International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 3, Issue 9, September 2014

Multiband Fractal Microstrip Patch Antenna for Wireless Applications

Arun, Student (M.Tech Student)*
Mrs. Ankita Mittal, Assistant Professor*
*ECE Department, Galaxy Global Group of Institutions, Ambala

Abstract: Multiband Wang-shaped fractal antenna is obtained by applying fractal geometry .Initially a rectangular patch is taken and fractal geometry is applied. Two iterations of fractal geometry are applied to form double wang-shaped fractal antenna. Best characteristics were obtained using slot cut DGS in which seven rectangular slots have been cut out. This antenna resonates at 3.7 GHz, 4.6 GHz, 5 GHz and 7.6 GHz with return loss of -20.75 dB, -18.3 dB, -21.1 dB and -27.3 dB, gain of 0.7 dBi, 2.36 dBi, 4.13 dBi and 2.63 dBi and bandwidth of 200 MHz, 300 MHz and 900 MHz at 3.7 GHz, 4.6 GHz, 5 GHz and 7.7 GHz. This antenna found applications for C band and X band applications.

Key words: Fractal antenna, Multiband, Microstrip patch antenna, DGS, E wang shape.

I.INTRODUCTION

An antenna can be defined as, "a usually metallic device for radiating or receiving radio waves". The IEEE standard definition of antenna is defined as, "a means for radiating or receiving radio waves." The antenna is a structure between free space and a device. Antenna is one of the largest components of the low profile wireless communication. It is an electric device which converts electric power into radio waves, and vice-versa. It is usually used with a radio transmitter or radio receiver. Antenna miniaturization plays an important role in achieving an optimal design for wireless communication. Fractal geometry is used to reduce the size of patch antenna. Fractal geometries are different from Euclidean geometries which have two common properties: space-filling and self-similarity. It has been shown that the self-similarity properties of the fractal shapes can be successfully applied to the design of multiband fractal microstrip patch antennas. There are a number of fractal shapes like Sierpinski Gasket, Minkowski, Hilbert Curve and Koch Curve, Fractal Arrays. Microstrip antenna has a few disadvantages like low return loss, less bandwidth and low gain. So as to improve such characteristics, fractal geometry has been applied. There are different feeding methods like microstrip line feed, probe feed to patch, inset feed and CPW (Coplanar Waveguide). Another method to improve antenna performance is to use defected ground structure. Defected ground structure is realized by etching a simple shape or defect from the ground plane. The shape of the defect can be changed from a simple shape to a complicated one for a better performance. Results have been obtained by applying two iterations one by one in IE3D software. Also by introducing DGS in the same patch geometry, better results are obtained. These microstrip antennas are of low profile, conformable to planar structures and non planar surfaces, also simple and inexpensive to fabricate using modern printed-circuit technology, mechanically robust when they are mounted on rigid surface, also compatible with MMIC design, and resonant frequency, polarization, high performance aircraft, missiles, cars, spacecraft, satellites and even handheld mobile telephones hence are very versatile in these.

II.DESIGN AND IMPLEMENTATION

One of most advantage of fractal geometry is size reduction and multiband characteristics. In order to make double E-shaped wang fractal microstrip patch antenna, first of all rectangle patch of dimensions 30 X 30 mm^2 is taken and coaxial feed is given at feed point (13, 0, 0). The FR-4 epoxy has been taken substrate of thickness 2.4 mm. The ground plane is having dimensions of 45 X45 mm^2. Dimensions of antenna are mentioned in table 1. Geometry of this zeroth iteration is shown in figure 1 (a). In order to design double E Wang shape fractal patch antenna, length is divided into 5 parts on

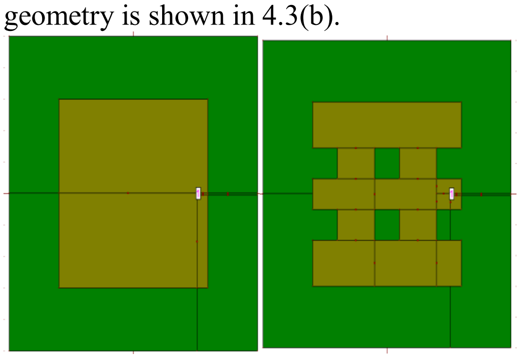
ISSN: 2278 – 909X

both sides and in centre so that each one represent E-shape antenna and when seen together, antenna can be thought of combination of two wang shape antenna

Table 1: Dimensions of Double Wang shaped Fractal Patch Antenna

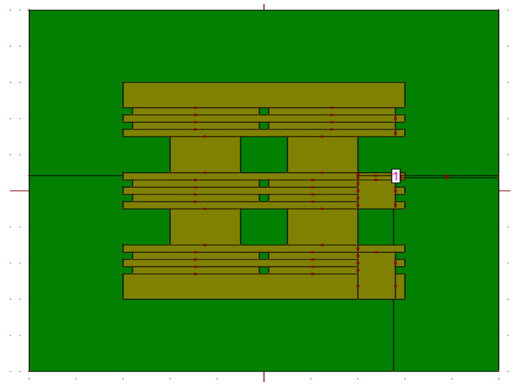
Variable	Value
Length of patch	30 mm
Width of patch	30 mm
Length of ground	50 mm
Width of ground	50 mm
Thickness of substrate	2.4 mm
Feeding technique used	Coaxial Feeding Technique
Substrate used	FR-4
Dielectric constant	4.4
Loss Tangent	0.02
Feed point	(13, 0, 0)
First iteration cut	5X5 mm^2
Second iteration cut	1X1 mm^2

In order to obtain first iteration of fractal geometry, first of all entire length of 30 m is taken. Fractal geometry has been applied on length of 25 mm leaving 2.5 mm top and bottom unchanged. 25 mm of length is divided into 5 parts and two squares with dimension of 5 mm are removed from sides and centre leaving double wang shape structure. This antenna designed is special; case of slot antenna. The geometry is shown in 4.3(b).



(a) (b)

Second iteration of fractal geometry is obtained by applying Minkowski fractal geometry algorithm on both sides. Second iteration is obtained by cutting slots of square of 1mm. In this way scale factor of one fifth is obtained.



(c)

Figure 1: Double Wang-Shaped FMPA **(a)** 0^{th} Iteration **(b)** 1^{st} Iteration and (c) 2^{nd} Iteration

Each square of 5 mm is taken and is divided into 5 equal parts of 1mm each leaving two squares cut to form wang shaped structure. Hence self-similar characteristics are obtained. Here this antenna is combination of four fractal shape geometry structure to form double wang shape fractal as shown in figure 1(c). Whenever DGS is applied to antenna, characteristics of antenna improve. There are three different DGS have been applied to antenna in order to analyze characteristics.

III.RESULTS AND DISCUSSIONS

Double wang-shaped structure as shown in figure 1(c) is obtained by applying two iterations on fractal geometry on square patch having rectangular slot. Slots have been cut on both sides of antenna and also in middle to obtain structure as shown in figure 1. Return loss versus frequency for different iterations are shown in figure 2. From these characteristics, it is found that characteristics of antenna improve by increasing number of iterations.

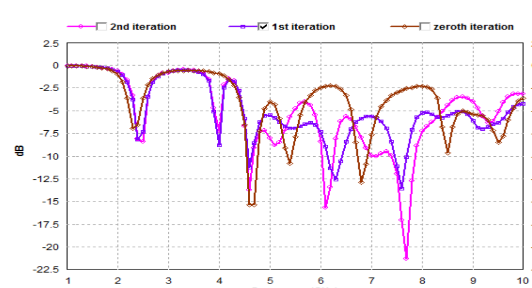
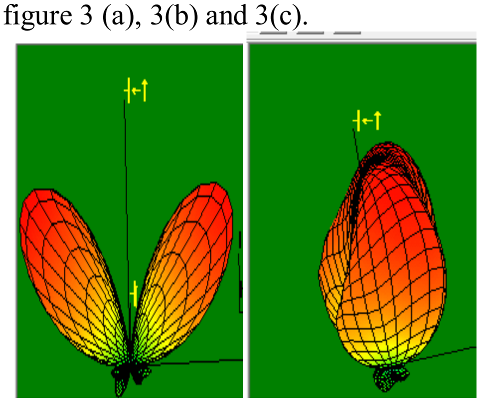


Figure 2: Return Loss Vs. Frequency for Different Fractal Iterations of Double Wang-shaped FMPA

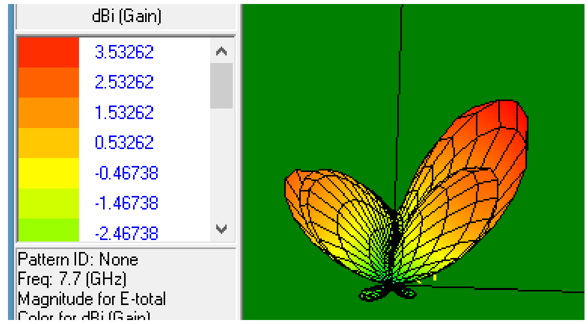
ISSN: 2278 – 909X

Different characteristics of antenna are represented by different colure lines. Square patch fed by coaxial feed resonates at 4.6 GHz and 6.8 GHz . This antenna resonates at two bands with return loss of -15.35 dB and -12.45 dB, gain of 1.773 dBi and 4.440 dBi. This antenna is represented by blue line. First iteration of fractal geometry is applied which caused antenna to resonate at 4.6 GHz, 6.3 GHz and 7.6 GHz. This antenna had good gain of 3.23 dBi, 6.50 dBi and 1.64 dBi with bandwidth of 90 MHz, 270 Mhz and 210 MHz at corresponding frequencies. By applying second iteration of fractal geometry, antenna shows improvement in characteristics. This antenna resonated at three bands namely 4.6 GHz, 6.7 GHz and 8.6 GHz with good characteristics. This antenna has return loss of -13.35 dB, -15.62 dB and -20.9 dB , gain of 3.28 dBi, 2.13 dBi and 3.53 dBi at corresponding frequencies. This antenna has return loss less but bandwidth needs to be improved as this antenna has bandwidth of 135 MHz, 240 MHz and 450 MHz at 4.6 GHz, 6.1 GHz and 7.7 GHz. Radiation pattern of antenna at different frequencies namely 4.6 GHz, 6.1 GHz and 7.7 GHz has been shown in figure 3 (a), 3(b) and 3(c).



(a) **(b)**

It is best method of representing complex impedance with respect to coefficients defined by the reflection coefficient. For analyzing impedance, admittance and for solving transmission line problems, Smith chart is an important tool. One of the important parameter is VSWR. Smith chart was invented by P.H Smith of Bell Laboratories in 1939. It is most useful tool for high frequency circuit applications



©

Figure 3: Radiation Pattern of Double Wang FMPA at **(a)**4.6 GHz, **(b)** 6.1 GHz and **(c)** 7.7 GHz

Smith chart of double wang shaped antenna is shown in figure 4.

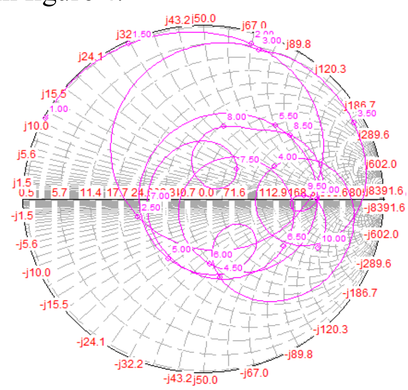


Figure 4: Smith Chart for Double Wang shaped FMPA

It describes how well antenna impedance matched to transmission line to which antenna is connected. It is the function of reflection coefficient and tells amount of power that gets reflected from antenna. VSWR of antenna as shown in figure 5.

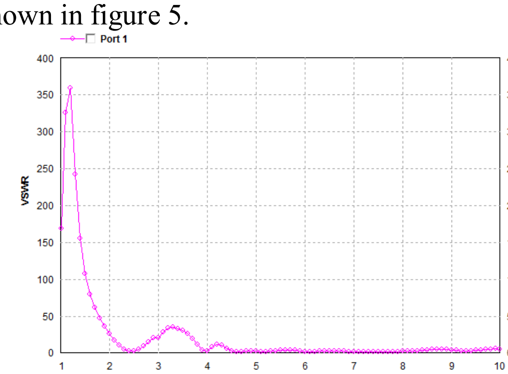


Figure 5: VSWR **Vs**. Frequency for Double Wang Shaped Antenna

Table 2. Shows comparison of results of different iterations of fractal geometry applied on rectangular patch to form double E-shaped

ISSN: 2278 – 909X

fractal antenna as shown in figure 1. Results are analyzed in terms of antenna parameters in the table 2.

Table 2: Comparison Results of Different Iterations of Double Wang Shape FMPA

Iteration Number	Resonance Frequency (GHz)	Return Loss (dB)	Gain (dBi)	Directivity (dBi)	Bandwidth (MHz)
0th Iteration	4.6	-15.35	1.73	5.9	225
	6.8	-12.45	4.40	10.6	195
Initiator by cutting slot	4.6	-11.20	3.23	7.86	90
	6.3	-12.35	6.50	10.70	270
	7.6	-13.65	1.64	7.18	210
2nd	4.6	-13.35	3.28	7.8	135
	6.1	-15.67	2.13	8.4	240
	7.7	**-20.85**	**3.53**	**6.7**	**450**

From above analysis, it is clear that as number of iterations increases, characteristics of antenna improved.

IV.CONCLUSION

Multiband wang-shaped fractal antenna is obtained by applying fractal geometry .Initially a rectangular patch is taken and fractal geometry is applied. Two iterations of fractal geometry are applied to form double wang-shaped fractal antenna. This antenna gives multiband characteristics. There are different configurations of DGS which can be applied but the DGS which has been dissertation is slot cut DGS. In order to analyze characteristics, antenna configurations are observed by using different DGS configurations, One of best comparison is made by using microstrip line and comparing result by use of coaxial feed Design and simulations are carried out using IE3D. Different DGS configurations been applied on ground to obtain wideband characteristics. By applying second iteration of fractal geometry, antenna shows improvement in characteristics. This antenna resonated at three bands namely 4.6 GHz, 6.7 GHz and 8.6 GHz with good characteristics. This antenna has return loss of -13.35 dB, -15.62 dB and -20.9 dB , gain of 3.28 dBi, 2.13 dBi and 3.53 dBi at corresponding frequencies

References

[1] Varadhan C. Pakkathillam J. Kizhekke, Kanagasabai M., Sivasamy R., Natarajan R. and Palaniswamy S. Kumar. "Triband Antenna structures for RFID Systems Deploying Fractal Geometry", "IEEE Letters on Antennas and Wireless Propagation", Vol. 12, pp 437-440, 2013.

[2] Janani. A., Priya. A. "Design of E-Shape Fractal Simple Multiband Patch Antenna for S-Band LTE and Various Mobile Standards", "International Journal of Engineering and Science", Vol. 3, Issue 1, pp 12-19, 2013.

[3] Ojaroudi M., Ojaroudi, N., Ghadimi, N. "Dual Band-Notched Small Monopole Antenna with Novel Coupled Inverted U-Ring Strip and Novel Fork-Shaped Slit for UWB Applications", "IEEE Antennas and Wireless Propagation Letters", Vol. 12, pp. 182-185, 2013.

[4] Behera S. and Vinoy K. J. "Multi-Port Network Approach for the Analysis of Dual Band Fractal Microstrip Antennas", "IEEE Transactions on Antennas and Propagation", Vol. 60, No. 11, pp 5100-5106, 2012.

[5] Ram V., Anjaria V., Boriya P. and Patel N. "Design and Development of Switchable Fractal Patch Antenna for GPS Application", "International Journal of Engineering and Science", Vol. 1, Issue. 7, pp 46-50, 2012.

[6] Agarwal Vivek Kumar, Shaw Anand Kumar, Das Mrinmoy. Kr, Mukherjee Jayati, Mandal Kaushik,. "A Novel Compact Dual Frequency Microstrip Antenna", "Sci Verse Science Direct Procedia Technology", Vol.4, pp 427-430, 2012.

[7] Dalsania Piyush, Shah Brijesh, and Dwivedi Vyas Dwivedi Ved Vyas. "Analysis of Multiband Behaviour on Square Patch Fractal Antenna", "Proceedings of IEEE International Conference on Communication Systems and Network Technologies (CSNT)", Rajkot, India, pp. 76-78, 2012.

[8] Chaimool. S, Chokchai. C, and Akkara ekthalin. P. "Multiband Loaded Fractal Loop Monopole Antenna for USB Dongle Applications", "IEEE Electronics Letters", Vol. 48 and Issue: 23, pp 1446-1447, 2012.

[9] Naser-Moghadasi M., Sadeghzadeh R. A., Fakheri, M. and Aribi T. "Miniature Hook-Shaped Multiband Antenna for Mobile Applications", "IEEE Letters on Antennas and Wireless Propagation", Vol.11, pp. 1096-1099, 2012.