Wideband Octagonal Shaped Iterated Fractal Antenna with DGS for Wireless Applications

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Abstract- *In this paper a wideband octagonal shaped fractal antenna with octagonal slotted iterated antenna is proposed for wireless applications, with defected ground structure. The proposed fractal antenna is designed to operate in wideband having bandwidth from 1.942 GHz to 5.157 GHz at resonant frequency 2.24 GHz for wireless applications with high gain and radiation patterncharacteristics, in the desired frequency band. The proposed fractal antenna is fabricated on a low-cost FR4 (lossy) substrate having dimensions 40mm(L) x 70mm(W) x 1.6mm(h) with ε_r=4.4 and tanδ=0.02S. This antenna shows acceptable gain with nearly similar omni-directional radiation patterns in the frequency band for wireless applications such as Wi-MAX and WLAN.*

Keywords- Fractal antenna, Wide band, CST Software, Return loss, Octagonal Shaped.

I. INTRODUCTION

The fractal geometries repeat their geometries by a particular scale in successive iterations. Consequently, they will possess a long length in a limited confined volume. Accordingly, several fractal geometries, such as the Koch, Minkowski, Hilbert and tree fractals, have been applied to dipole and loop antennas [1].Number of fractal antenna geometries have been suggested for wireless applications in the recent years. [2]-[3]. The infrastructure of fractal antenna for various wireless communications such as ISM, GPS, GSM, Bluetooth, RFID, WLAN, Wi-Fi, Wi-Max in the lower microwave frequency regions (from 900MHz to 12GHZ) combined with increasing popularity, directs the antenna technology to multiband and wideband radiator solutions, to maintain backward compatibility. Small size antennas with good performance are real changing the needs of integration as well as cost , size and efficiency of the emerging wireless world. Wireless Local Area Network (WLAN) Bands are 2.4 GHz (2.4-2.48 GHz), 5.2 GHz (5.150-5.350 GHz), and 5.8 GHz (5.725-5.825 GHz). World Interoperability For Microwave Access (Wi-Max) System Bands are 2.5 GHz (2.51-2.69 GHz),3.5 GHz (3.4-3.69 GHz), and 5.8 GHz (5.25-5.825 GHz) and Bluetooth at 2.4 GHz. The concept of fractal antenna was initially exposed by French Mathematician B. B. Mandelbrot during year 1975, research on several naturally occurring irregular and fragmented self similar geometries [2]-[5]. Fractal antenna engineering is an engineering field that employs fractal concepts for developing new types of antennas with different characteristics. Some properties of fractal antenna are: small scale, simple recursive processes, self-similarity, fractal dimension. Among many, main property of fractal antenna is self-similarityand space filling characteristics [6]. Use of fractal geometry is to improve the several features and performance of antennas [2]. Several slot geometries are as: square, rectangular, triangular, trapezoidal, circular, elliptical etc. in combination with either a rectangular, fork like or circular tuning stub, optimized for wide band operations [3]-[7]. The growth of different wireless communication systems has necessitated that antennas for portable devices be compact size, low profile,packaged, and wide-band to allow operation at multiple frequency bands, eliminating the need for separate antennas for each application. Miniature antennas are well desired for wireless communications systems. Because of space-filling and self-similarity characteristics, fractal concepts have emerged as a novel method for designed compact UWB, multiband, and wideband antennas. In this paper a octagonal shaped fractal antenna with octagonal iterated slot is proposed for wireless applications, with defected ground plane. Simulated results are presented to demonstrate the performance of a proposed antenna.

II. ANTENNA DESIGN SPECIFICATIONS

The geometry of the proposed fractal antenna is shown in the Fig. (1). This proposed fractal antenna is designed and printed on FR4 (lossy) substrate with size of 40 x 70 x 1.6mm3, including substrate thickness h= 1.6mm, and dielectric constant ε_r = 4.4 with 0.025 loss tangent.This structure designed by CST (Computer Simulation Technology) microwave studio simulation software.Defected Ground plane structure is shown in figure (2). The effective reflection coefficient and characteristics impedances calculated with the help of equation (1) and (2).

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r+1}{2}\left[\frac{1}{\sqrt{1+12\frac{h}{w}}}\right] \qquad (1)$$

$$z_0 = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{w}{h}+1.393+0.667\ln\left(\frac{w}{h}+1.444\right)\right]} \qquad (2)$$

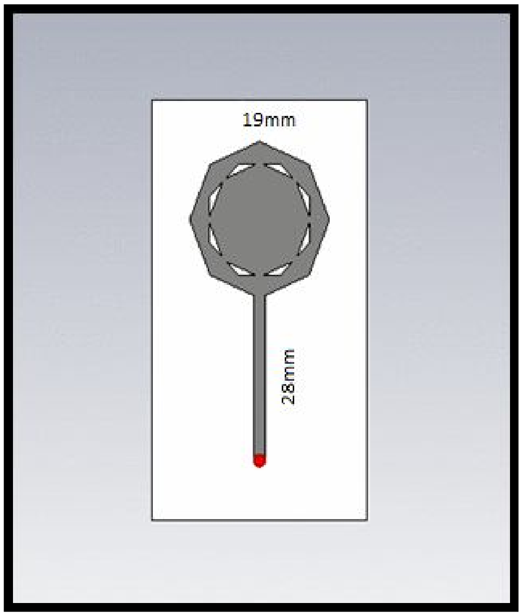

Figure 1. Front view structure of fractal antenna

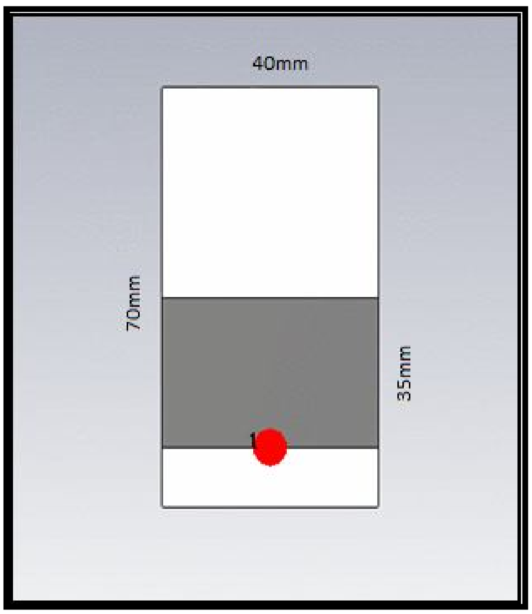

Figure 2. Back view structure of fractal antenna

III. SIMULATION RESULTS AND DISCUSSION

To understand the behaviours of the fractal antenna's structure and to determine the different parameters, the antenna was simulated usingCST (computer simulation technology) Microwave studio software 2010. This Fabricated octagonal shaped iterated fractal antenna is shown in figure (3) &(4) , which is very compact in size as . The return loss curve of fractal antenna (s- parameter versus frequency) is shown in figure (5) which has very wide frequency band from 1.9391 Ghz to 5.1541 Ghz and gain about 51.228 db. Polar plot and smith chart curve is shown in figure (6) and (7) respectively.

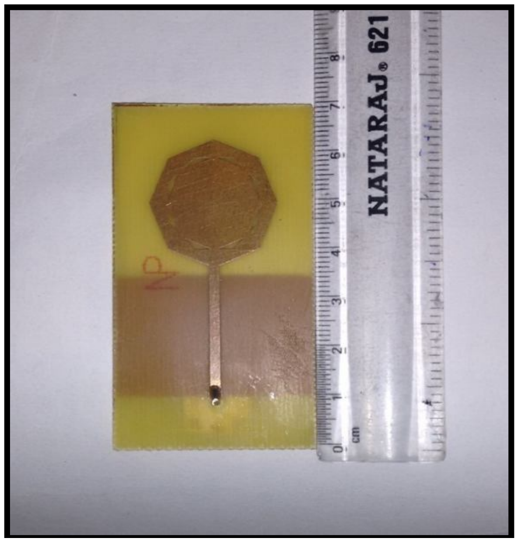

Figure 3. Front view of Fabricated fractal antenna

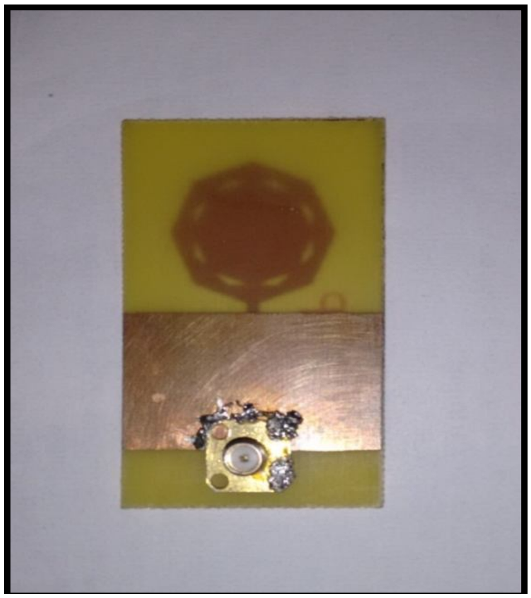

Figure 4. Back view of Fabricated fractal antenna

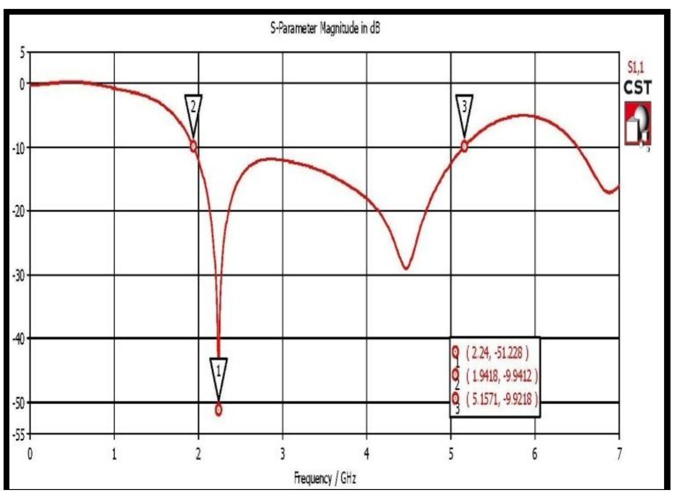

Figure 5. Return loss for fractal antenna

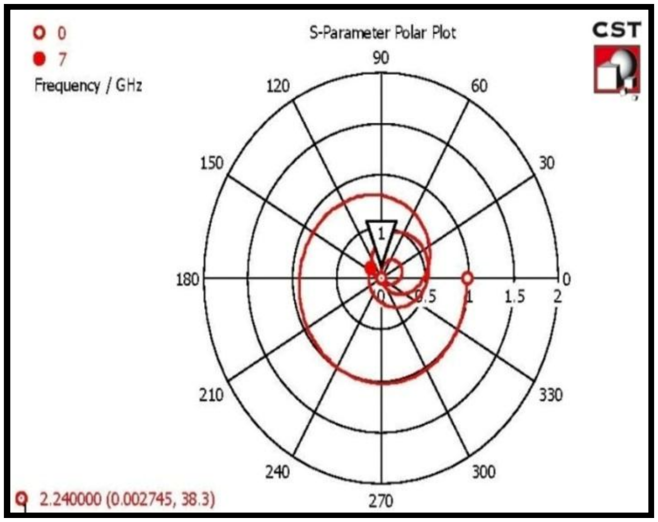

Figure 6. Polar plot of fractal antenna

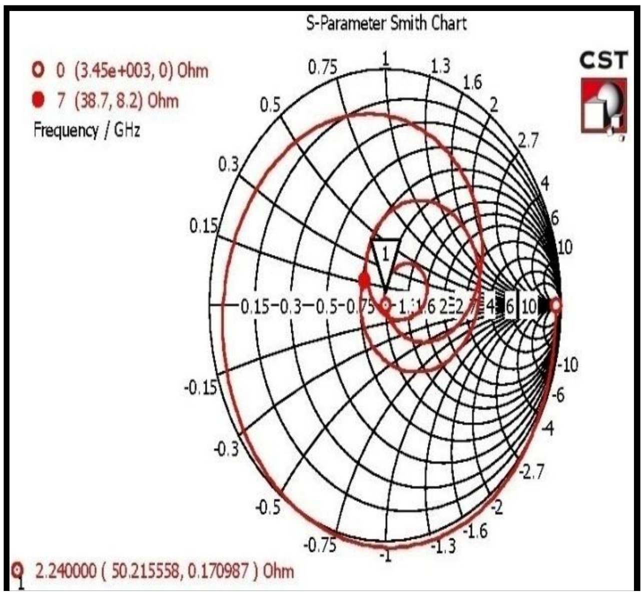

Figure 7. Smith chart of fractal antenna

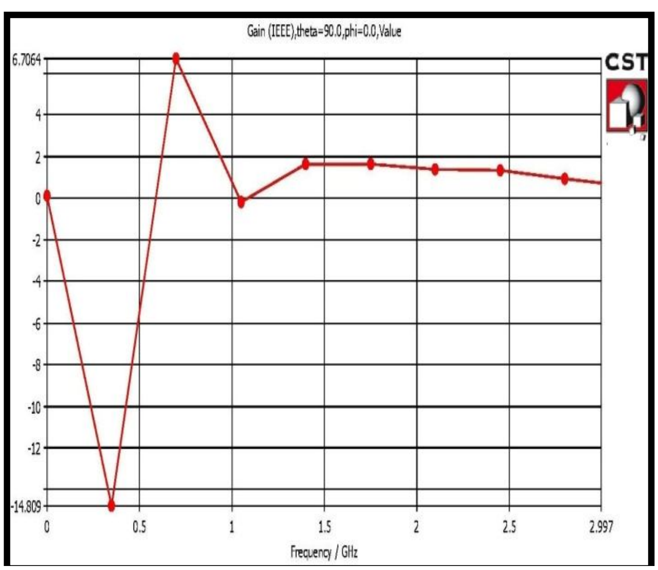

Figure 8. Gain of octagonal fractal antenna

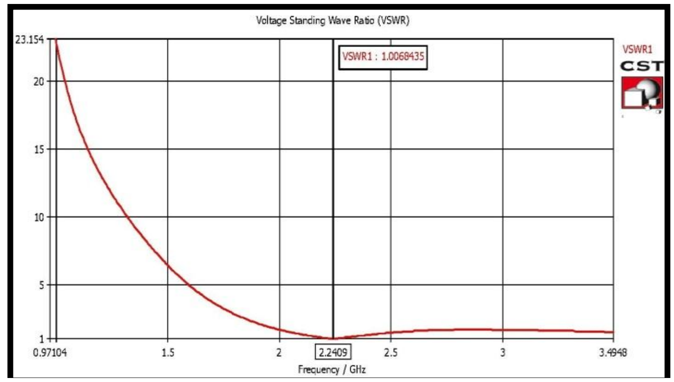

Figure 9. Voltage Standing Wave Ratio of fractal antenna

Gain and voltage standing wave ratio of hexagonal shaped star slotted fractal antenna is shown in figure (8)&(9) respectively. For perfect antenna VSWR should be approximately equal to 1 at cut off frequency, which is clearly shown in above figure. And figure (10) shows the polar radiation pattern of octagonal shaped iterated fractal antenna. And figure (11) shows the antenna measurement system of the octagonal fractal antenna, which is latest equipment for the measurement of radiation pattern of antenna. And this radiation pattern will measure with this equipment. Figure (14) shows the spectrum analyzer with the help of that reflection coefficient or return loss measures.

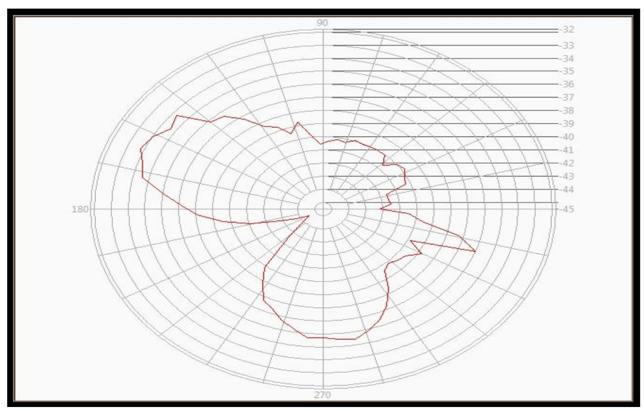

Figure - 10 Measured radiation pattern of octagonal fractal antenna.

Figure – 11 Antenna under measurement using antenna measurement system.

Fig. 11 & 12 shows the transparent radiation pattern with antenna design of hexagonal shaped star slotted fractal antenna with defected ground structure. In this antenna maximum directivity is about the horizontal axis.

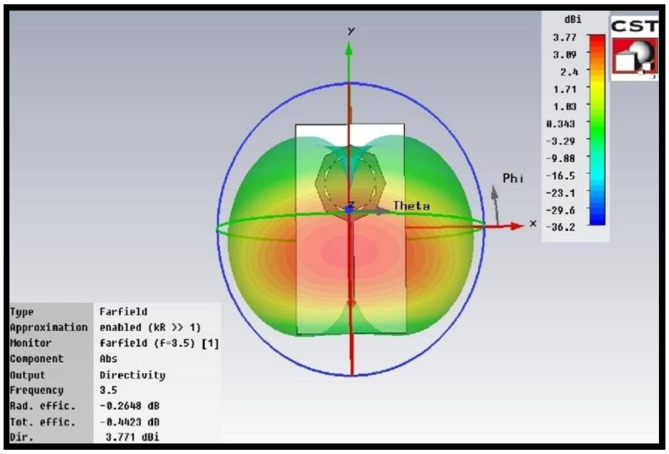

Figure 12. Absolute radiation pattern of octagonal fractal antenna

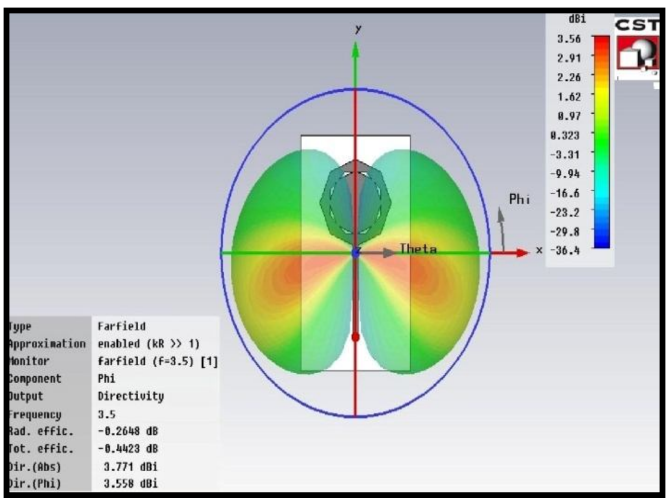

Figure 13.Angular radiation pattern of octagonal fractal antenna

Figure 14. Measurement with the help of spectrum analyzer

IV. CONCLUSION

A Wideband octagonal shaped fractal antenna with octagonal slotted iterated antenna is proposed with a defected ground plane and implemented for wireless applications. To obtain the wide bandwidth the width ofground plane and length of slot, have been optimized by parametric analysis. The results of this proposed fractal antenna indicate wide impedance with relatively stable and nearly similar omni-directional radiation patterns which makes the design more suitable for various wireless applications asWi-MAX and WLAN. In this paper proposed fractal antenna has compact size, large bandwidth about 3.215 Ghz and very high gain about 51.228 db.

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