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Design and Comparison of Crown Square Fractal Antenna Using Two Feeding Techniques

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***Abstract* – This paper presents a design of fractal micro strip patch antenna. This design is achieved by cutting multi shapes in crown fractal pattern and placing a micro strip line feed .This proposed design has been studied up to 3 iterations. In this paper frequency range is 2GHz to 8 GHz. The analyzed antenna is designed on 1.6mm thick FR4 glass proxy substrate with dielectric constant Er of 4.4 and is fed by transmission line and probe feed. Performance of proposed antenna has been designed in terms of return loss, VSWR, input impedance, gain, and bandwidth in the 2GHz to 8GHz frequency range. The proposed antenna provides the comparison between two feeding techniques result.**

***Keywords* – Feed, FR4, Micro Strip Patch Antenna, Return Loss, Crown Square Shape, VSWR, Probe Feed, Transmission Feed.**

I. Introduction

In modern wireless telecommunication system and there are various types of micro strip antenna the most common of which is micro strip patch antenna . A patch antenna is a wide-beam, narrow band antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate . A micro strip patch antenna is a type of radio antenna which can be mounted on flat surface. It consists of a flatbed rectangular sheet or " patch antenna " of metal, mounted over a larger sheet of metal called a ground plane. A patch antenna is usually retraced on a dielectric substrate using the same materials used to make printed circuit boards. Micro strip antenna is becoming increasingly useful because they can be printed directly onto a circuit board .These antennas are low cost, low profile & simply fabricated. These are relatively cheap to manufacture & design because of the simple 2 dimensional physical geometry and are less weight, conformal shaped, capable of frequency operations. In recent years multiple antenna

Configurations based on fractal geometries have been reported. Fractal geometry permits to design miniature antenna and integrating several telecommunication services into single device.

Micro strip or patch antennas are becoming more and more useful because they can be printed directly onto a circuit board [6]. Fractal antenna can be put to use in a variety of application, especially where space is minimal [11].

In this paper, we introduce a new self- similar fractal antenna based on nearly square shape with a circular polarization. This new type of antenna which is called crown square fractal antenna display frequency which results in reduced antenna size. This paper presented a design of micro strip patch antenna using crown square fractal antenna slots with an aim to achieve a smaller size antenna [13].In this design software is used like IE3D, IE3D from Zealand software. IE3D has a menu driven graphic interface for modern generation with automatic meshing and uses a field based on full wave 3d shape [7].

II. Design Consideration

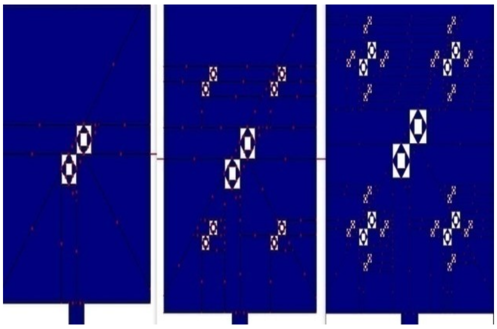

Fig 1: Combined design of crown square with 1 iteration, 2 iteration, 3 iteration.

Design parameters

Transmission line and probe feed line design is used to design and analyses rectangular micros trip fractal antenna through simulation process of IE3D software.

Patch Width and Length

In this firstly design the patch to suitable substrate of suitable thickness. The width w and the length L depends on the resonant frequency Fr for micro strip patch antenna

To design the rectangular patch width of the antenna is given below.

Width of The Patch

$$W = \frac{c}{fr}\sqrt{\frac{2}{er+1}} \qquad (1)$$

Where, c is the speed of light

Fr is the resonant frequency

Effective Dielectric constant

$$\epsilon_{reff} = (\epsilon_r+1)/2+(\epsilon_r-1)/2\sqrt{1+12h/w} \qquad (2)$$

Where, ϵ_{reff} is the effective dielectric constant,

ϵ_r is the dielectric constant,

h is the height of the substrate ,

W is the width of the patch.

Taking into Account the Fringing Effect

The fringing fields along the width of the structure are taken as radiating slots and the patch antenna is electrically seen to be a bit larger than its physical size.

$$\Delta L = 0.412h - \frac{(\epsilon reff+0.3)(\frac{W}{h}+0.264)}{(\epsilon reff+0.258)(\frac{W}{h}+0.8)} \quad (3)$$

Calculating the effective length of the patch

$$L_{eff} = \frac{c}{2fr\sqrt{\epsilon r}} \quad (4)$$

Calculating the actual length of the patch

$$L = L_{eff} - 2\Delta \quad (5)$$

There are different ways to feed a micro strip fractal antenna and we have used the probe feed and micro strip line feed technique [15].

III. Design of Fractal Antenna

A. Micro strip line feed

1st Iteration

First a micro strip patch at the required operating frequency is designed .Two crown square fractal slot is cut from the center and they are placed diagonally to each other from center slot . The dimension of the central crown square fractal slot is 2-2(length-width). The length of the micros trip patch antenna is L= 20mm and W= 20 mm. The feed location is adjusted so as to connect to the metallic portion of the patch .Figure 2 shows the location of the feed.

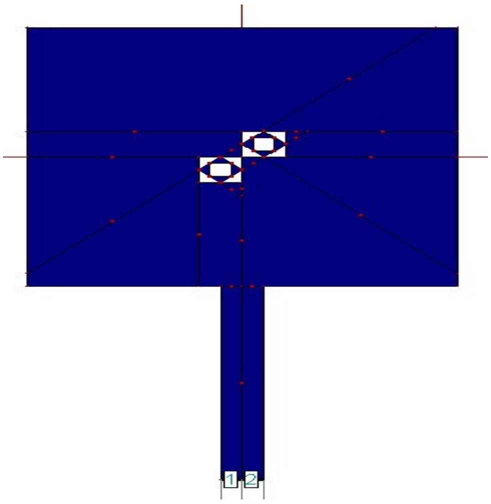

Fig 2: Design for First iteration

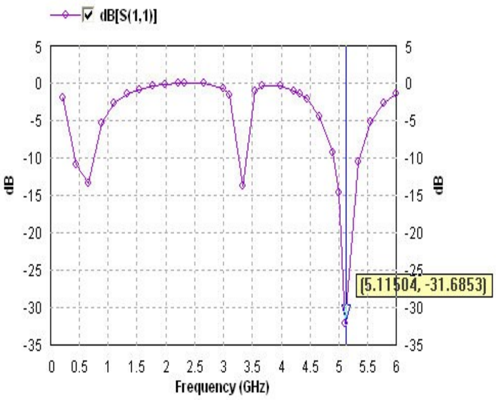

Fig 3: S11 parameter

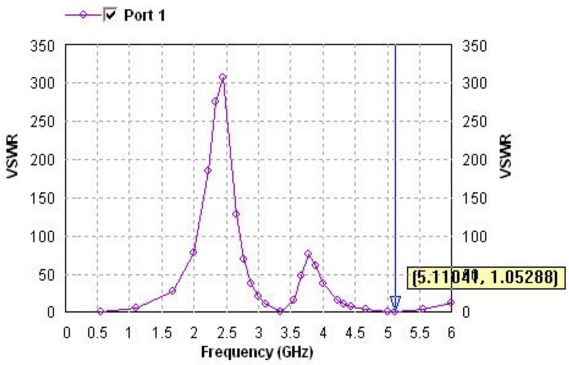

Fig 4: VSWR

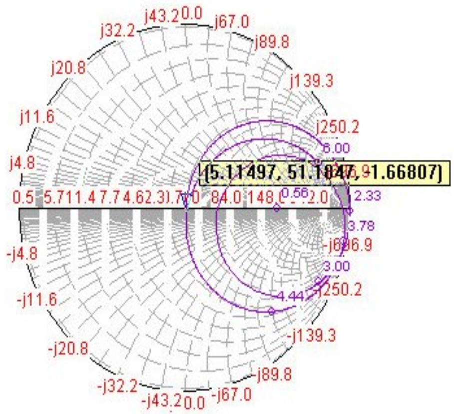

Fig 5 : Impedance loci using smith chart of first iteration

Figure 2 shows the design of First iteration antenna. Figure 3,4 ,5 shows the results from IE3D simulations, at may be noted that the antenna has a good return loss of magnitude -31.689 at the frequency 5.1150

2nd iteration

The geometry of second iteration of proposed micro strip patch antenna using crown square fractal slots is presented. This design comprised of four crown square fractal slots which are cut facing each side of the rectangular micro strip antenna with dimensions of 1-1(base -height).

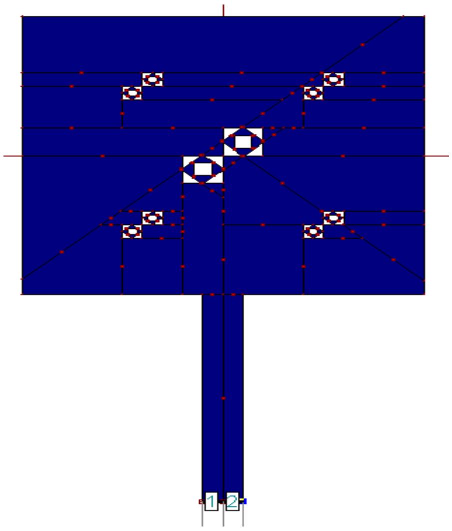

Fig 6: Design for Second iteration

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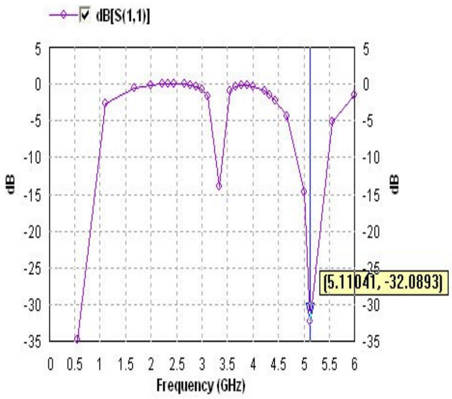

Fig 7: S11 parameter

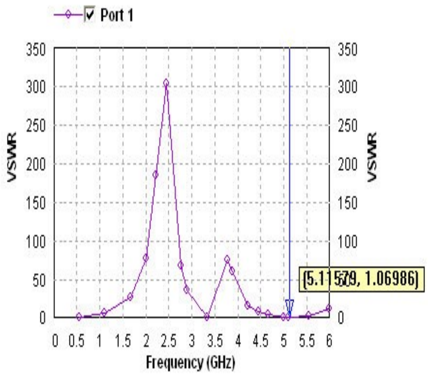

Fig 8: VSWR

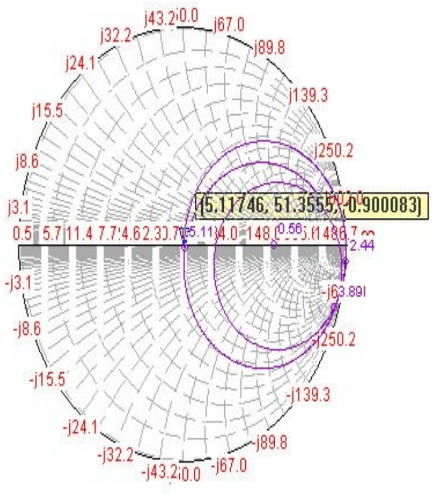

Fig 9: Impedance loci using smith chart of second iteration

The figure 6 shows the design of 2nd iteration antenna. Figure 7, 8, 9 shows the results from IE3D simulations, at may be noted that the antenna has a good return loss of magnitude -32.089 At the frequency 5.11041.

3rd iteration

The geometry of Third iteration of proposed micro strip patch antenna using crown fractal slots presented in fig10. Third iteration is obtained by further four crown square fractal slots which are cut facing each side of the rectangular micro strip antenna.

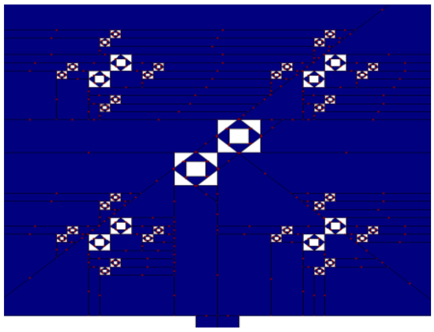

Fig 10: Zoom design for Third iteration.

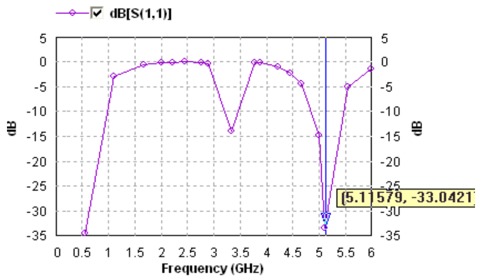

Fig 11: S11 parameter.

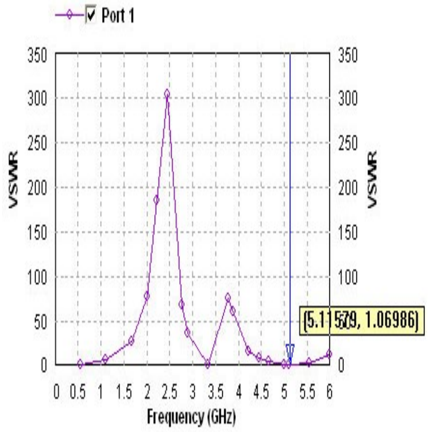

Fig 12: VSWR

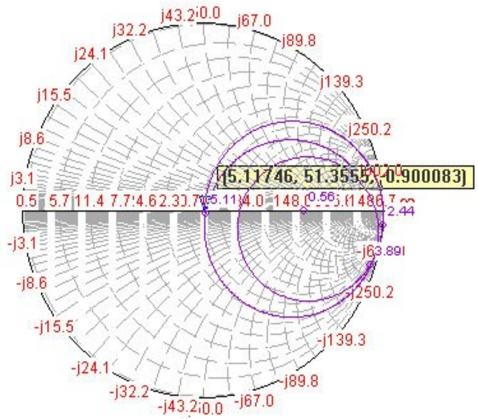

Fig 13: Impedance loci using smith chart of third iteration

The figure 10 shows the design of 3rd iteration antenna. Figure 11, 12, 13 shows the results from IE3D simulations, as may be noted that the antenna has a good return loss of magnitude -33.0421 at the frequency

5.11579.

B. Probe feed

1st Iteration

The design of I iteration for probe feed antenna and the impedance loci using smith chart are shown in Fig 14 and fig 17 respectively. The points for the probe feed are ((x, y) = 3, 8.5).

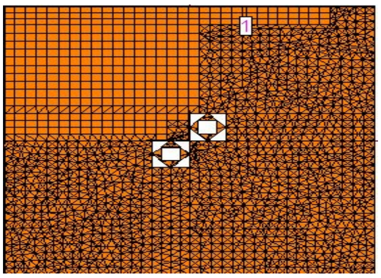

Fig 14: Design for First iteration

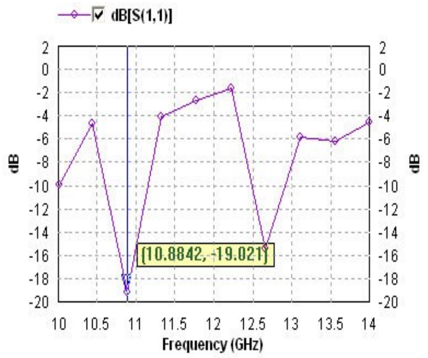

Fig 15: SII parameter

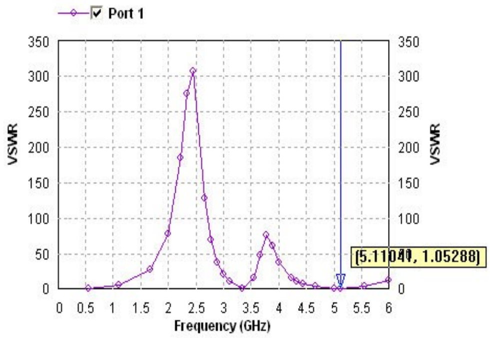

Fig 16: VSWR

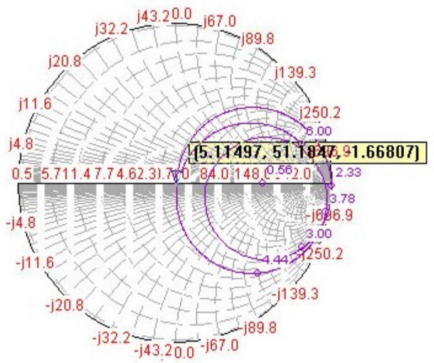

Fig 17: Impedance loci of using of smith chart

2nd Iteration

The location of the probe feed and SII parameter is shown in fig 18 .probe feed is location is placed as to connect to the metallic portion of the patch and where a max. Return loss is observed in fig 16 presents the results from IE3D simulations.

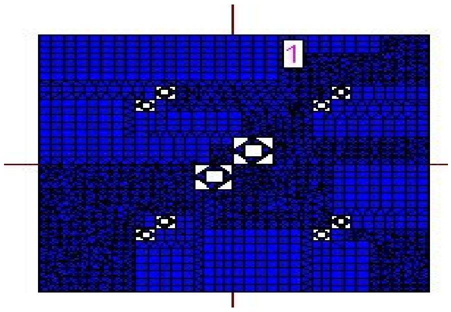

Fig 18: Design for second iteration

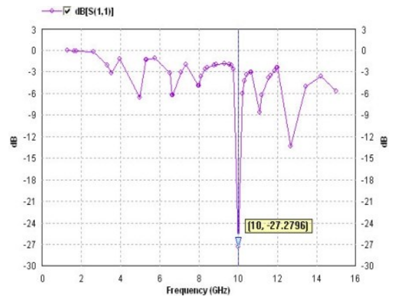

Fig 19: SII parameter

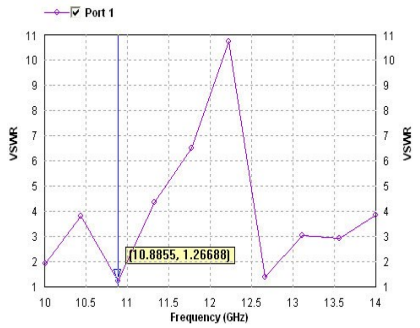

Fig 20: VSWR

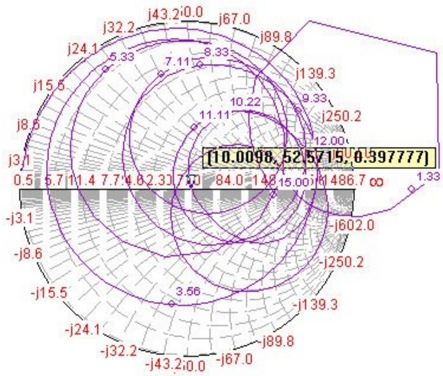

Fig 21: Impedance loci using smith chart

3rd Iteration

The location of the probe feed is shown in fig 19. The probe feed location is adjusted so as to connect to the metallic portion of the patch and where a maximum return loss is observed and fig 19 shows the results from IE3D simulations. Their feed points are (x, y) = (3,8.5).

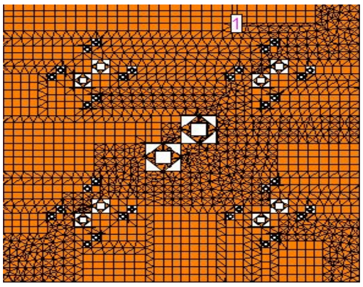

Fig 22: Design for Third iteration

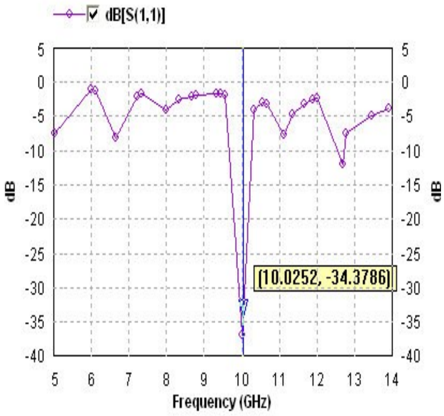

Fig 23: SII parameter

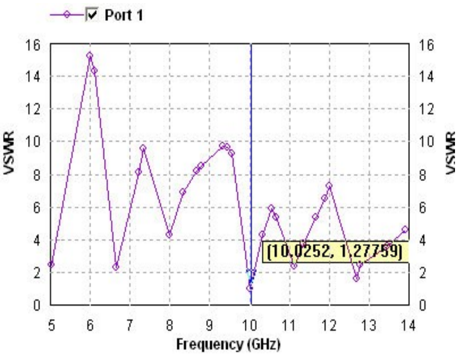

Fig 24: VSWR

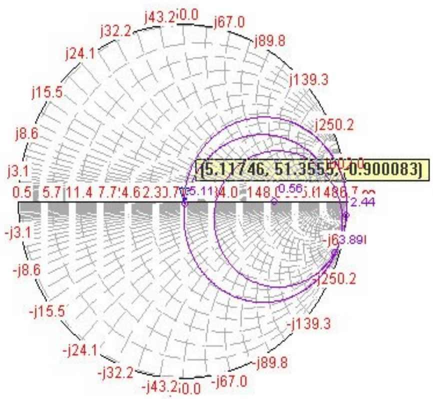

Fig 25: Impedance loci using smith chart

Table 1: Comparison of different results of Iteration 1, 2 and 3.

Micro strip line - feed

TYPES	1Iteration	2Iteration	3Iteration
Resonant frequency	5.11504	5.11041	5.11579
Bandwidth	40.5%	40.25%	45.45%
VSWR	1.0528	1.0698	1.0698
Return loss	-31.6853	-32.0893	-33.0421

Probe - feed

TYPES	1Iteration	2Iteration	3Iteration
Resonant frequency	10.8842	10.8842	10.8842
Bandwidth	15.5%	17.25%	20.45%
VSWR	1.0528	1.2688	1.2775
Return loss	-19.0216	-27.2796	-34.3786

IV. Conclusion

In Traditional wideband antennas and arrays can be analyzed with fractal geometry to shed new light on their on operating frequency principles Design is simulated and result of the designed antenna is obtained using two different feeding techniques [14].More to the point, a number of new configurations can be used as antenna elements with good multiband characteristics. due to the shape filling properties of fractals, antennas designed from certain fractal shapes can have far better electrical to physical size ratios than antennas designed from an understanding of shapes in Euclidean space .The measurement results show a maximum patch size reduction is achieved by the proposed fractal antennas, without debasing the antenna performances, such as the return loss .The essence of this size reduction technique is loading the inductive elements along the patch edges, and loading self- sown slots inside the patch , to increase the length of the current path .The main advantages of the propounded method are (i) size reduction (ii) maintained radiation patterns ,(iii) wider operating frequency (iv) simple and easy design Thence, This is the most effective technique propounded for the size reduction of micro strip patch antenna so far.

The design results indicate that the antenna is suitable for wireless LAN systems [14] and satellite communication for direct broadcast TV and other low frequency networkable PDA.

V. Result and Discussion

The proposed antenna is signed up to 3rd iteration. Simulations of proposed antenna has been Carried out in terms of return loss, VSWR, gain, and bandwidth. The return loss is the parameter, which indicates the amount of power radiated that is lost to the load and does not return as are reflection. In this antenna bandwidth is 45% for transmission feed and for probe feed bandwidth is 20% and VSWR is another important input parameter, which must be taken into consideration while analyzing the antenna input impedance matching is necessary in case of antenna. When an antenna and feed line do not have matching impedances, some of the electrical energy cannot be transferred from the feed line to the antenna. It is always desirable for VSWR to be always less than 2. In IE3D, from Zeland software Inc. is an electromagnetic simulation and optimization software useful for circuit and antenna design. The variation of return loss with frequency, VSWR and bandwidth for I iteration, II and III for transmission line feed and probe feed [3] is shown in Table 1.

In the result shows resonant frequency is 5.11041 GHZ for transmission line feed & for probe feed is 10.8842 GHZ. Return loss for the iteration I, II & III is -31.6853, -32.0893 & -33.0421 respectively for transmission line feed and for the probe feed I iteration ,II and III is -19.0216, -27.2796 & -34.3786 respectively.

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