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# Design and Analysis of Hexagonal Fractal Antenna for UWB Application

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## Abstract

A fractal antenna having the shape of hexagonal for UWB application is designed. The frequency band is considered from 3 to 10.6 GHz. This antenna is designed on a dielectric FR4 epoxy substrate of dimension (50mm X 40mm) permittivity €r =4.4 and height = 1.6mm and it is fed by a 50 ohm microstrip line. With this structure the return loss less than -10dB, VSWR, radiation pattern get improved. The proposed antenna is simulated by using the HFSS software. The simulated results are in good agreement with experimental results.

**Keywords:** fractal antenna, hexagonal antenna, return loss, HFSS software.

## I.INTRODUCTION

In modern telecommunication systems require antennas with smaller dimension and wider bandwidth than conventional ones. The microstrip antenna consist of a very thin metallic patch placed a small fraction of a wavelength above a ground plane. The strip and ground plane are separated by a dielectric substrate. The patch shapes such as the square, rectangular, circular, triangular, semicircular, annular ring, elliptical shapes are used [1-2].

Microstrip antenna can be fed by two method –contacting and Non-contacting. In contacting method the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In Non- contacting method electromagnetic field coupling is done to transfer power between the microstrip line and radiating patch [3].

The requirement of antennas are high gain, wide bandwidth, low cost, high performance and multiband support. In MSA has many advantages as well as some drawbacks like narrow bandwidth , low gain, low efficiency or low directivity. There are many techniques to reduce the size and increase the bandwidth without effecting the antenna performance. One of these techniques is fractal [4].

Fractal antennas are multiband antenna and these antennas are alternative to traditional antenna system. The fractal antenna operate dual and triple band of frequency and it increase in bandwidth and gain as well as reduced the size of antenna.

A fractal is a recursively generated structure having two properties: self-similarity or space-filling. The self-similarity property help for the design of multiband frequency. The space-filling property can be utilized to miniaturize antennas. The benefits of the fractal antenna is reduced the size, compactness and capable of operating at many different frequency [5].

In this paper, a hexagonal shaped fractal antenna is designed. The hexagonal fractal is constructed by reducing a hexagon generator shape to one third its former sizes and grouping six smaller hexagons together. Without changing the dimensions of the hexagonal shape patch bandwidth of antenna get improved.

## II. ANTENNA DESIGN

The proposed antenna consists of a hexagon-shape. A hexagonal shape is selected because of the compact geometry having area coverage more than other shapes like triangle or circle. A hexagonal shape patch element is printed on a dielectric layer over a ground plane.

To design a hexagonal fractal antenna a dielectric substrate FR4 epoxy is used having 1.6mm of height, dimensions (50mm X 40mm) and a relative permittivity of 4.4 and it is fed by a 50 Ω microstrip line. The microstrip line feed technique is used to design hexagonal fractal antenna. It is a just conducting strip connecting to the patch .this technique is used because it is simple and easy to match by controlling the inset position. The antenna design was divided into three

stages. The first stage is a hexagonal patch. From the first iteration comes to second iteration and from second iteration to third iteration. The proposed hexagonal fractal antenna shown in fig 1.

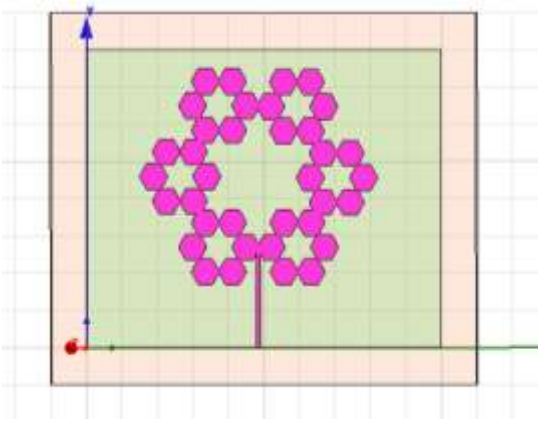

Fig 1: Hexagonal fractal antenna

## III. SOFTWARE USED

**High Frequency Structure Simulator (HFSS)**

HFSS introduced from 90s and it is transfer to Ansoft HFSS after Nov.1, 2001. HFSS is a high-performance full-wave electromagnetic field simulator for 3D volumetric passive device modeling. It computes s-parameters, resonant frequency and full wave fields far arbitrarily-shaped 3D passive structure and powerful drawing capabilities to simplify design entry. It consume tremendous memory if fine result is needed. It is one of several commercial tool used for model half, quarter, octet symmetry or create parameterized cross section 2D model. HFSS is an interactive simulation system whose basic mesh element is a tetrahedron. This will help us to solve any arbitrary 3D geometry, especially those with complex curves and shapes. Now a days, HFSS continues to lead the industry with innovations such as Modes-to-Nodes and Full-Wave Spice. The flow chart of Ansoft HFSS illustrates in fig. 2.

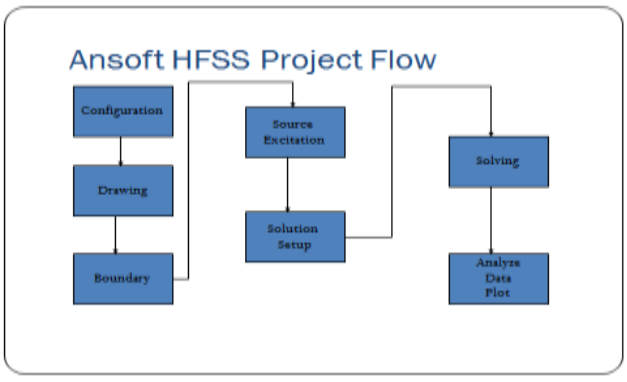


Fig 2: Ansoft HFSS Project Flow

## IV. SIMULATION AND RESULT

The antenna performance has been demonstrated via a Finite Element Program, HFSS. The simulations around the performance of return loss S11 in dB, VSWR ratios and radiation pattern are carried out for the hexagonal fractal antenna.

S11 is a measure of how much power is reflected back at the antenna port due to mismatch from the transmission line. A small S11 indicates a significant amount of energy has been delivered to the antenna. S11 also simply referred to as return loss. When the antenna and transmission line are not perfectly matched, reflection at the antenna port travel back towards the source and cause a standing wave form Values of S11≤ -10 dB, (VSWR <2) are considered..The simulated result for the return loss is shown in fig. 3.

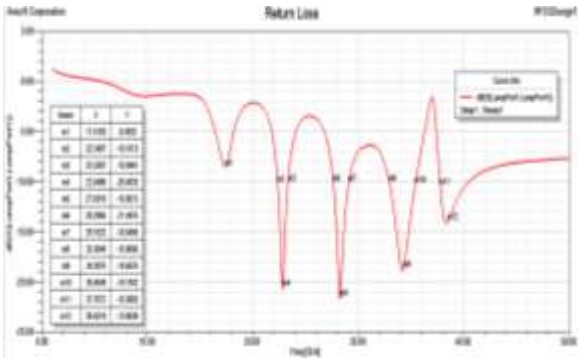


Fig 3: Simulated return loss

This fig. show that the antenna has good VSWR performance (VSWR <2) which is required for UWB antenna. The simulated and measured VSWR values for the antenna is shown in fig. 4.

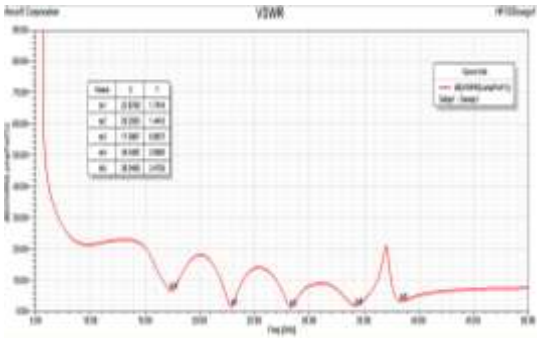


Fig 4: Simulated VSWR

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Radiation pattern determines how an antenna radiates. If the antenna is said to be Omni directional antenna then it should radiates in all directions. The patterns are usually presented in polar or rectilinear form with a dB strength scale. The radiation pattern for φ=0, φ=90, φ=180, φ=270 and φ=360 degree are shown in fig 5.

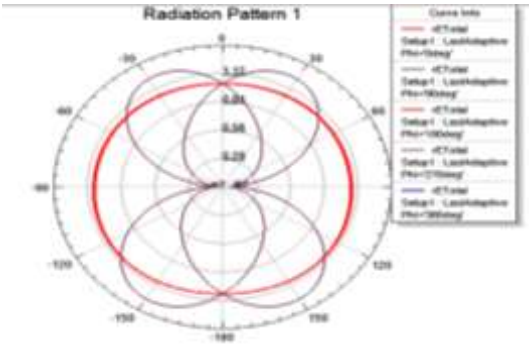


Fig 5: Radiation Pattern

The current distribution of the hexagonal fractal antenna is removing some portion of metallization from hexagonal disc increases the effective path of the surface current. The effective length of current path is increased by removing triangular patterns inside and outer edge of hexagonal disc. The current distribution of hexagonal fractal antenna is shown in fig. 6.

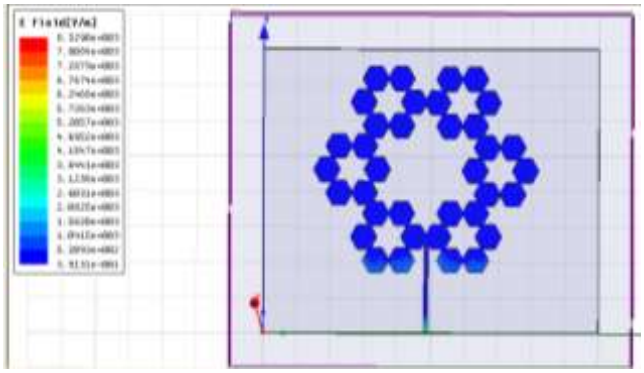

Fig 6: Current Distribution of the Hexagonal Fractal Antenna

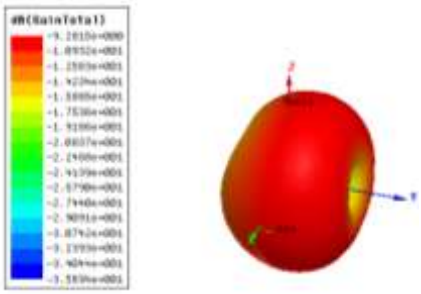

Fig 7: Polar Plot

## V. CONCLUSION

A hexagonal fractal antenna was designed, optimized and measured for UWB applications. The simulated results have shown a good return loss, VSWR and radiation structure. The higher return loss is -21.57dB and the VSWR is 1.44 (VSWR<2). The all result of simulation has been obtained by HFSS. In this paper the first three iteration of hexagonal fractal antenna has been designed. The number of iterations can increased to different patterns with different characteristics which require further experimental investigation.

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