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A Design of Square Fractal Antenna With Microstrip Feed For Ultra Wideband Applications

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Abstract: *The paper presents the design of a square fractal antenna. The proposed antenna is designed on FR-4 glass epoxy substrate with dielectric constant Er of 4.4 and is fed by microstrip line.The proposed antenna provide contribution in the field of ultra wide band application.This proposed design operates over the frequency range 1GHz to 12GHz.For the proposed design return loss -9dB has achieved at frequency range of 11.5GHz.Also,VSWR<1 for entire operating frequency range.The proposed design exhibits gain upto3.6dB over frequency range.The simulation of the proposed antenna design has done by Advanced Design System(ADS).*
Keywords: *FR4, Microstrip Feed, Return loss, square shape, Gain, 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 [1]. 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 [2].It is incorporated with a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called the ground plane[3].A patch antenna is mainly built on a dielectric substrate employing the same materials & lithography techniques in order to make printed circuit boards[4]. Microstrip or patch antennas are becoming more and more useful because they can be printed directly onto a circuit board[5].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[6].Achieve wideband frequency band or multiband frequencies. Their efficiency is very less. It has different iterations (scale sizes)[7].In this paper, we have presented a design of microstrip Patch antenna using square shape fractal slot [13],with rotated 45 angles and also with T.Sathya, S.Sharlin Sheebha, C.S.Subashini,S.Swathy B.E Students,Department of ECE an aim to achieve a smaller size antenna [8]. In the present work, a combined square fractal antenna has been designed to operate between 1-12GHz around the resonant frequency of 0.5575GHz[9]. Target of this work is to design a microstrip patch antenna and carrying out results using commercial simulation software like Advanced Design Simulation which is an electromagnetic simulation and optimization software useful for circuit and antenna design.

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. 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 Er of 4.4 and is fed by microstrip line. The basic shape of proposed antenna consist of 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

range.The resonant frequency selected for this design is 0.5575 GHz.

IV. Feed Technique (Microstrip Line)

1) First iteration

It is achieved by cutting square fractal slot is deploying square geometry of each side length 4mm in the center of the square patch as shown in fig.1. Return loss of -33.97db and VSWR of 1.067

Fig.1) Model of 1st iteration

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. The proposed antennas is designed using FR4 substrate with dielectric constant, Er =4.4, loss tangent equal to 0.001and h= 1.6mm 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. 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= 1.6mm.this design only. Lastly, the resonant frequency (fr) of the antenna must be selected appropriately. The frequency range used is from 1GHz – 12GHz and the design of antenna must be operated within this frequency

2) Second iteration

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.2)Model of 2^{nd} iteration

3) Third iteration

central square fractal slot deploying crown geometry is cut and twenty similar structured fractal taken on each corner of the central slot with reduction in their sizes These fractal slots have dimension of each side equalsL1=4mm, L2=2mm, L3=1mm. shown in fig.3

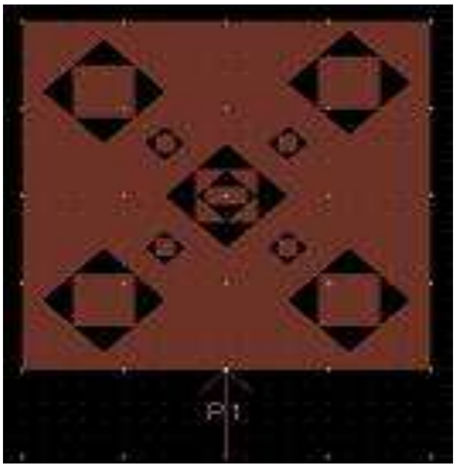

Fig.4)Radiation patterns of proposed design

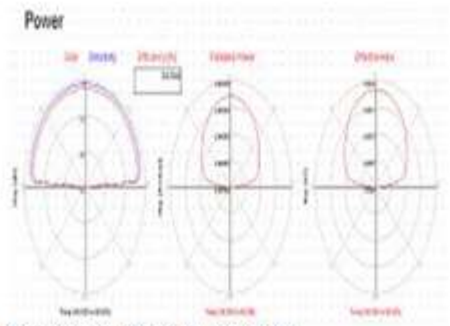

Fig.4)Radiation patterns of proposed design

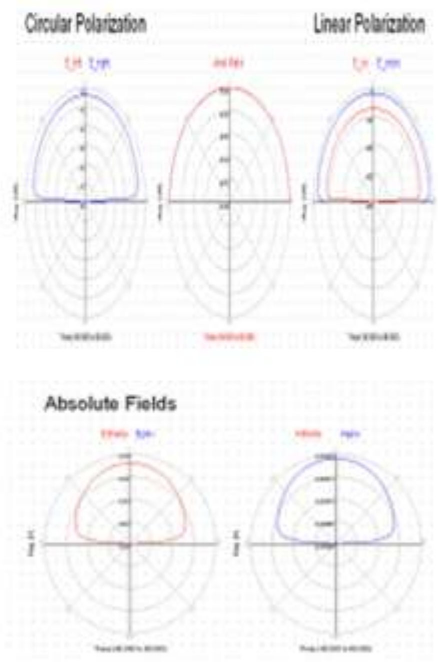

Fig.3) Model of 2nd iteration

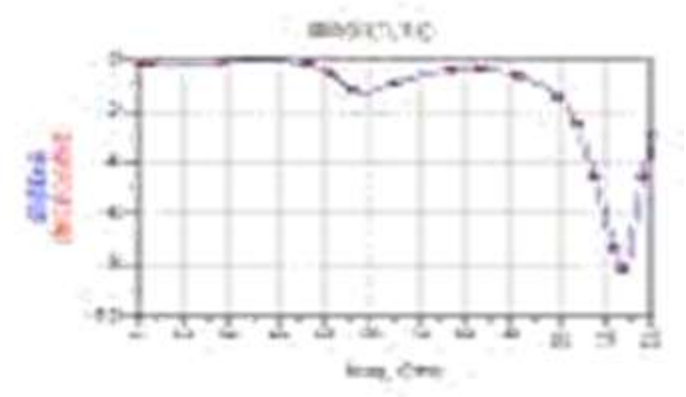

Fig.5) Resonant frequency over the frequency range

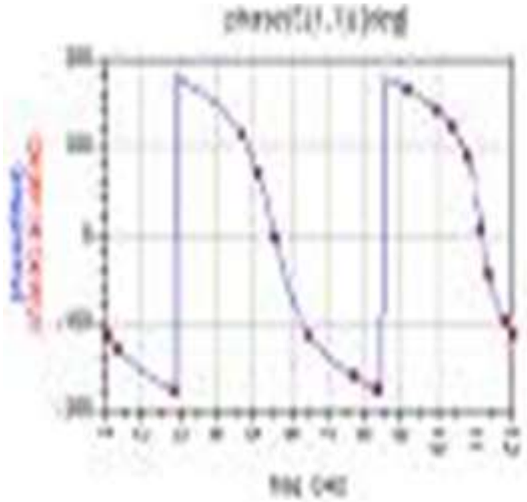

Fig.6) Phase the frequency range The below table shows result in each iteration improves with respect to Bandwidth, VSWR

Table.2: Result comparison of Iteration of 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 ADS 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.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.

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