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Fractal Array antenna Design for C-Band Applications

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Abstract: ***In current article, 1x4 fractal array antenna is designed on substrate of relative permittivity 2.2 of stature 1.57mm is designed. Proposed structure is working at two frequencies with return loss of -19.7dB with impedance band width of 60MHz and peak gain of 12dB. To validate the simulated results are compared with experimentally measured results.***

Index Terms: ***Sierpinski fractal (SF), Array antenna; C-band; satellite TV; Fractal antenna; Sierpinski carpet; shorting pins; Micro strip***

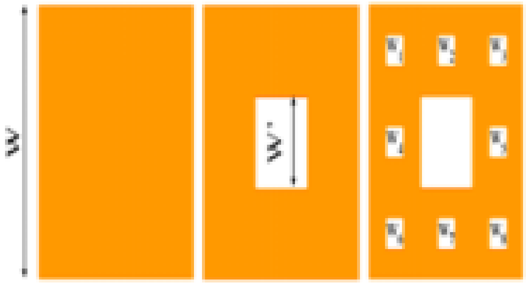
I. INTRODUCTION

The hasty development of technology at present demand the cohesive multifunctional and reduction of size of all parameters in electronics and telecommunication has increased a lot. This makes the antenna design very compact and operation of multiple resonance frequencies is a need in coming future. The C band frequency spectrum for link is 5.925GHz - 6.425GHz and for downlink is 3.7GHz - 4.2GHz. Temperature and subtropical climatic conditions effect is minimum in C band so data transmission is more reliable[1-5]. Compact antennas have advantage of low profile, less weight but exhibiting narrow bandwidth, and less power gain [6-15]. To avoid drawbacks in literature so many techniques were proposed [16-31]. In current study, fractal geometry is considered. Numerous fractal shaped antennas are available in literature. During the study, in current article. First of all, a square patch antenna resonating at 4.2GHz is considered as fundamental structure. Next, fundamental antenna is converted into SF carpet antenna. To enhance the gain 1x4 fractal array antenna resonating at dual frequencies (i.e., f1= 3.91GHz and f2=6.083GHz) is designed.

II. DESIGN METHODOLOGY

A. Sole SF Antenna

The sole SF antenna is designed in three iterations. During first iteration square shaped microstrip patch antenna is operating in C-band is designed, considered as reference for next models and depicted in Figure 1(a). The complete structure is printed on Rogers RT/duroid 5880 substrate. During second iteration, a square hole of area 'W' is etched at the center of fundamental square patch. During third iteration, eight holes are etched surrounding to center hole.



(a) Iteration 1 (b) Iteration 2 (c) Iteration 3

Fig. 1. SF carpet antenna

Table I: Design parameters and its values.

Parameters	Size	Coordinates,(x, y)
W_g	31.2mm	-15.6mm, -15.6mm
W	22.5mm	-11.25mm, -11.25mm
W	7.5mm	-3.75mm, -3.75mm
W1	2.5mm	-8.75mm, -8.75mm
W2	2.5mm	-8.75mm, -1.25mm
W3	2.5mm	-8.75mm, 6.25mm
W4	2.5mm	-1.25mm, -8.75mm
W5	2.5mm	-1.25mm, 6.25mm
W6	2.5mm	6.25mm, -8.75mm
W7	2.5mm	6.25mm, -1.25mm
W8	2.5mm	6.25mm, 6.25mm

Table 1 shows the squares of the coordinates along with size. The architecture is fed by coaxial probe, diagonal to the patch results circular polarization. To enhance impedance band width patch antenna is provided with shorting pin.

B. Results

The proposed antenna is compact in size and resonating at two frequencies, one is 3.91GHz with impedance bandwidth of 137MHz, another frequency is at 6.083GHz with impedance width 219MHz.

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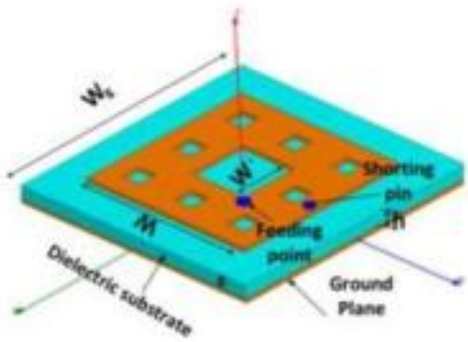
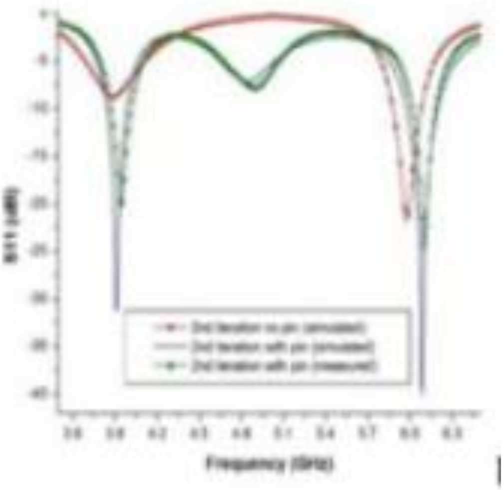
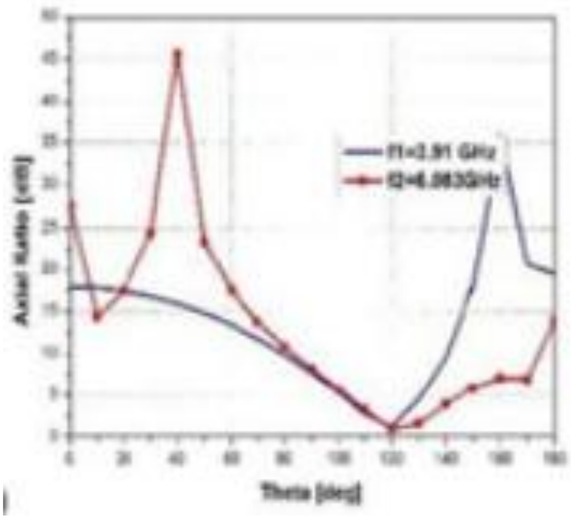


Fig. 2 (a) Lattice of solo SF antenna.

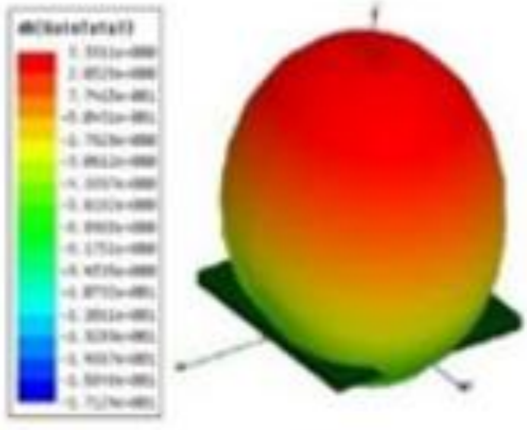
The simulated results are depicted in fig 3.



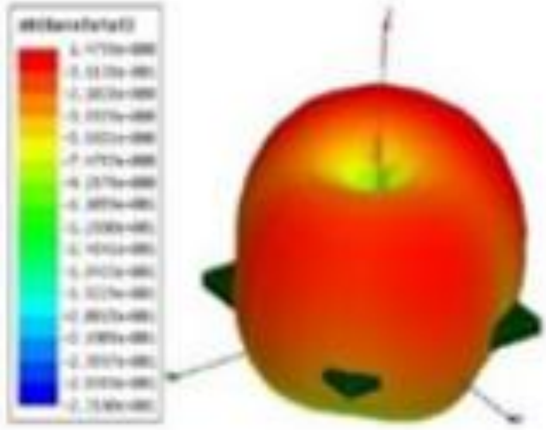
(a) Frequency verses reflection coefficient.



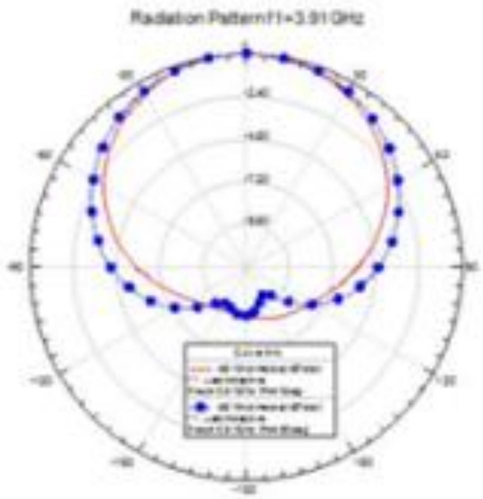
(b) Graph of Axial ratio.



(c) 3D polar Gain Pattern at 3.91GHz



(d) 3D polar Gain Pattern at 6.08GHz



(e) Radiation Pattern at 3.91GHz

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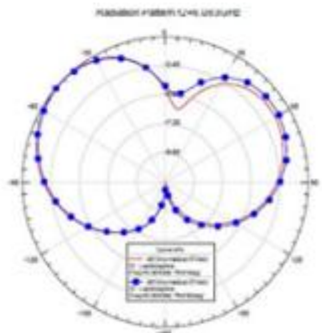


(f) Radiation pattern at 6.08GHz.

Fig. 3. Radiation characteristics of the SF antenna.

C. 1X4 Array antenna Design:

The gain produced by a single fractal antenna is very low, to increase overall gain, the fractal 1X4 array antenna is designed suitable for satellite-TV applications. The detailed design parameters of 1X4 array antenna is depicted in Fig. 4.

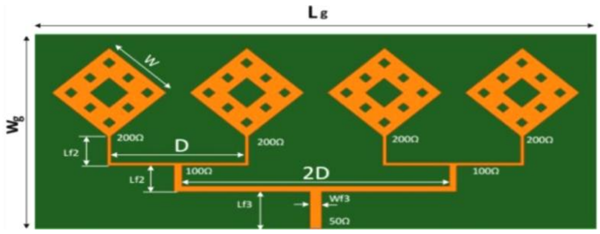


Fig. 4. Lattice of 1X4 SF antenna array.

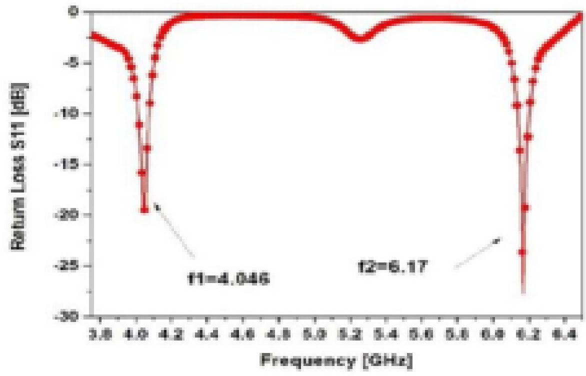
The magnitudes of SF antenna array are composed in Table II.

Table II: Design parameters

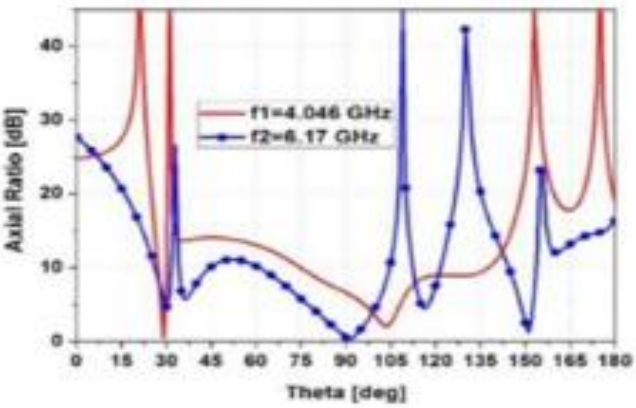
Parameters	Size(mm)
Lg	153.34
Wg	67.84
D	37.5
Ln	10.5
Wn	1
Lc	9
Wc	2
Lo	13
Wo	3

III. MATHEMATICALREPLICATION AND TRIALS

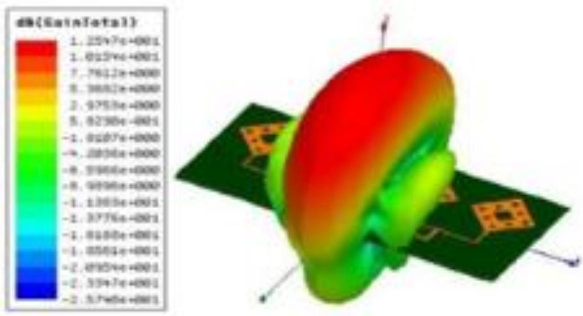
In 1X4 array antenna, the distance between two elements is 37.5mm. The antenna is resonating at 4.046GHz with impedance band width of 60MHz, peak gain of 12.54dB, and second resonating frequency of 6.17GHz with impedance band width of 66MHz, peak gain of 14.1dB. The simulated results are shown in Fig. 5.



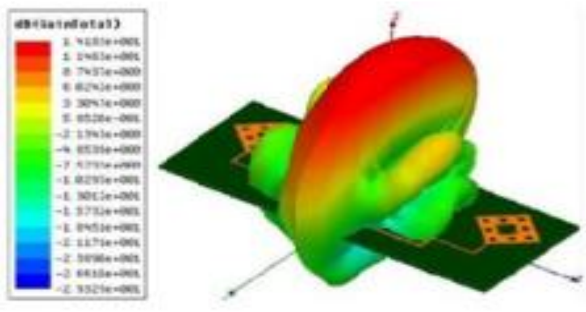
(a) Return loss characteristics.



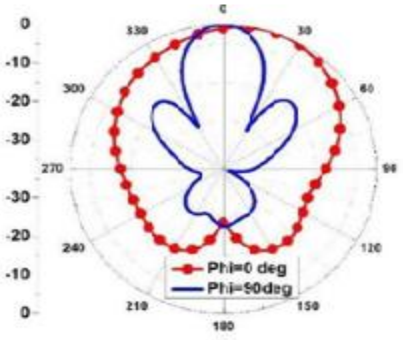
(b) Axial ratio characteristics.



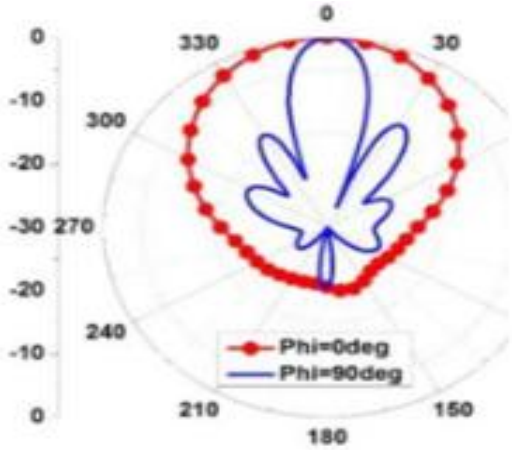
(c) 3D Polar Gain pattern at 4.046GHz.



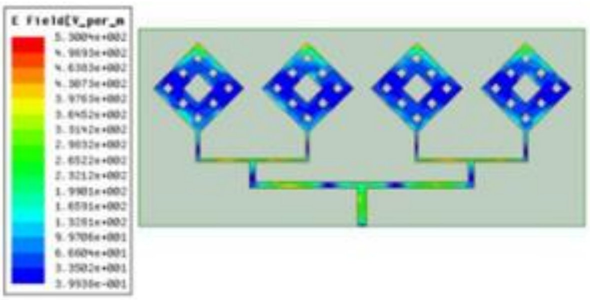
(d) 3D Polar Gain pattern at 6.17GHz.



(e) Radiation Pattern at 4.046GHz.



(f) Radiation Pattern at 6.17GHz.



(g) Surface current distribution.

Fig. 5. Radiation characteristics of 1X4 SF array antenna.

IV. SUMMARY

The design of array antenna which develops a solo SF carpet antenna is presented. To improve the gain, 1X4 SF array antenna is designed. Which is resonating at dual frequencies. First operating frequency is at 4.046GHz with impedance band width of 60MHz, peak gain of 12.54dB, and second resonating frequency of 6.17GHz with impedance band width of 66MHz, peak gain of 14.1dB.

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