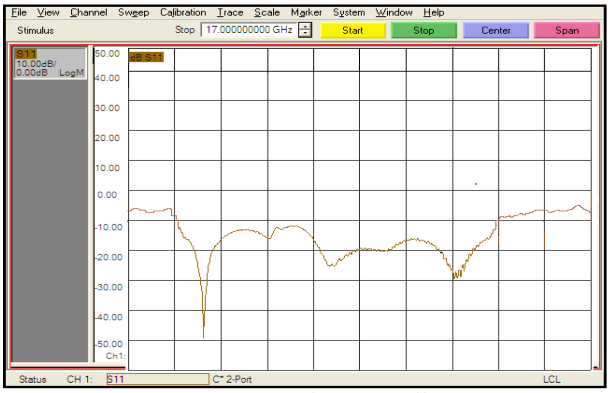

Fig. 4: Measured Reflection Coefficient.

The figure below shows VSWR versus frequency curve, where VSWR is less than 2 at resonance frequencies. An antenna is said efficient, its reflection coefficient plot should less than -10dB and VSWR plot should less than 2dB. Which means 90% of antenna power is radiate and 10% power is reflect.

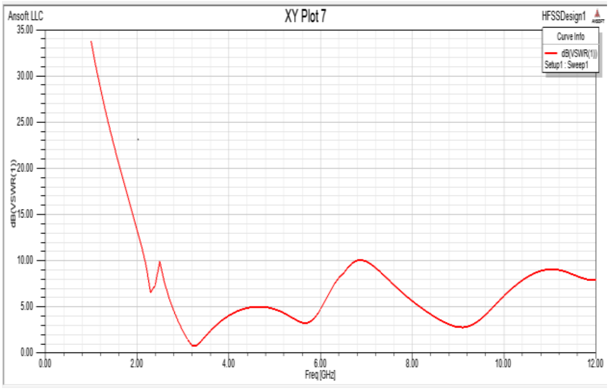

Fig. 3: VSWR Plot.

The gain versus frequency curve is depicted in the figure.which shows that gain is 10.2dBi, 4. 3dBi, 1. 3bBi, 3dBi at respective resonance frequencies.

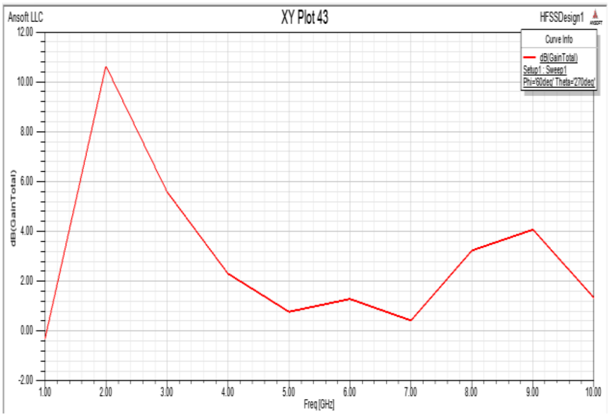

Fig. 5: Gain Plot.

Radiation pattern of proposed octagonal fractal antenna is shown below at different resonance frequencies.

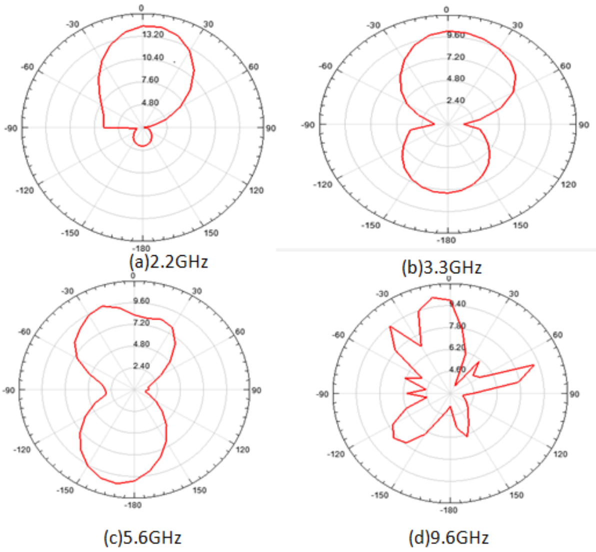

Fig. 6: Radiation Pattern of Antenna at Resonance Frequencies.

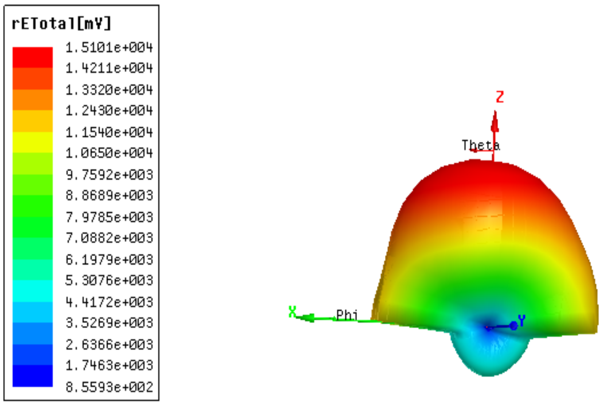

Fig. 6: 3D Radiation Pattern.

Surface current distribution of proposed octagonal fractal antenna is depicted in the figure.

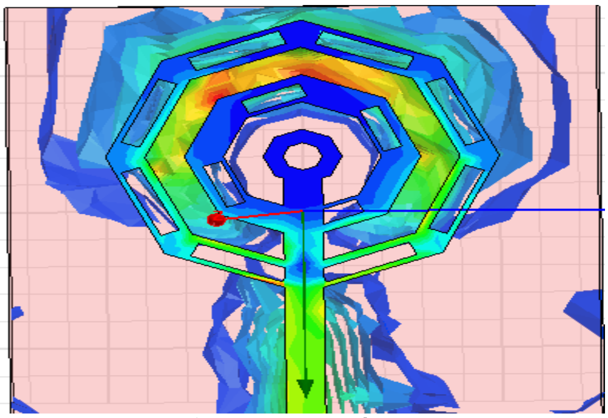

Fig. 7: Current Distribution.

5. Conclusions

The proposed octagonal fractal antenna have wide band and multi band characteristics which operating from 2.2 GHz-12 GHz. The resonance frequencies are 2.2GHz, 3. 3GHz, 5. 6GHz 9.6GHz and 12GHz.the peak gain of proposed antenna is 10.2 dBi. The parametric study of antenna is done using HFSS software. This octagonal antenna has dimension 30x32mm^2,whch is small in area compared to other UWB fractal antenna From the simulation results proposed antenna is suitable for UWB(3.1-10.6 GHz), S(2-4GHz), C(4-8GHz), and X(8-12GHz) band applications.

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References

[1] Puente C.Fractal Antennas .Dept.Signal Theory Commun.Univ.Politenica De Catalunga.Phd.Dissertation.June, 1997.
[2] Reddy V.Vv,Sarma Nvsn .Triband Circularly Polarzed Koch Fractal Boundary Microstrip Antenna,Ieee Antenna Propg.Lett 2014:13:1057-60.
[3] Krishna D D, Gopalakrishna, Anandan Ck,Moham P.Compact Wideband Koch Fractal Printed Slot Antenna.Iet Member.
[4] Homayoon Oraizi,Senior Member.Ieee And Shahran Hedegat.Miniaturization Of Microstrip Antenna By The Novel Application Of Giuseppe Peano Fractal Geometry.Ieee Transaction On Antenna And Propagation Vil.60,No:88 .Aug 2012.
[5] Manisha Gupta1, Vinita Mathur2 Wheel Shaped Modified Fractal Antenna Realization For Wireless Communications International Journal Of Electronics And Communicationss1434-8411(16)31578-3.
[6] S. Beril, 2 T. Anita Jones Mary Department Of Electronics And Communication, Karunya University The International Journal Of Engineering And Science (Ijesissn: 2319 – 1813 Isbn: 2319 – 1805.
[7] Nehya Chaudhary, Sonika Sindhiya, K.K Tirphati (A.K.G.E.C) International Journal of Advanced Research in Electronics and Communication Engineering (Ijarece) Volume 3, Issue 1, January 2014.
[8] Sarthak Singhal, 1 Pragya Singh, 2 And Amit Kumar Singh1asymmetrically Cpw-Fed Octagonal Sierpinski Uwb Fractal Antenna Microwave And Optical Technology Letters / Vol. 58, No. 7, July 2016.
[9] R. Vivek; G. Yamuna; Y. P. Kosta; S. Suganthi; Mahesh. N. Jivanicrown Shaped Broadband Monopole Fractal Antenna for 4g Wireless Applications.
[10] Zhen Yu; Jianguo Yu; Chenhua Zhu; Zhengyi Yang An Improved Koch Snowflake Fractal Broadband Antenna For Wireless Applications.