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Design and Simulation of Reconfigurable Fractal Antenna

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***Abstract:** Now-a-days in modern wireless telecommunication systems, antennas with smaller size, greater efficiency, and wider bandwidths are in great demand. To fulfill these requirements fractal concept in antennas are very popular which provides compactness and can generate multiple frequencies and also enhances its bandwidth. So this paper presents design and simulation of Square shaped fractal antenna using HFSS 15.0 software. This Square shaped fractal antenna is designed for 3 GHz resonant frequency using FR-4 epoxy as substrate. This antenna incorporates a pin diode integrated on its surface to change the current distribution path which changes the resonance frequency depending on the state of the pin diode i.e. on its on and off position thus making it a frequency reconfigurable antenna. Also the simulated results are presented in this paper.*
***Keywords:** Fractal Antenna, Reconfigurability, High Frequency Structure Simulator (HFSS), FR-4 Epoxy Substrate, Wireless Communication*

I. INTRODUCTION

During last few years there is increase in need of antennas in wireless communication systems which is smaller in size, shows multiband characteristics and should be low-cost too. Recently much research has been done on antennas based on fractal geometries because reports have shown that it enhances antenna efficiency, shows multi-band characteristics and also because these antennas are smaller in size. Basically fractal antennas are nothing but a single elementary shape that shows multiple iterations making it a complex shape that possess a self-similarity in their geometrical structure. Various researches have proposed fractal antennas of different shapes such as Sierpinski fractal antenna, tree-shaped fractal antenna, and some other types including snowflake fractal antenna and Koch fractal antenna. Though these antennas reduce the size and cost, but in case of communication system many applications are used that works at different frequency band hence a single fractal antenna cannot be used to serve the purpose of the whole communication system. To resolve this issue researchers have proposed reconfigurable antennas. These antennas resonate at different frequencies at different time by using switches therefore reduces the cost and overall size of the system. In this paper a reconfigurable fractal antenna is designed which has square shape as its elementary shape and shows three iterations thus making it a complex structure patch. To make it reconfigurable a pin diode is used as switch at the feeding line to show multi band behavior.

II. FRACTAL ANTENNA DESIGN

In this design the FR4 epoxy substrate is used as a substrate material with dielectric constant 4.4, thickness 1.6mm and the resonant frequency taken as 3 GHz. There are many parameters has been taken into consideration while designing patch antennas such as resonant frequencies, substrate thickness, length of the patch, width of patch etc. These dimensions are calculated by using the rectangular patch design equations (1) to (7) as shown below [1].

The Width of Patch element (W) is calculated using

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (01)$$

The Effective Dielectric Constant is calculated using

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (02)$$

The Effective Length is calculated using

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}} \qquad (03)$$

The Length Extension is calculated using

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \qquad (04)$$

The actual length (L) of the patch is calculated using

$$L = L_{eff} - 2\Delta L \qquad (05)$$

Where C = Velocity of light in free space

h = Substrate height

ε_r = Relative Permittivity of Substrate

Calculation of Substrate (or Ground) Length and Width

$$L_g = L + 6h \qquad (06)$$

$$W_g = W + 6h \qquad (07)$$

Where $h = \frac{0.0606\lambda}{\sqrt{\varepsilon_r}}$

Table1: Design Parameters of Antenna

Sr. No.	Parameter	Value
1	Operating Frequency	3 GHz
2	Dielectric Constant of Substrate	4.4
3	Length of the ground and substrate	47.75 mm
4	Width of the ground and substrate	47.75 mm
5	Length of the Patch	30.42 mm
6	Width of the Patch	30.42 mm
7	Height of the Substrate	1.6 mm

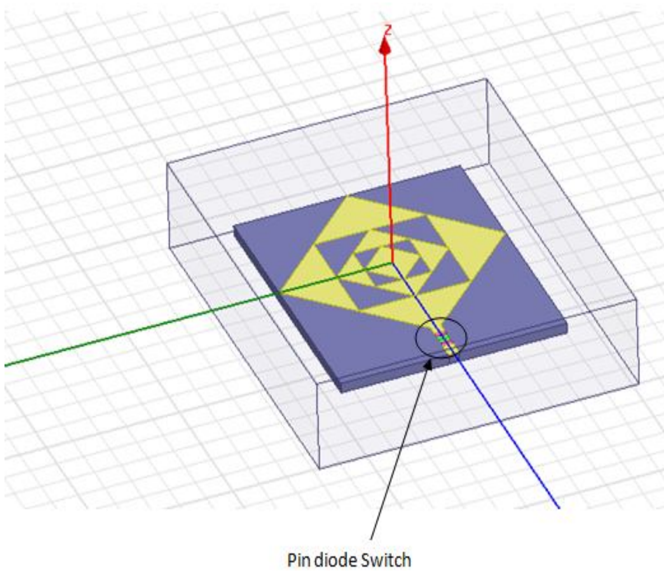


Fig.1: Square shaped Reconfigurable Fractal Antenna in HFSS

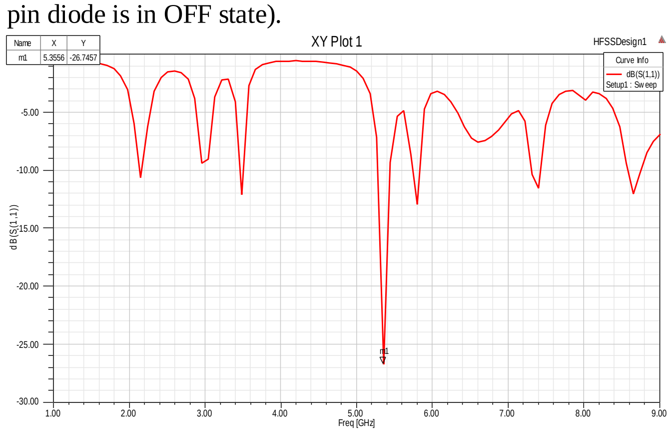
III.SIMULATION RESULTS

Ansoft HFSS is a high performance full wave electromagnetic (EM) field simulator. It integrates simulator, visualization, solid modeling and Automation in an easy-to-learn environment where the solution of the 3D EM problem is quickly and accurately obtained [3]. The schematic of the proposed antenna is shown in Figure 1. It is composed of a radiating element in the form of a square shape patch, fed by a microstrip line on its upper side. The antenna is based on FR4-epoxy substrate with a dielectric constant of 4.3, thickness of 1.6 mm, and loss tangent of 0.0018. In order to achieve the frequency reconfiguration that allows adjusting to the desired band and bandwidth, four horizontal slots with integrated PIN diode switch are incorporated to the antenna patch feed line. This switch is employed to shift the operating band by varying the electrical length of the antenna. After the completion of the design part of proposed antenna, simulated results such as Reflection Coefficient, VSWR, Radiation and current distribution pattern and Gain obtained and that are as follows-

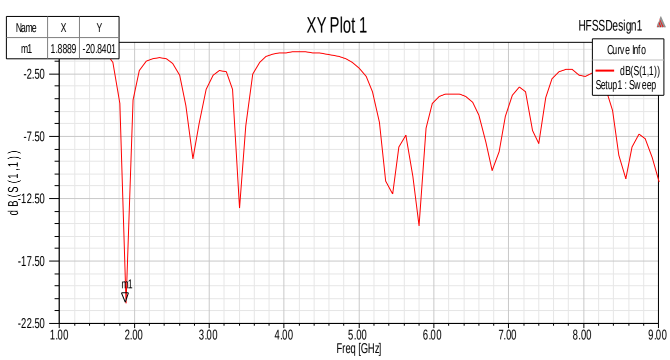
Reflection coefficient is a logarithmic proportion estimated in dB that looks at the power reflected by the antenna to the power that is sustained into the radio wire from the transmission line.

$$Reflection\ Coefficient = -10log10(\frac{Pin}{Pref})$$

The reflection coefficient is a parameter that depicts the amount of an electromagnetic wave is reflected by impedance brokenness in the transmission medium. It is equivalent to the proportion of the abundancy of the reflected wave to the occurrence wave. Figure 3 shows the simulated reflection coefficient i.e. return loss of two different configurations. Figure 2(a) shows reflection coefficient of whole band & it is –26.74 dB at 5.3 GHz (i.e. when pin diode is in ON state). Figure 2(b) shows reflection coefficient of sub band 1 & it is -20.84 dB at1.8GHz(i.e. when pin diode is in OFF state).



(a)



(b)

Fig. 2: Reflection Coefficient

The VSWR represents Voltage Standing Wave Ratio, & it is likewise alluded as standing wave proportion (SWR). VSWR is a component of reflection coefficient which portrays control reflected from the antenna. The VSWR plot for square shaped reconfigurable fractal antenna is shown in Figure 3, where in Figure 3(a) shows VSWR 0.79 for frequency 5.35 GHz, Figure 3(b) shows VSWR of 1.58 for frequency 1.8 GHz. Ideally, VSWR must lie in the range of 1-2 near the operating frequency value

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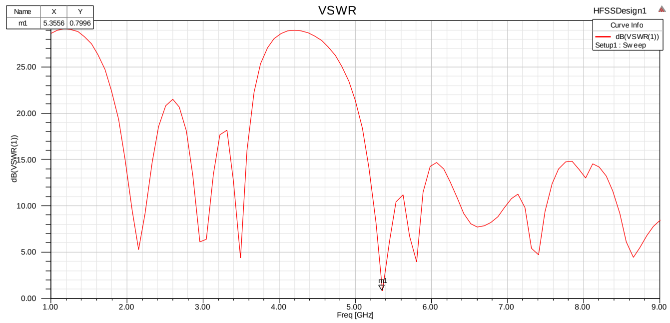
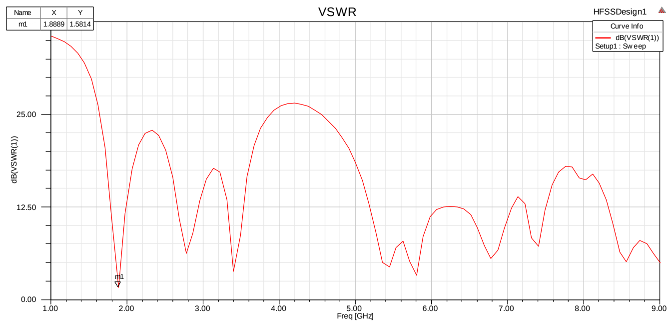


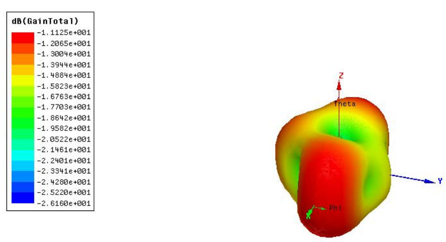
(a)



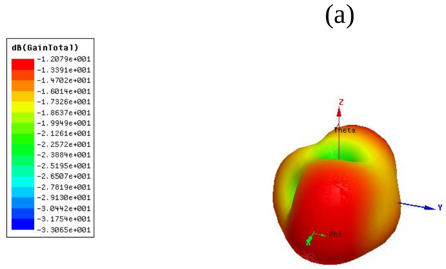
(b)

Fig. 3: VSWR (for 5.3GHz and 1.8GHz)

The gain of the antenna basically shows the efficiently antenna works. Gain of antenna is that parameter that describes the capability of antenna to direct energy through a given direction to give a better picture of the radiation performance. Gain is usually expressed in dB which refers in the direction of the maximum radiation. Figure 4 shows the simulated result of the gain of the proposed antenna.



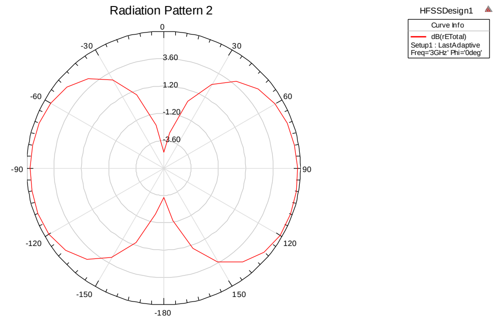
(a)



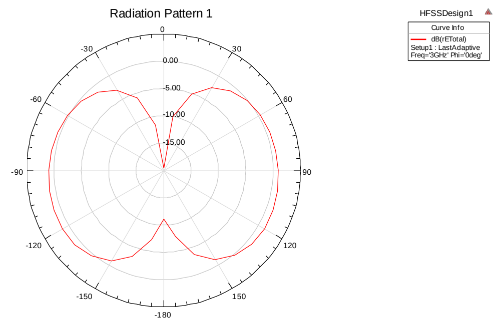
(b)

Fig. 4: Gain Measurements (for 5.3GHz and 1.8GHz)

The radiation pattern of Microstrip Patch Antenna describes the power radiated or received by the antenna. It is the function of angular position and radial distribution from the antenna. The radiation pattern of the proposed antenna is shown in Figure 5.



(a)



(b)

Fig. 5: Radiation Pattern (for 5.3GHz and 1.8 GHz)

IV. CONCLUSIONS

A Square Shaped Reconfigurable Fractal Antenna with Square Shaped fractal patch and FR-4 epoxy as substrate have been successfully designed according to its design specifications, simulated and analyzed using HFSS software. The performance of the proposed antenna is described in terms of reflection coefficient, VSWR, gain and radiation pattern which achieves the required or desired results.

V. ACKNOWLEDGMENT

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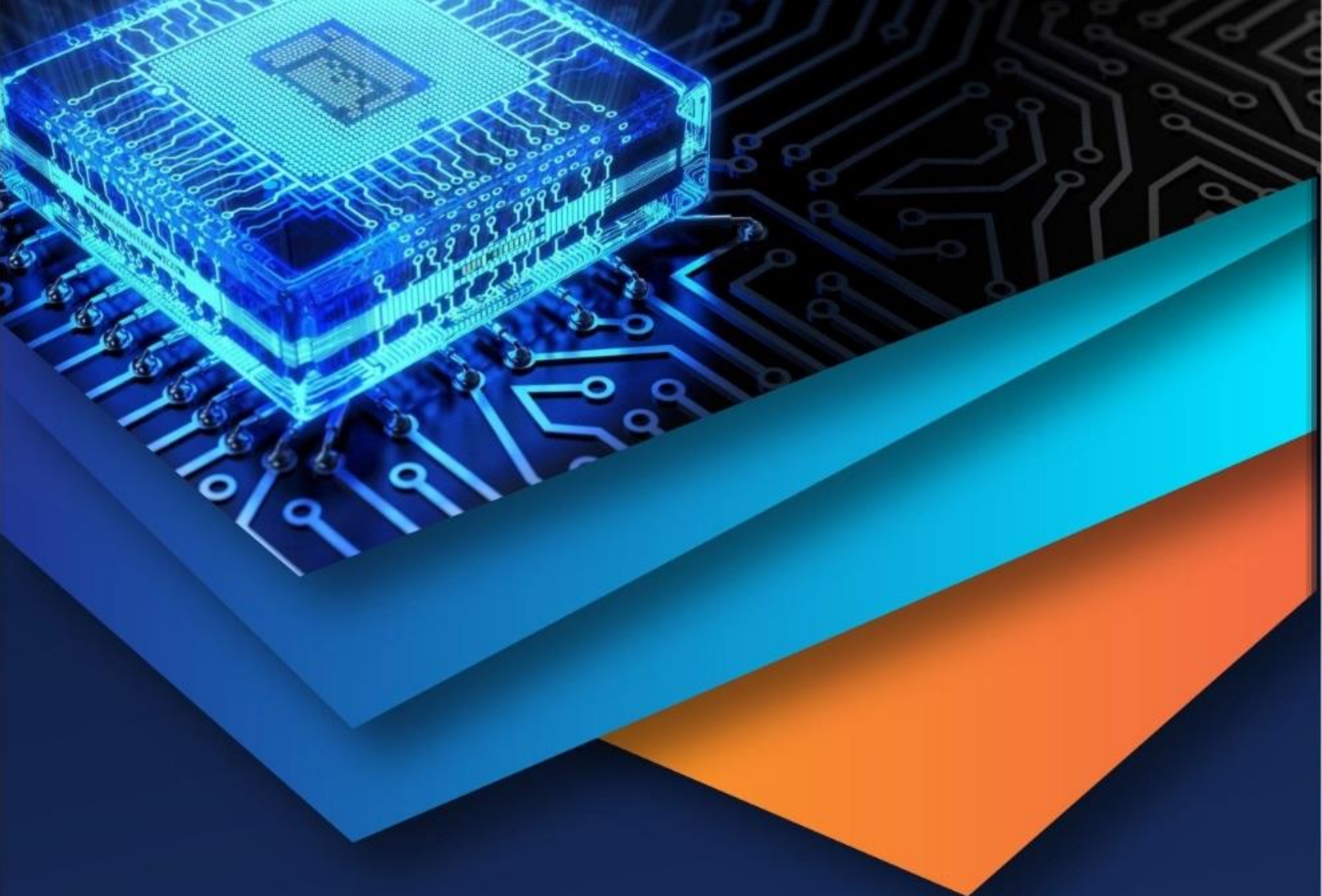
REFERENCES

[1] Constantine A. Balanis, Antenna Theory and Design. John Wiley & Sons, Inc., 1997.
[2] L.Berlemann and S. Mangold, Cognitive Radio and Dynamic Spectrum Access, JohnWiley & Sons, ISBN 978-0-470-51167-1, West Sussex, United Kingdom, 2009.
[3] S.Haykin, “Cognitive radio: Brain-empowered wireless communications”, IEEE J. Sel. Areas Commun., vol. 23, no. 2, pp. 201–220, Feb 2005.
[4] Ansoft Corporation, HFSS User's Guide, version 10 &12, Ansoft Corporation,Pittsburgh,CA,20
[5] D. Pozar, Microwave Engineering, 2nd Edition, John Wiley and sons Inc., New York. 2005.
[6] Y. Huang and Kevin Boyle, Antennas from Theory to Practice, Wiley-Blackwell, 2008.
[7] Eng Hock Lim and Kwok Wa Leung, Compact Multi-functional Antennas, John Wiley & Sons, Inc, 2012



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