

A Design of Crown Square Fractal Antenna Using Transmission Line Feed

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Abstract— The paper presents the designs of a crown square fractal antenna. The propounded antenna is designed on 1.6mm thick FR4 glass proxy substrate with dielectric constant ϵ_r of 4.4 and is fed by transmission line. The proposed antenna design helps in reducing the metal usage, save cost and provides good reflection coefficient and good VSWR. Performance of proposed antenna has been analyzed in terms of return loss, VSWR, input impedance, gain, and bandwidth in the 1 GHz to 7GHz frequency range. The proposed antenna provides an impedance bandwidth of 45 % around the resonant frequency of 0.5575 GHz and good return loss of -36.44.

Keywords— Feed, FR4, Micro strip patch antenna, Return loss, crown square shape, VSWR.

I. INTRODUCTION

In the electronics and communication system, variety of micro strip antennas are being utilized, the most general of which is microstrip patch antenna [12]. A patch antenna is a compact, narrow band, wide-beam, light-weight, conformal-shaped antenna which is fabricated by etching the antenna element pattern in metal trace conjoined to an insulating dielectric substrate [3]. It is incorporated with a flat rectangular sheet or “patch” of metal, mounted over a larger sheet of metal called the ground plane. A patch antenna is mainly built on a dielectric substrate employing the same materials & lithography techniques in order to make printed circuit boards. Microstrip or patch antennas [6] are becoming more and more useful because they can be printed directly onto a circuit board.

The word fractal is derived from the Latin word “fractals” meaning broken, uneven, any of various extremely irregular curves or shape that repeat themselves at any scale on which they are examined. Achieve wideband frequency band or multiband frequencies. Their efficiency is very less. It has different iterations (scale sizes).

In this paper, we have presented a design of microstrip Patch antenna using crown square shape fractal slot [13],

with rotated 45 angles and also with an aim to achieve a smaller size antenna [4]. In the present work, a combined crown and sierpinski fractal antenna has been designed to operate between 0-7GHz around the resonant frequency of 0.55 75GHz. Target of this work is to design a microstrip patch antenna and carrying out results using commercial simulation software like IE3D. IE3D, from Zealand software, Inc [17], is an electromagnetic simulation and optimization software useful for circuit and antenna design. IE3D has a menu driven graphic interfaces

II. ANTENNA PERFORMANCE MEASUREMENTS

To successfully design an antenna a number of measurements must be made to quantify the antenna performance. Below are the various antenna performance measurements.

A. Impedance and Antenna Bandwidth:

Antenna impedance is typically measured as return loss or VSWR [4]. The equipment used to measure this parameter is a Network Analyzer. The impedance measurement often requires special fixtures and assemblies to allow access to the antenna terminals.

B. Gain and Radiation Patterns:

Calibrated measurements of antenna gain and radiation patterns are made in an Anechoic Chamber. The anechoic environment eliminates all reflections and allows precise and repeatable measurements to be made. The device under test is typically rotated 360 degrees in multiple orientations to determine the shape of the radiation pattern from many different directions. Reference antennas are used as calibrated gain standards. As with impedance measurements, gain and radiation patterns should be measured using a complete product.

C. Efficiency Measurements:

As mentioned earlier, efficiency may be the single most important parameter to be measured, especially for an embedded antenna which can have degraded efficiency due to its tight integration with the device. Efficiency can be calculated from the calibrated gain and radiation pattern measurement but this can be a time-consuming effort.

III. DESIGN OF FRACTAL ANTENNA

The propounded antenna is designed on 1.6mm thick FR4 glass proxy substrate with dielectric constant ϵ_r of 4.4 and is fed by transmission line. The basic shape of proposed antenna consist of crown square patch of each sideLength 20mm has been taken on the ground planesubstrate of length = 20mm and width =20mm.

Table.1: Design values of proposed micro antenna.

ANTENNA PARAMETERS	DESIGN VALUE
Dielectric constant	4.4
Substrate height(mm)	1.6
Loss tangent	0.001
Length of patch(mm)	20
Width of patch (mm)	20
Length of substrate (mm)	20

There are three essential parameters for design of a rectangular microstrip Patch Antenna. The dielectric constant of the substrate material is an important design parameter. Firstly, the dielectric material of the substrate is selected for the design.

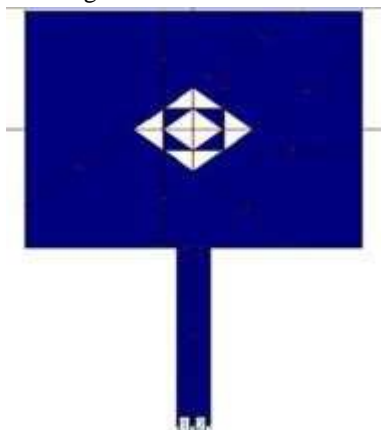


Fig.1(a): Model of 1st iteration,

The proposed antennas is designed using FR4 substrate with dielectric constant, $\epsilon_r = 4.4$, loss tangent equal to 0.001 and $h = 1.6\text{mm}$ which is the

height of the substrate. For feeding, transmission feeding method is used. For all iterations, the location of feed is same and the length of feed is 10mm. Same procedure is repeated and the result of simulation studies is presented up to third iteration. The frequency range is used from 2GHz to 7GHz.

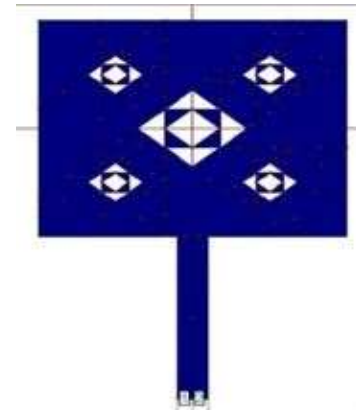


Fig.1.b) Model of 2nd iteration,

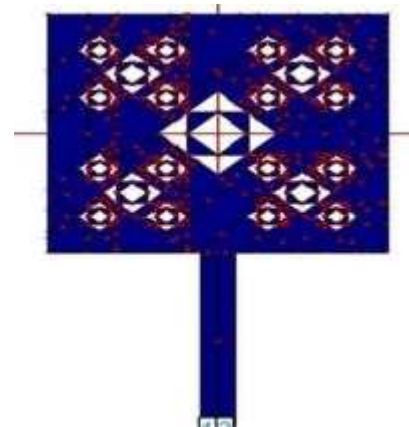


Fig.1.c) Model of 3rd iteration

Secondly, substrate thickness is another important design parameter. Thick substrate increases the fringing field at the patch periphery like low dielectric constant and thus increases the radiated power. The height of dielectric substrate employed in this design of antenna is $h = 1.6\text{mm}$. this design only. Lastly, the resonant frequency (f_r) of the antenna must be selected appropriately. The frequency range used is from 2GHz – 7GHz and the design of antenna must be operated within this frequency range. The resonant frequency selected for this design is 0.5575 GHz.

IV. FEED TECHNIQUE (MICROSTRIPLINE)

1) First iteration



Fig.2: The model for 1st iteration

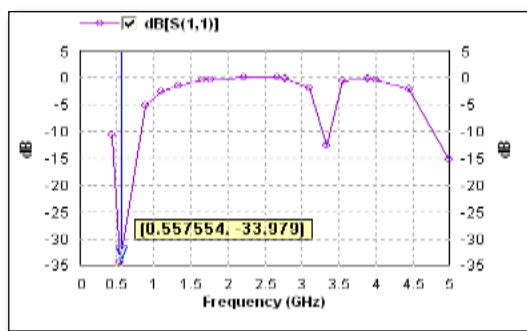


Fig.3: S11 Parameter

It is achieved by cutting crown square fractal slot is deploying crown geometry of each side length 4mm in the center of the square patch as shown in fig.2. Return loss of -33.97db and VSWR of 1.067

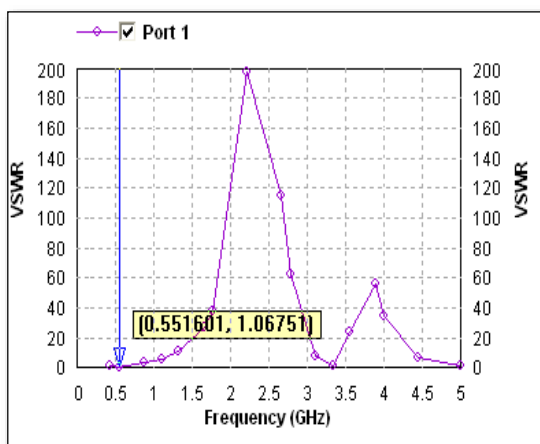


Fig.4: VSWR

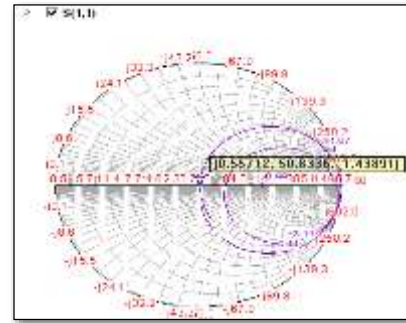


Fig. 5: Input impedance loci using smith chart

2) Second iteration

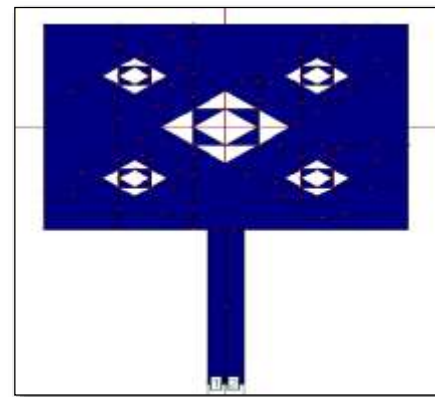


Fig.6: The model for 2nd iteration

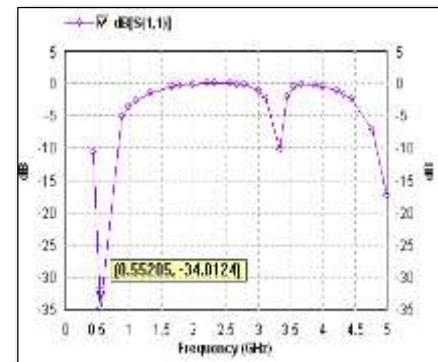


Fig.7: S11 parameter

Fig 6 shows the results of the second iteration of the proposed fractal antenna. In the centre one crown square fractal slot deploying crown square geometry each of side length 4mm is taken and similar four slots each of side length 2mm are taken on each corner of the central slot. A VSWR of 1.04 and return loss of -34.01 are available at the resonant frequency.

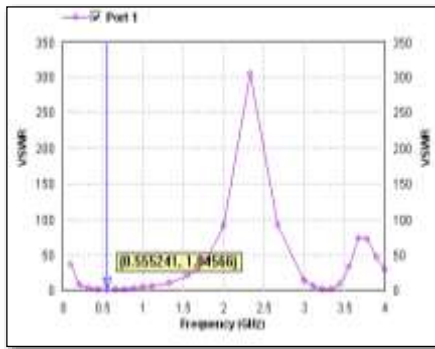


Fig.8: VSWR

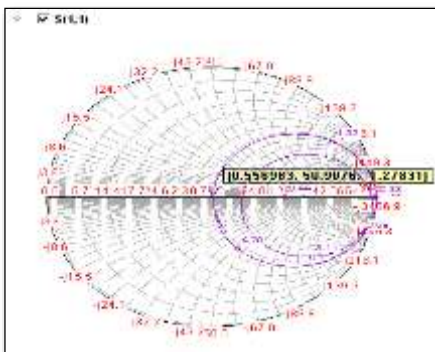


Fig.9: Input impedance loci using smith chart

3) Third iteration

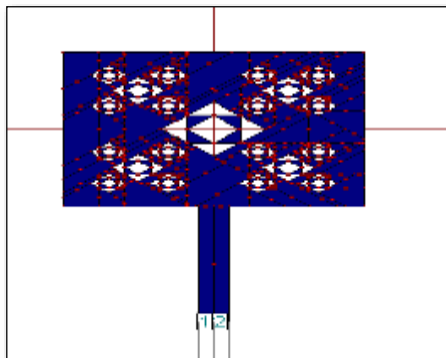


Fig.10: The model for 3rd iteration

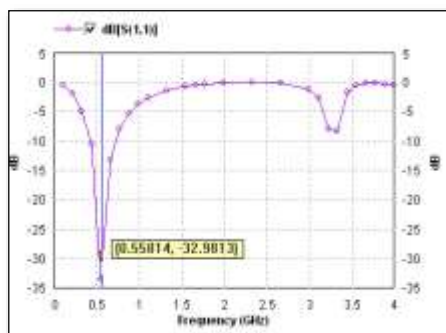


Fig.11: S11 parameter

In this one central crown square fractal slot deploying crown geometry is cut and twenty similar structured fractal slot are taken on each corner of the central slot with reduction in their sizes. These fractal slots have dimension of each side equals $L_1=4\text{mm}$, $L_2=2\text{mm}$, $L_3=1\text{mm}$. shown in fig: 10

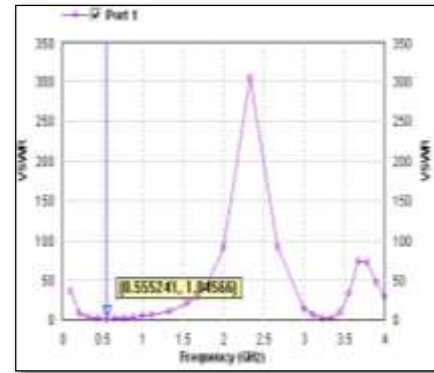


Fig.12: VSWR

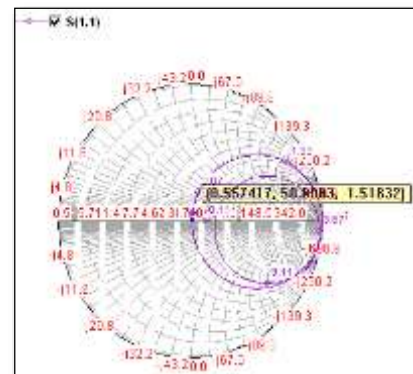


Fig.13: Input impedance loci using smith chart

The below table shows result in each iteration improves with respect to Bandwidth, VSWR

Table.2: Result comparison of Iteration 1, 2 & 3

Parameters	Iteration 1	Iteration 2	Iteration 3
Resonant Frequency	0.5576	0.5576	0.5576
Bandwidth	40.00%	45.20%	45.25%
VSWR	1.067	1.045	1.045
Return Loss	-33.979	-34.012	-32.981

V. CONCLUSION

The antenna is simulated by using IE3D by Zealand Software. The results demonstrated a maximum patch size reduction by the proposed any type fractal antennas, without degrading antenna's performance, such as the return loss

and radiation pattern, VSWR. The basis of the maintenance of the antenna radiation patterns is the self-similarity and Centro-symmetry properties of the fractal shapes [9]. The main advantages of the discussed method are: (i) miniaturization (ii) maintained radiation patterns (iii) wider and better operating frequency bandwidth, (iv) simple and easy to design. This paper presented a modified crown square shape antenna on a FR4 substrate of relative permittivity of 4.4 & thickness 1.6 mm.

Table 1 shows the variation of return loss with frequency, VSWR and Bandwidth for iteration I, II and III for transmission line feed this geometry shows high self-similarity and symmetry [14].

REFERENCES

- [1] James, J.R. and Hall, P.S.: 'Handbook of Microstrip Antennas'(Peter Peregrinus)
- [2] Constantine A. Balanis: 'Antenna Theory, Analysis and Design'(John Wiley & Sons)
- [3] Bhomia Y., Chaturvedi A., YadavD., "Truncated Tip Triangular Microstrip Patch Antenna", Proc. IEEE. IntSymp. Antenna Propag. vol. 2, pp. 212 -214, 2010.
- [4] Kai-Fong Lee, Kwai- Man Luk, Jashwant S. Dahele, 'Characteristics of the Equilateral Triangular Patch Antenna' IEEE Tran. Antennas Propag.1988; 36;1510.
- [5] C. L. Mak, K. M. Luk, K. F. Lee, 'Wideband Triangular Patch Antenna' IEE. Proc. Microwave Antennas Propag. 1999
- [6] I. J. Bahl and P. Bhartia, 'Microstrip Antennas, Artech House, Dedham, MA, 1980.
- [7] Jaswinder Kaur, Rajesh Khanna, M. V. Kartikeyan, "Optimization and Development of O-shaped Triple-band Microstrip Patch Antenna for Wireless Communication Applications", IETE Journal of Research, Vol. 60, Iss. 2, 2014
- [8] VahidSharbati, PejmanRezaei, Mohammad M. Fakharian&EhsanBeiranvand, "A Switchable Band-Notched UWB Antenna for Cognitive Radio Applications", IETE Journal of Research, Vol.61, Issue 4, 2015.
- [9] M. F. Barnsley, R. L. Devaney, B. B. Mandelbrot, H. O. Peitgen, D.Saupe, R. F. Voss, Y. Fisher, and M. McGuire, The Science of Fractal Images. New York: Springer-Verlag, 1988.
- [10] Yogesh Bhomia et.al., "V-Slotted Triangular Microstrip Patch Antenna", Int. Journal of Electronics Engineering, vol. 2,no.1, pp. 21-23,2010
- [11] K. J. Vinoy, J. K. Abraham, and V. K. Varadan, "On the Relationship Between Fractal Dimension and the Performance of Multi-Resonant Dipole Antennas using Koch Curves," IEEE Transactions on Antennas and Propagation, AP-5 1, 9,2003,pp.2296-2303.
- [12] Bhomia, Y., A. Kajla, and D. Yadav, "Slotted right angle triangular microstrip patch antenna," International Journal of Electronic Engineering Research, Vol. 2, No. 3, 393-398, 2010.
- [13] Bhomia Y.,Chaturvedi A., Yadav D., "Microstrip Patch Antenna Combining Crown and Sierpinski Fractal-Shapes ", Proc. IEEE. IntSymp. Antenna Propag.,vol. 2, pp. 212 -214, 2010
- [14] Ankur Aggarwal, M.V.Kartikeyan,"Design of Sierpinski Carpet Antenna using two different feeding mechanism for WLAN applications", IEEE,2010.
- [15] Yogesh Bhomia, AshviniChaturvedi, Yogesh Kumar Sharma," Microstrip Patch Antenna combining crown & Sierpinski Fractal Shapes, ACM, ICACCI'12.
- [16] H. O. Peitgen, H. jurgens, and D. Saupe, Chaos and Fractals. NewYork: Springer-Verlag, 1990.
- [17] IE3D by Zeland software Inc.
- [18] Mahdi NaghshvarianJahromi, AbolfazlFalahti and Rob.M.Edward, "Bandwidth and Impedance-Matching Enhancement of Fractal Monopole Antenna Using Compact Grounded Coplanar Waveguide", IEEE Transaction on Antenna and Propagation, Vol.59, No.7, July 2011.
- [19] Sarita Bajaj, Ajaykaushik,"Analysis of Patch Antenna Based on the Sierpinski Fractal", International Journal of Engineering Research and Applications, Vol.2, Sep-Oct 2012, pp.023-026.
- [20] Neetu ,Savina Bansal, R.K.Bansal,"Design and Analysis of Fractal Antennas Based on Koch and Sierpinski Geometries,"International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering ,Vol.2,June2013.