© UNIVERSAL RESEARCH REPORTS | REFEREED | PEER REVIEWED
ISSN: 2348 - 5612 | Volume: 04 Issue: 03 | July - September 2017

Multi-Band Characteristics of Fractal Shape Antenna

Kavita[1] & Naresh Kumar[2]
[1]M.Tech Student, ECE, HCTM Technical Campus, Kaithal K.U.K University Kurukshetra
[2]Astt. Professor, ECE, HCTM Technical Campus, Kaithal K.U.K University Kurukshetra
E-mail: kavita.chahal004@gmail.com; nareshchhokar@gmail.com

ISSN : 2348-5612 © URR

***Abstract* – In this paper, relative study of Hexagonal structure Microstrip patch antenna for two different dielectric constant substrate. If the material's of dielectric substrate is resulting, escalated, and depression of microstrip patch antenna. The coordinate geometry is result of back-and-forth in bandwidth, impedance and efficiency. RT-Duroid and FR4 is used for determine the performances. Feeding technique is used to coaxial probe-feed. The Measurement likes width, feed-point coordinates, length, and ground measurement for substrate is determined. The process of antenna is performed using the Method of Moments (MOM) based on IE3D from Zeland Software Inc, USA.**

***Keyword*- Microstrip patch antenna, *MOM*, feed-point coordinates.**

1. **INTRODUCTION**- Microstrip patch antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. The resonant length of the antenna is slightly shorter because of the extended electric "fringing fields" which increase the electrical length of the antenna slightly. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger Bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact Microstrip patch antenna, substrates with higher Dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a trade-off must be realized between the antenna dimensions and antenna performance. Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers aerospace, radar, satellite communication, defense, missiles and many more etc. The telemetry and communication antennas on missiles need to be thin and conformal and are often Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication.

Microstrip antenna consists of conducting patch of any planar/geometry or non-planar geometry on one side of dielectric substrate with ground plane on other. Extended of substrate which in reducing bandwidth, radiation efficiency and. Thus selection of dielectric substrate plays an almost important role in designing method of antenna.

2. ANTENNA DESIGNING - The radiations pattern can b circular, triangular, hexagonal, dipole sector etc. Here hexagonal is used other due to some reasons-

- Due to greater bandwidth, more area
- Low time required
- Slot process easier
- Easy to design

The hexagonal microstrip patch antenna dimensions on ground surface as length L, width W and measure the dielectric materials constant as width w, permittivity ϵ, length l, and height h. the impedance change and from radiating of signal from dielectric material. The given parameters are responsible for selecting the dielectric constant material:

- relative dielectric constant ϵ
- Substrate height h
- Loss tangent, tan δ

Hence, in order to account for radiation and a loss mechanism, one must introduce a radiation resistance Rr and a loss resistance Rl. A lossy cavity would now represent an antenna and the loss is taken into account by the effective loss tangent δeff which is given as:

$$\delta\text{eff} = \tan\delta + \frac{\Delta}{\text{h}} + \frac{\text{Pr}}{\omega\text{rWr}}$$

The given equation describes the total effective loss tangent for the microstrip patch antenna.

3. CALCULATING PARAMETERS:

The transmission line model described earlier will be used to design the antenna. The following equations are used to calculate the required dimensions for S-band.

1 Calculation of the Width (*W*):

The width of the fractal patch antenna is given as:

$$\text{w} = \frac{\text{c}}{2\text{f}_{\circ}\sqrt{\left(\frac{\mathcal{E}\text{r}+1}{2}\right)}}$$

Where,

$c = 3\,x\,10^{8}\text{m/s}$

$\text{W} = \frac{c}{f_r}\sqrt{\frac{2}{\epsilon+1}}$

f_r = operational frequency

ϵ = permittivity constant of a material

2 Calculation of the Bandwidth (Bw):

Bandwidth is a measure of frequency range and is typically measured in hertz. For an antenna that has a frequency range, the band width is usually expressed in ratio of the upper frequency to the lower frequency where they coincide with the -10 dB return loss value. The formula for calculating bandwidth is given by:

$$\%\text{Bw} = \frac{\text{fh}-\text{fl}}{\sqrt{\text{fhfl}}}\,\mathcal{X}^{100\%}$$

3 Computation of effective dielectric constant (ϵ_{eff}):

Effective dielectric constant the value of effective dielectric constant is given lower than permittivity of the substrate. However also more in the air. So, it's defined as-

© UNIVERSAL RESEARCH REPORTS | REFEREED | PEER REVIEWED
ISSN: 2348 - 5612 | Volume: 04 Issue: 03 | July - September 2017

$$\epsilon_{eff} = \frac{\epsilon+1}{2} + \frac{\epsilon-1}{2} [1+12\frac{h}{w}]^{-1/2}$$

Where,
h is height.
w is width of substrate material.

4 Calculation of the length (L):
The length is:

$$L = \frac{c}{2f_{\circ}\sqrt{\varepsilon r}}$$

For narrow band proved to be an important factor as it determines resonant frequency. The value of length is given by-

$$l_{eff} = \frac{c}{2f_r} \frac{1}{\sqrt{\epsilon_{eff}}} - 2dL$$

Here dL is the length extension and its value can be determined by using equation-

$$dL = 0.412h \frac{(\epsilon_{eff} + 0.3)(\frac{w}{h} + 0.264)}{(\epsilon_{eff} - 0.258)(\frac{w}{h} + 0.8)}$$

5: Feeding technique is used: The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. An idealization that simplifies the computation is to replace the electric current by a uniform line current ribbon. To determine the probe impedance for a microstrip antenna, the canonical problem of a parallel plate waveguide fed by a coaxial line has been analyzed using the integral formulation. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, its major drawback is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates And its location There are four techniques are used microstrip line feed, coaxial feed, proximity coupled feed and aperture coupled feed. The most common technique is coaxial feed. In this the inner layer is extend from side of dielectric and is soldered to the patch, whereas outer one is linked to ground plane. The core benefit of using coaxial feed is feed can be positioned at any looked-for location to equivalent its input impedance. Thus, increasing return losses, bandwidth and performances. Using following equation one can calculate feed point-

Patch's width
$A_f = \frac{w}{2}$

Patch's length
$B_f = B_o - dL$

Here,
$$B_o = \frac{l}{\Pi} cos^{-1}\sqrt{\frac{50}{Y_o}}$$

⇨ $Y_o = \sqrt{50 * Y_{in}}$

⇨ $Y_{in} = 90 * \frac{\epsilon^2}{\epsilon+1}\left(\frac{l}{w}\right)^2$

4. PROPOSED GEOMETRY:

FR-4 glass epoxy is a popular and versatile high-pressure thermo set plastic laminate grade with good strength to weight ratios. With near zero water absorption, FR-4 is most commonly used as an electrical insulator possessing considerable mechanical strength. The antenna is designed a hexagon shapes.

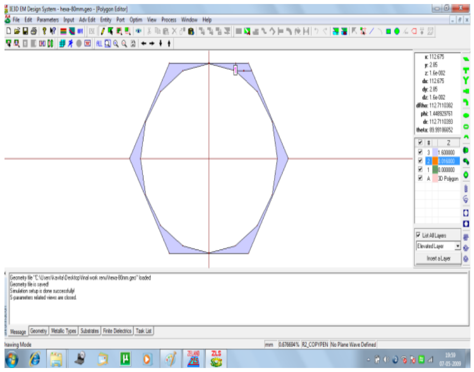

Fig 4.a: First iteration

Second iteration is shown in fig.4.b in which shape is generated within the base shape.

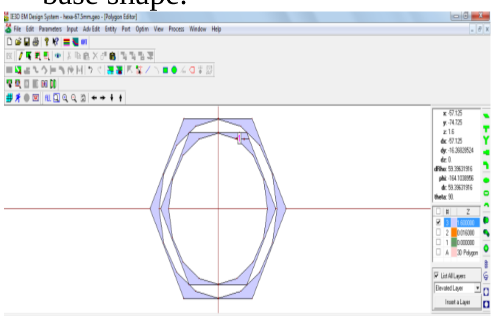

Fig 4.b: Second iteration

Third iteration is shown in fig. 4.c in which shape is generated within the base shape.

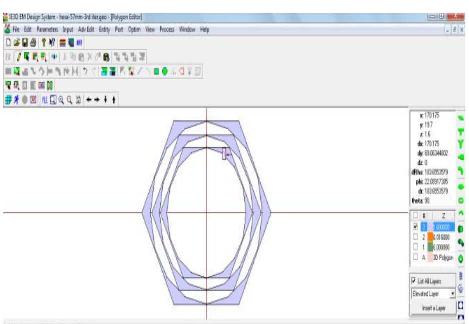

Fig 4.c: Third iteration

For designed VSWR, fractal shape antenna, Return loss, & Radiation pattern

5. RESULTS AND CONCLUSION:

The response of antenna is compared to others.

5.1 FR-4

This paper of antenna is used for FR-4 constant materials.The design and simulation is done using simulation software–IE3D-14.65. I have designed three antennas based on fractal, so called fractal antenna for S-band (2-4 GHz) , and I got the results for this band, which is used in short range communication. The antenna is designed on FR4 substrate with dielectric constant 4.4 and substrate height 1.6 mm.

5.1.1 Simulation results

In this MOM method is used for iteration of structure. Voltage source is 1 volt and frequency range is from 1GHz to 5 GHz. the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.2 GHz with the return loss of about -12 dB. Bandwidth of the antenna as calculated is 3.24 %. The radiation pattern are shown from fig 5.1a

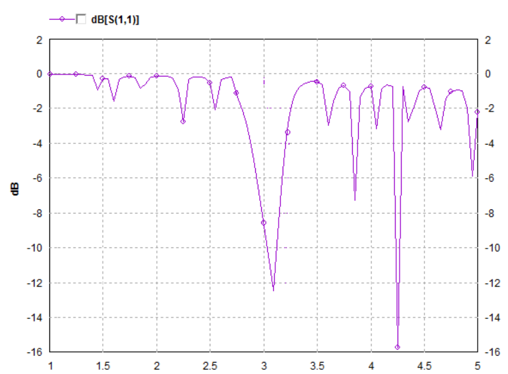

Fig 5.1a: Variation of return loss for First iteration

Fig.5.1b shows the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.6 GHz with the return loss of about -10.5 dB. Bandwidth of the antenna as calculated is 2.18%.

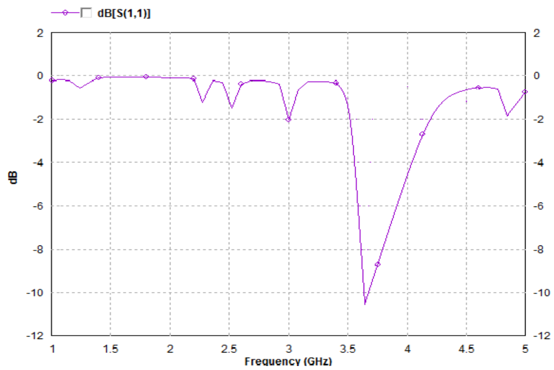

Fig 5.1b: Variation of return loss for Second iteration

Fig. 5.1c shows the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.2 GHz with the return loss of about -12 dB. Bandwidth of the antenna as calculated is 3.12%.

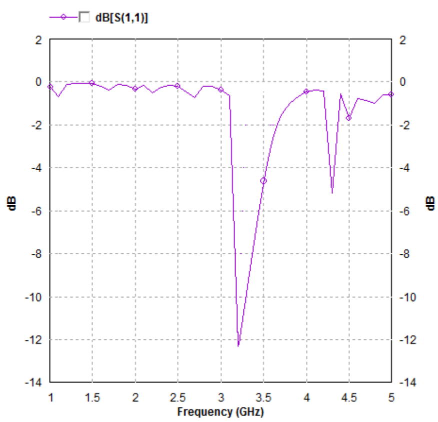

Fig 5.1c: Variation of return loss for Third iteration

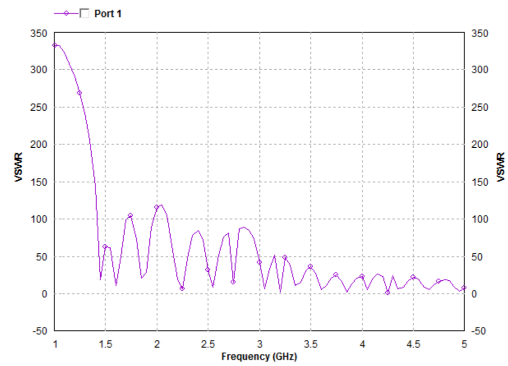

Fig 5.1d: Variation in VSWR for First Iteration

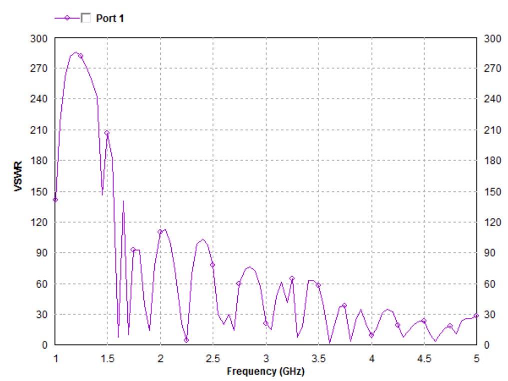

Fig 5.1e: Variation in VSWR for Second iteration

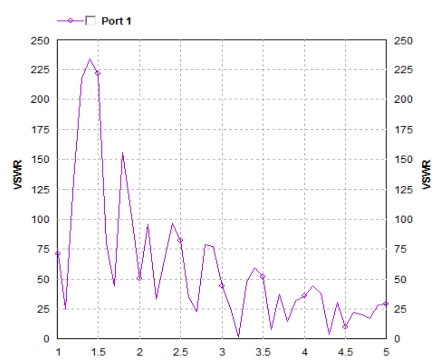

Fig 5.1f: Variation in VSWR for Third iteration

© UNIVERSAL RESEARCH REPORTS | REFEREED | PEER REVIEWED
ISSN: 2348 - 5612 | Volume: 04 Issue: 03 | July - September 2017

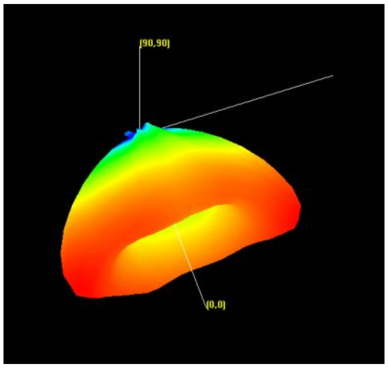

Fig 5.1g: Radiation pattern at 3.30 GHz

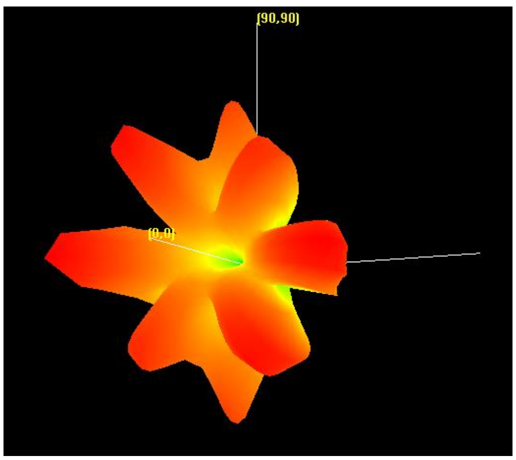

Fig 5.1h: Radiation pattern at 3.13 GHz

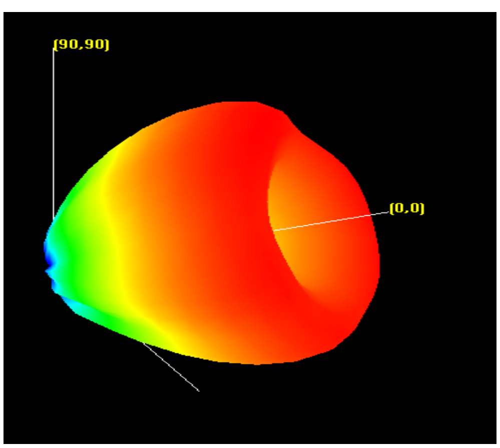

Fig 5.1i: Radiation pattern at 2.02 GHz

SUMMARIZING OF RESULTS

PARAMETER	First iteration	Second iteration	Third iteration
Frequency	3.2GHZ	3.6GHZ	3.2GHZ
Bandwidth%	3.24%	2.18%	3.12%
Return loss	-12dB	-10dB	-12dB
Radiation Pattern	3.30	3.13	2.02

CONCLUSION – Result indicates that the feed location has huge impact on the antenna parameters and by changing them they vary. The fractal concept can be applied to advance the small size antenna’s bandwidth. Also, the projected configuration has small dimensions .It is concluded that it’s an improved antenna for 1-5 GHz range.

ACKNOWLEDGMENT
The authors wish to acknowledge the assistance and support Assoc. Prof. Naresh Kumar Professor & Head ECE, HCTM Technical Campus, Kaithal

REFERENCE

[1] B.B. Madelbrot, the Fractal Geometry of Nature, New York: W.H. Freeman, 1983.
[2] J.D. Kraus, Antennas, New York: McGraw-Hill (2nd Ed.), 1988.
[3] K.J. Falconer,FractalGeometry:Mathematical Foundations and Applications, New York: Wiley, 1990.
[4] Pozar, D.M.,D.H.Schaubert,"Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays",New York: IEEE Press, 1995.
[5] N.Cohen, "Fractal Antenna Applications in Wireless Telecomm." in Proc.Professional Program Elect. Industry Forum, pp. 43-49, 1997.
[6] Yahya Rahmat-Samii and Eric Michielssen, Electromagnetic Optimization by Genetic Algorithms, John Wiley, 1999.

[7] Ramesh Garg, Prakash Bartia, Inder Bahl, Apisak Ittipiboon, "Microstrip Antenna Design Handbook'', Artech House Inc. Norwood, MA, pp 168, 253-316, 2001.
[8] C.A.Balanis,"Antenna Theory Analysis And Design", 3rd ed., Hoboken, New Jersey: Wiley, 2005.
[9] J. Anguera, A. Cabedo, C. Picher, I. Sanz, M. RiM, and C.Puente, "Multiband handset antennas by means of ground plane modification," presented at the IEEE Antennas Propag. Society Int.Symp., Honolulu, HI, Jun. 2007.