Design and Analysis of Square Patch Fractal Antenna for C-Band Application

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***Abstract:*- This paper proposes the design of a square patch antenna with fractals for C-band applications. The designed antenna, has been fed, with aperture coupled feeding technique and fractal structure produces a single band operation for the C-band applications. The simulated results for various parameters like return loss, radiation pattern etc have been presented. The designed antenna operates for single band at 5.4 GHz with increase in Gain and Bandwidth. Especially it is used for wireless communication ranging approx. from 5.2 GHz to 5.4 GHz. Such type of antennas is useful in Telecommunication, Wi-Fi, Satellite communication, Radar, Commercial and Military application.**

Key words- Square patch, Fractal antenna, Return loss, Directivity, Gain, Voltage Standing Wave Ratio

I. INTRODUCTION

Square Patch Fractal Antenna is a good example of the properties of fractal boundary patch antennas. As the fractal iteration increases, perimeter of patch increases and effective area of antenna decreases. The radiator is now resonant at more frequencies. It gives multiband properties to fractal geometry antenna with directive patterns. The examples presented here have resonant frequency in C band with wideband characteristics. This behavior is obtained with a simple feeding scheme. So, fractal boundary patch antennas are an interesting replacement in the multiband antenna with broadside radiation patterns and with efficient directivity. This geometry offers numerous variations in dimension and design, hence gives wide scope for various commercial applications [2].

The fractal concept can be used to reduce antenna size, such as the Koch dipole, Koch monopole, Koch loop, and Minkowski loop. Or, it can be used to achieve multiple bandwidths and increase bandwidth of each single band due to the self-similarity in the geometries, such as the Minkowski fractal antenna. In other designs, fractal structures are used to achieve a single very wideband response, e.g., the printed circuit fractal loop antenna [3].

The use of fractal geometries in antenna design has shown to be a good strategy in order to attain the following benefits: broadband and/or multiband frequency response, compact size compared to conventional designs while maintaining good efficiencies and gain, mechanical simplicity and robustness and flexibility of designing for particular multi-frequency characteristics [6]. Fractal antennas are mainly categorized into four types such as fractal line antennas, fractal three-dimensional antennas, fractal planar antennas and fractal antenna arrays. In this project, the design of fractal planar antenna as a combination of Minkowski and Koch curves is considered.

II. ANTENNA GEOMETRY

This antenna has been designed on dielectric substrate εr = 4.4, thickness = 1.6mm with aperture coupled feed. A 50-Ω microstrip feed line with a width of 2 mm is centrally fed to the antenna at one side of the substrate. Simple slots are etched on the ground plane allows the proposed antenna to work in different frequency bands. By adjusting the parameters to an optimum value, the proposed antenna provides good impedance matching of 50 ohms.

III. DESIGN METHODOLOGY

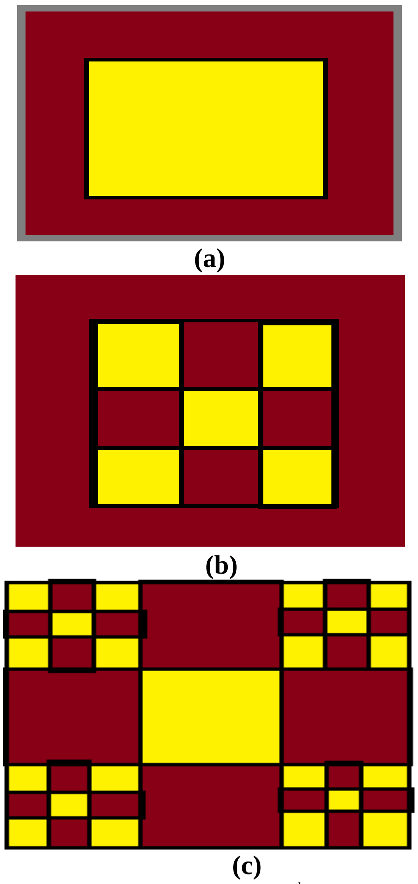

Figure1. Geometry of the fractal antenna, (a) 0^{th} iteration (b) 1^{st} iteration (c) 2^{nd} iteration

Figure 1(a) shows initially a reference patch is designed, which is square in shape. After designing reference patch a series of iteration involving etching is carried out. In figure 1(b) shows first iteration of proposed antenna, where in etching is done in dimension equal to one third of the main patch. This etching is done in an alternative manner. In figure 1(c) shows the second iteration of the proposed fractal antenna which follows the same method as done in first iteration.

IV.SIMULATION RESULTS:

1. *Reference patch antenna results:*

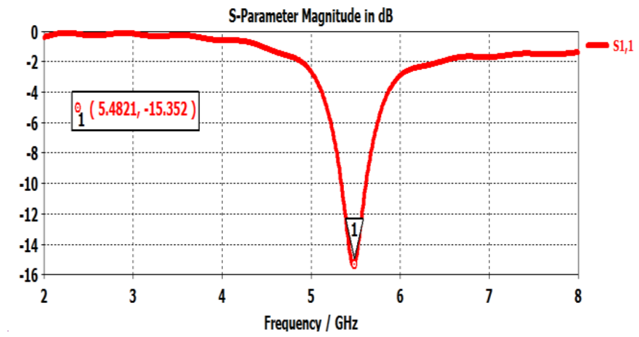

Figure 2: Return loss plot of proposed antenna

Figure 2 Figure 4 shows proposed antenna with the return loss -15.352dB at a frequency of 5.4 GHz. The bandwidth is approximately around 211Mz. The proposed antenna design gives better impedance of, approximately, 50 ohms.

2. Fractal Antenna-First Iteration Result:

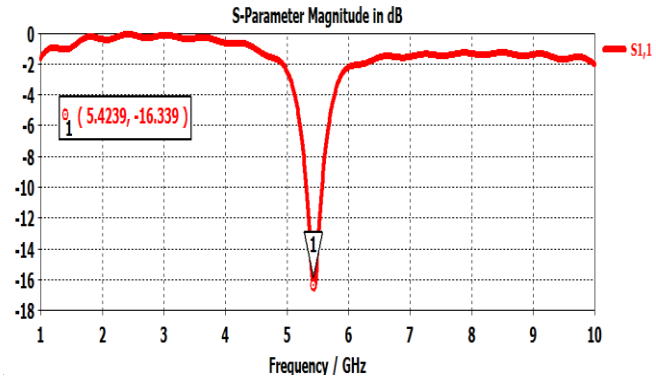

Figure 3: Return loss plot of proposed antenna (First Iteration)

Figure 3 shows the proposed antenna first iteration with the return loss of -16.339dB at the frequency of 5.4GHz having bandwidth 245MHz.

3. Fractal Antenna -Second Iteration Results:

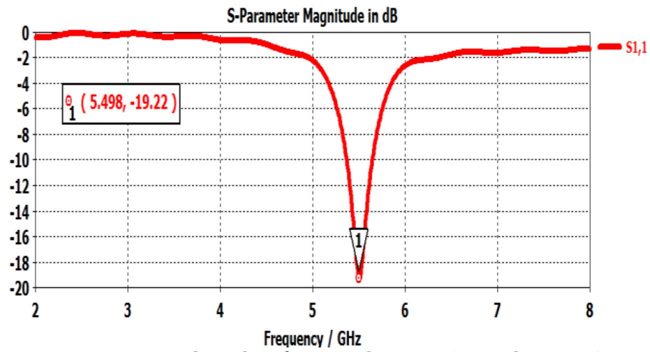

Figure 4: Return loss plot of proposed antenna (Second Iteration)

Figure 4 shows the return loss plot of second iteration, resonates at the frequency of 5.4GHz having bandwidth 185MHz with a return loss of -19.22dB.

4. Directivity Results:

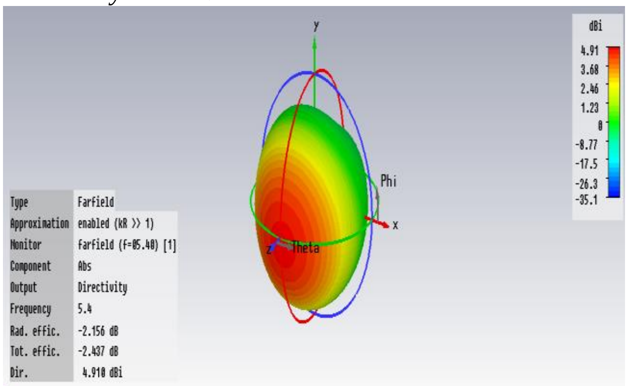

Figure 5: directivity plot of proposed antenna at 5.4GHz

The Figure 5 shows Directivity plot (3D view) represents amount of radiation intensity i.e, is equal to 4.1dBi. The simulated antenna radiates more in a particular direction as compared to the isotropic antenna which radiates equally in all directions, by an amount of 4.91dBi.

5. Gain:

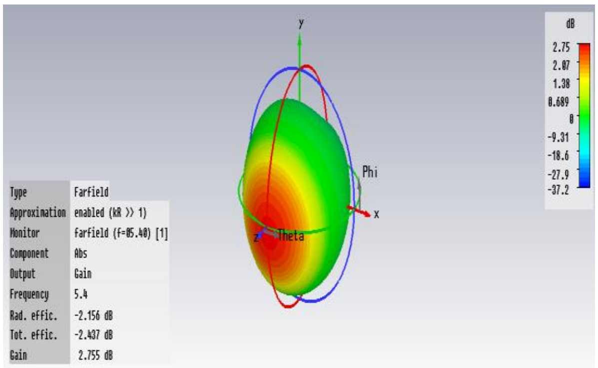

Figure 6. Gain plot of Proposed Antenna

Figure 6 shows the gain of proposed antenna, with the gain of 2.755dB at a frequency of 5.4GHz

6. Voltage Standing Wave Ratio:

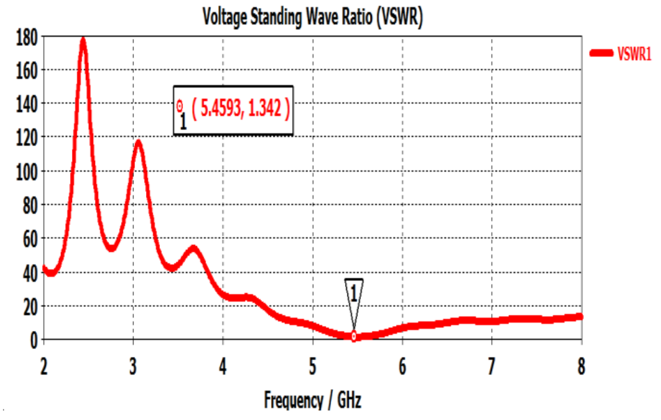

Figure 7: VSWR plot of proposed antenna (First Iteration)

The Figure 7 shows the VSWR plot of proposed antenna, frequency to VSWR of VSWR value < 1.3 works, on the frequency of 5.4 GHz with a bandwidth of 185MHz.

V.CONCLUSION

In this paper, Minkowski based fractal antenna is proposed. The proposed square patch antenna with fractals has been designed to exhibit the single band operation. The reduction in return loss indicates that only small amount of reflection waves where returned back to the source and most of the power will be radiated from the patch. The reduction of return loss ultimately improves gain of fractal antenna which makes fractal antenna more directive.

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