Proximity Coupled Rhombus shaped Sierpinski Fractal Microstrip Antenna for wireless applications

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Abstract- Fractal antennas are characterized by space filling and self-similarities properties which results in considerable size reduction as compared to base antenna. This paper presents a comparison between the Proximity coupled Rhombus shaped Microstrip Antenna (PRMSA) and the proximity coupled rhombus shaped Sierpinski gasket fractal microstrip antenna with first and second iteration. The reference PRMSA is designed to operate for 2.4GHz (Bluetooth application). The proposed antenna of PRMSA with Sierpinski gasket fractal concept which gives a good size reduction and increase in gain. The resonant frequency is reduced from 2.4GHz to 2.25GHz after 1st and 2nd iteration respectively. Thus there is a considerable size reduction of 14.2% and increase in gain of 21.49% compared to reference PRMSA. The simulation is carried out by IE3D software and practical results are measured by Vector Network Analyzer (VNA) with model E5062A. The performance characteristic behaviors of simulated antenna results are in good agreement with practical antennas.

Keywords – Proximity coupled rhombus shaped microstrip antenna (PRMSA), Sierpinski gasket, size reduction, gain.

I. INTRODUCTION

In recent years, rapid progress in communication technology need antenna having lightweight, low profile, superior performance[1]. Microstrip patch antennas can accomplish these requirements. Microstrip antenna gives a less bandwidth and less impedance matching [2]. The Proximity coupling provides large bandwidth and low spurious radiation [3]. Moreover, flexibility exists in choosing the feedline geometry. This feature is useful in selecting the desired resonating frequencies and for impedance matching.

The term "fractal" means broken or irregular fragments, it was named by Mandelbrot. A fractal is a rough or fragmented geometric shape that can be split into parts, each of which is reduced-size copy of the whole and this property is called self- similarity [4]. In our work we focus on generation of lower frequency with a same are as reference antenna. A Proximity coupled Rhombus shaped microstrip antenna (PRMSA) is taken as a base shape and the sierpinski gasket [5] fractal concept is embedded with the reference antenna with space removal of 1/3 of rhombus shaped radiating patch in the center of the reference antenna. Similarly second iteration is applied with the rhombus shape with length and width is 1/3 the 1st iteration.

II. ANTENNA DESIGN

The reference or base proximity coupled rhombus shaped microstrip antenna (PRMSA) is shown in figure 1. The antenna is designed by using two substrate made up of glass epoxy having each of thickness of 1.6 mm which is placed one above the other. Optimized resonating frequency of the designed antenna which is operating at 2.4GHz for that we are considered length and width of a radiating patch is 29mmX29mm. Simulated geometry of the PRMSA with 1st and 2nd iteration as shown in figure 3 and figure 4.

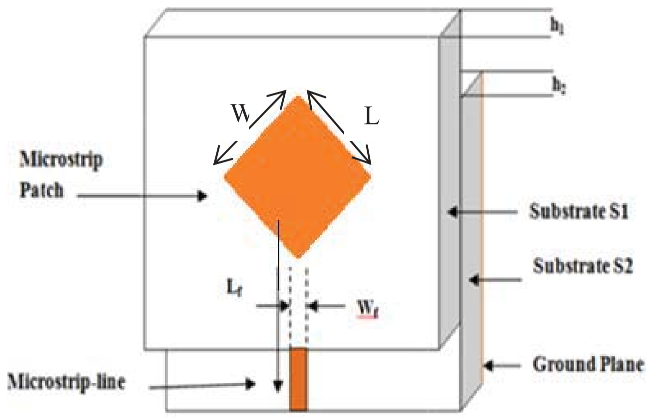
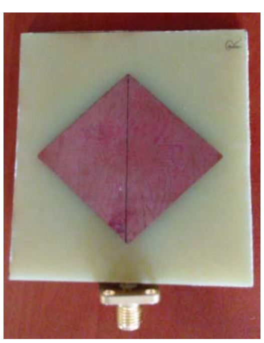
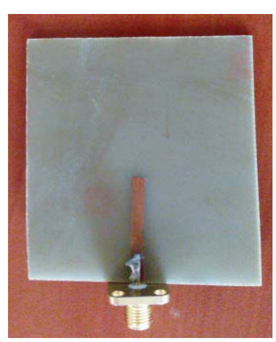


Figure 1. Geometry of Rhombus shaped Proximity couple antenna

The Proximity coupled Rhombus shaped microstrip antenna whose substrate material used is glass epoxy with dielectric permittivity of ε_r=4.4, which is designed to operate at 2.4GHz. The optimized dimensions of designed antenna are as follows: h_1=1.6mm, L=29mm, W=29mm, L_f=24.75mm, W_f=3mm and h_2=1.6mm.With a ground plane of dimension (51.2 x 60.2) mm^2, the feeding patch is placed between two substrates and it is connected through SMA connector. The fabricated top and bottom view of practical proximity coupled reference Rhombus shaped microstrip antenna shown in Figure.2.



a) Top view of substrate 1



b) Top view of substrate 2

c) Bottom view of substrate 2

Figure 2. Proximity coupled Rhombus shaped microstrip antenna (top and bottom view).

The first iteration patch antenna by considering designed dimensions of L_1=6mm and W_1=6mm on the radiating patch as shown in figure 3. The second iteration antenna by considering designed dimensions of L_2=2mm and W_2=2mm dimension on the radiation patch of the first iteration antenna as shown in figure 4.

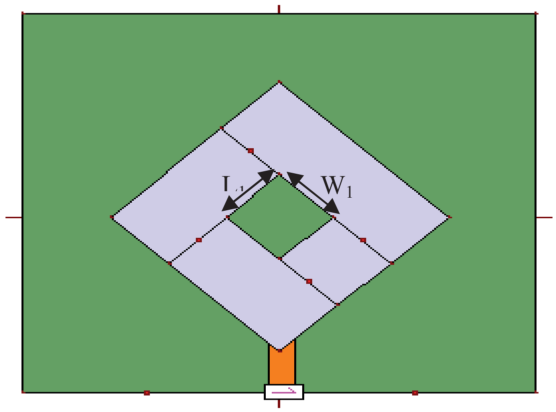


Figure 3. 1st iteration Proximity coupled Rhombus shaped microstrip antenna.

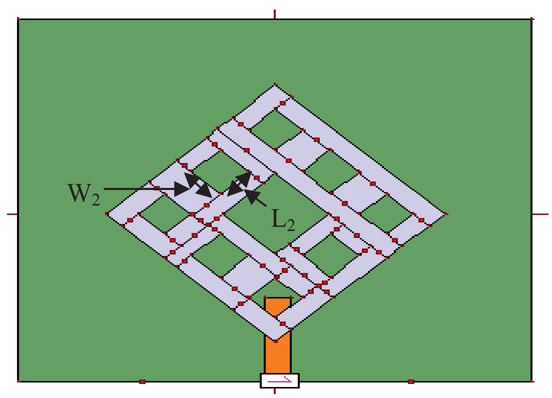
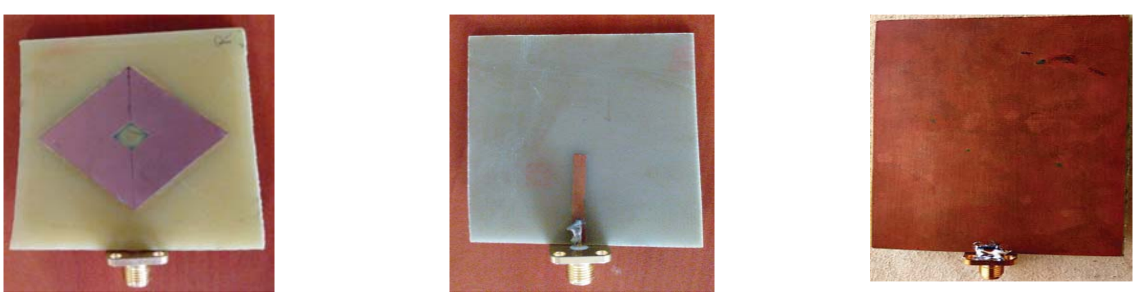


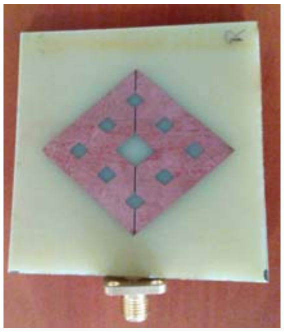
Figure 4. 2nd iteration Proximity coupled Rhombus shaped microstrip antenna.

The Photographic view of practical PRMSA with 1st iteration and 2nd iteration shown in Figure.5 and Figure 6 respectively.



a)Top view of substrate 1 | b) Top view of substrate 2 | c) Bottom view of substrate 21st

Figure 5. iteration Proximity coupled Rhombus shaped microstrip antenna (top and bottom view)



a)Top view of substrate 1

b) Top view of substrate 2

c) Bottom view of substrate 2

Figure 6. 2nd iteration Proximity coupled Rhombus shaped microstrip antenna (top and bottom view)

III. EXPERIMENTAL RESULTS

The performance characterization behavior in terms of return loss of simulated and practical PRMSA shown in Figure 7, the return loss and bandwidth values are summarized in table 1. The Figure 8 shows the performance gain characteristic of PRMSA with a maximum gain of 2.147dBi at resonant frequency. The radiation pattern of PRMSA as show in Figure 9.

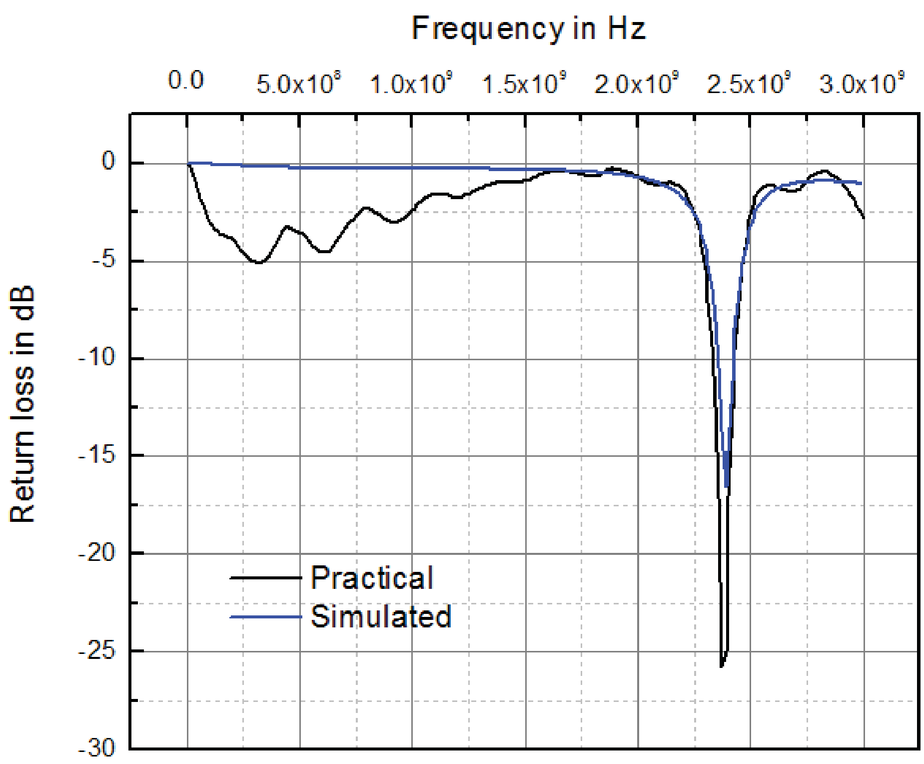


Figure 7. Return loss versus frequency of Proximity coupled Rhombus shaped microstrip antenna.

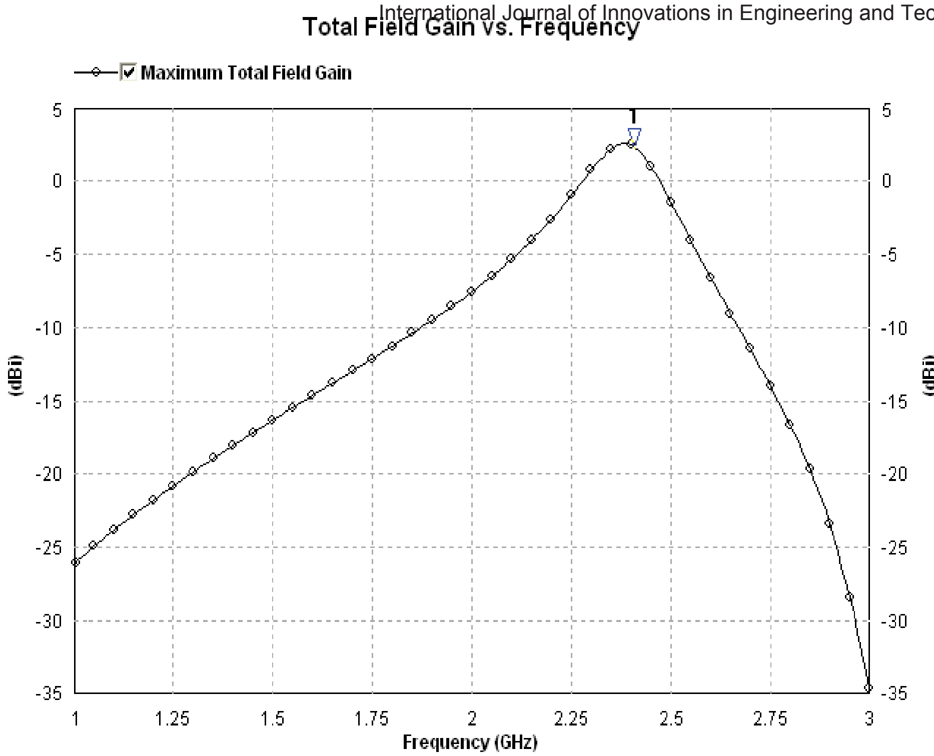


Figure 8. Gain versus frequency of Proximity coupled Rhombus shaped microstrip antenna.

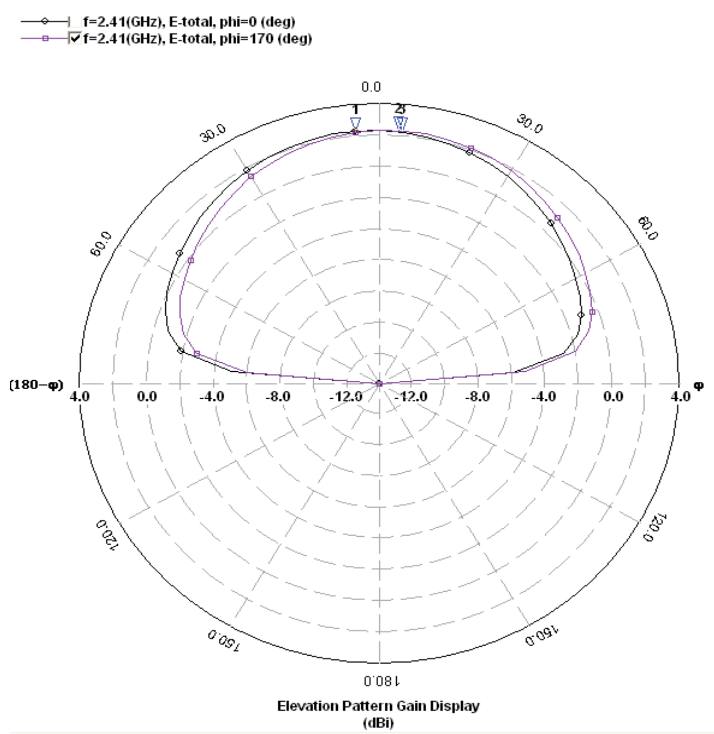


Figure 9. Radiation pattern of Proximity coupled Rhombus shaped microstrip antenna.

The performance characterization behavior in terms of return loss of simulated and practical PRMSA with 1st iteration sierpinski gasket fractal property shown in Figure 10, the return loss and bandwidth values are summarized in table 1. The Figure 11 shows the performance gain characteristic of PRMSA 1st iteration sierpinski gasket fractal property with a maximum gain of 2.69dBi at resonant frequency. The radiation pattern of 1st iteration sierpinski gasket fractal property on PRMSA as show in Figure 12.

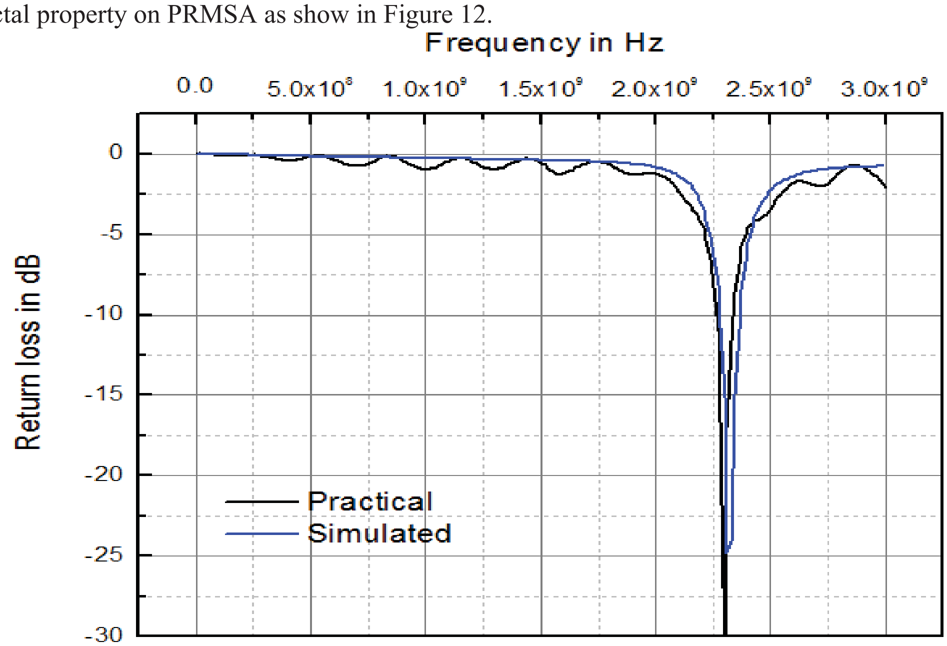


Figure 10. Return loss versus frequency of Proximity coupled Rhombus shaped sierpinski fractal microstrip antenna.

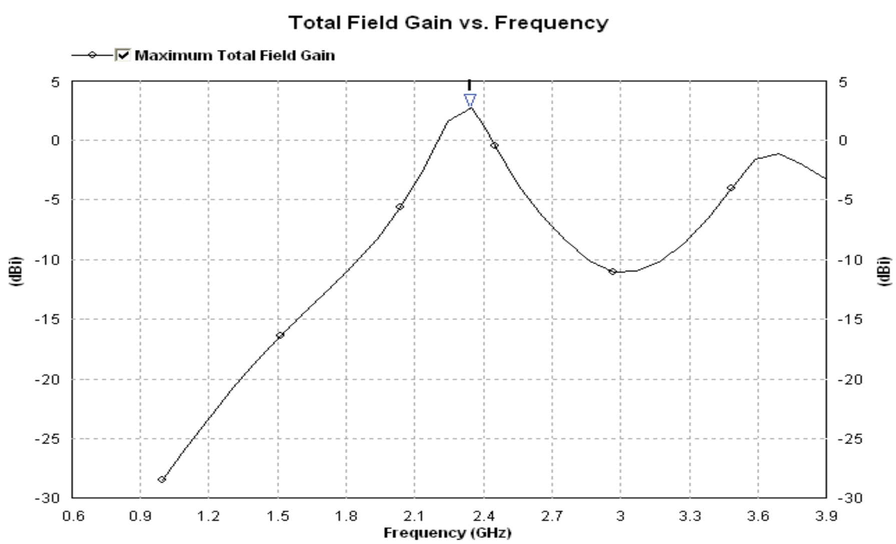


Figure 11. Gain versus frequency of Proximity coupled Rhombus shaped sierpinski fractal microstrip antenna.

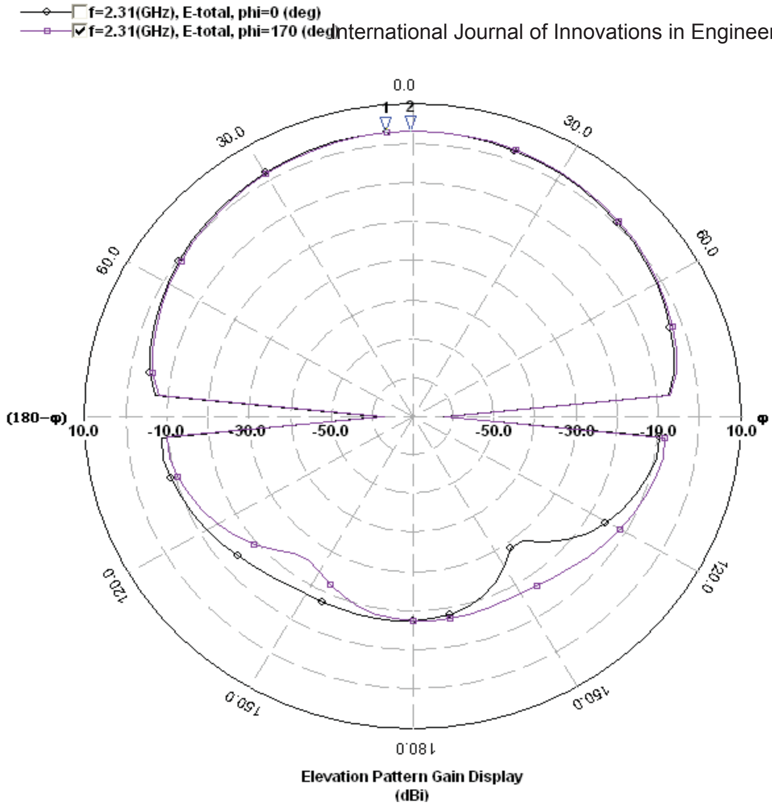


Figure 12. Radiation pattern of Proximity coupled Rhombus shaped sierpinski fractal microstrip antenna.

The return loss characterization of simulated and practical Proximity coupled rhombus shaped sierpinski gasket fractal microstrip antenna with 2nd iteration shown in Figure 13, the return loss and bandwidth values of 2nd iteration fractal antenna are summarized in table 1. The Figure 14 shows the performance gain characteristic of proximity coupled rhombus shaped sierpinski gasket microstrip antenna with a maximum gain of 2.6Bi at resonant frequency. The radiation pattern of proximity coupled rhombus shaped sierpinski gasket fractal microstrip antenna with 2nd iteration as show in Figure 14.

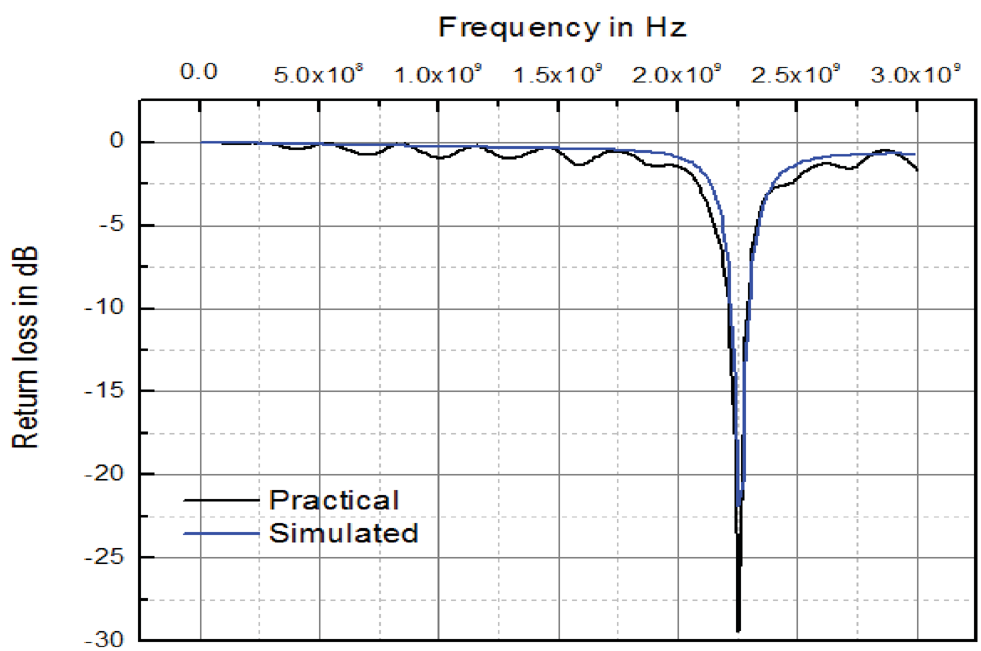


Figure 13. Return loss versus frequency of Proximity coupled Rhombus shaped sierpinski fractal microstrip antenna with 2nd iteration.

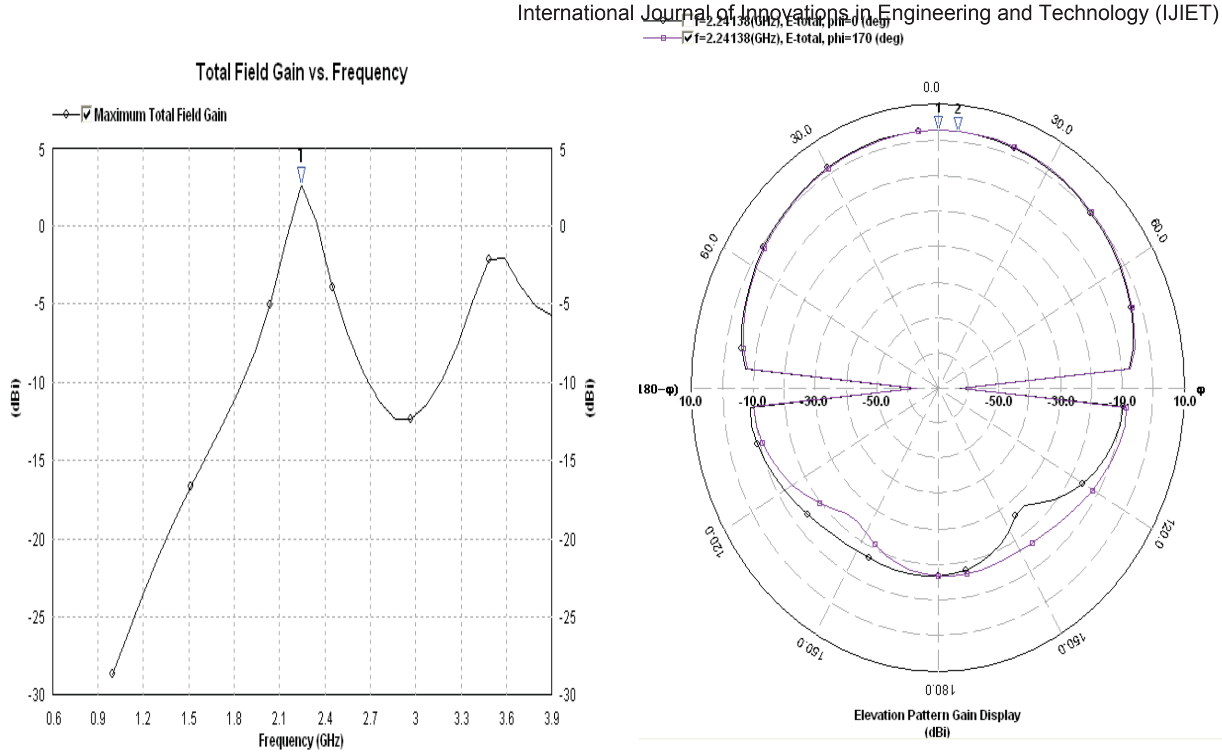


Figure 14.Gain and Radiation pattern of Proximity coupled Rhombus shaped sierpinski fractal microstrip antenna with 2nd iteration.

SL No	Prototype Antenna	Resonant Frequency f_r (GHz)		Return Loss (dB)		Bandwidth (MHz)		Impedance (Ω)		Gain (dBi)
		Simul.	Pract.	Simul.	Pract.	Simul.	Pract.	Simul.	Pract.	
1	Proximity coupled Rhombus shaped microstrip antenna	2.41	2.4	-11.92	-24.2	48.8	96.8	45.26	46.72	2.147
2	Proximity coupled Rhombus shaped Sierpinski Fractal microstrip antenna with 1st iteration	2.34	2.29	-13.40	-38.4	69.7	77.62	44.67	48.17	2.69
3	Proximity coupled Rhombus shaped Sierpinski Fractal microstrip antenna with 2nd iteration	2.24	2.25	-16.29	-28.9	101	83.6	41.67	56.68	2.6

Table 1: Results of the proposed antennas.

IV.CONCLUSION

Proximity coupled Rhombus shaped Sierpinski gasket fractal antenna with iteration size 1/3rd and order 2 are considered. PRMSA gives equivalent gain of 2.6dBi with size reduction of 14.2%. The design reference antenna is operating at 2.4GHz i.e Bluetooth and 2nd iterated antenna operating at 2.2GHz which is useful in CDMA application. The simulation results are good agreement with the measured results. Radiation pattern of the designed antennas give broad side radiations.

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