Bandwidth Enhancement of a Simple Hexagonal Antenna by Using Fractal Geometry

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Abstract: Microstrip patch antennas are attractive and popular antenna due to their advantages such as light weight, conformability and low costs. But it has some drawback like narrow bandwidth, low gain, more bulky. Fractal geometry is one of technique used for bandwidth enhancement. A novel single band simple hexagon shape fractal antenna is proposed. Koch & Sierpinski fractal geometry algorithm is applied on simple hexagonal antenna. With help of these two techniques bandwidth of this antenna get enhanced from 26.70MHZ to 60MHZ.

Keywords: *MSA, Fractal Antenna, Koch, Sierpinski.*

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I. INTRODUCTION

The explosive growth in the wireless industry has renewed interest in compact and multi-band antennas. Microstrip antenna fulfillment all these requirements. But it has some limitations like low bandwidth, low gain. Different types of techniques used to overcome these drawbacks e.g. by placing slots on the patch, using defected ground structure (DGS), by applying fractal geometry algorithm on patch. Fractal antenna is an emerging field that employs fractal concepts for developing new types of antennas with notable characteristics such as multiband, miniature, and high-directive elements [1]. Using fractal in an antenna maximizes the length, or increase the perimeter (on any side of structure), of material that can receive or transmit electromagnetic radiation within a given total surface area or volume. Fractal is a concept which is being implemented in microstrip antenna to have better characteristics than microstrip antenna. Due to their method of generation, some fractals possess unique feature such as self-similarity, which allows for wideband or multiband antenna designs [2]. Also, the space filling property, when applied to a patch antenna, leads to reduce the total area occupied by the antenna. The geometry of fractals is important because the effective length of the fractal antennas can be increased while keeping the total area same.

In this paper, a novel bandwidth enhancement technique for a hexagonal shape patch antenna based on fractal shapes. Without changing dimensions of patch bandwidth of antenna get improved [3]. Applying Koch fractal and Sierpinski fractal algorithm on hexagonal Patch bandwidth of antenna gets increases from 26.70 MHZ to 60 MHZ [4].

II. DESIGN PROCEDURE

The proposed antenna can be considered as hexagon-shape. Hexagonal shape is selected because, hexagon forms the most compact geometry having area coverage more than other basic shapes like circle and triangle. By taking simple hexagonal patch it will show good behavior. The hexagon- shape patch is printed on the one of side of the dielectric substrate and other side a ground plane is printed below the patch. The hexagonal fractal is constructed by reducing a hexagon generator shape to one third its former sizes, and grouping six smaller hexagons together. The triangles within the hexagonal fractal antenna are interconnected to maintain conductivity and to preserve electrical self-similarity [2-3].
Working of hexagonal fractal antenna is based on self-similarity and space filling properties of fractal antenna. Due to self-similarity property of fractal antenna get multiple band of frequencies .space filling property help to reduce size of antenna. In this paper Koch fractal & Sierpinski fractal algorithm is applied on simple hexagonal patch antenna.

To design a Hexagonal Fractal antenna,
Parameters is been used.
• Dielectric constant, €r = 4.4
• Substrate height, h = 1.6 mm
Circular equation is used to calculate the actual radius, a of circular patch antenna to match at
1.6 GHz.

$$a = F / \{[1 + (2h / \pi \epsilon_r F][\ln (\pi F / 2h) + 1.7726]\}^{1/2}$$

International Journal on Recent and Innovation Trends in Computing and Communication
Volume: 3 Issue: 3
SSN: 2321-8169
1274– 1277

Where,

$$F = \frac{8.791 \times 10^9}{fr\sqrt{\varepsilon r}}$$

$$a = \frac{F}{\{1 + 2h/\pi\varepsilon rF\, [\ln(\pi F/2h) + 1.7726]\}^{1/2}}$$

= 2.504cm @ 25mm

Substatate Caculations-
λ=c/f=187mm
Where c –velocity of light=3x10^8m/s2
Ground plane should be λ/2 i.e. 90mm

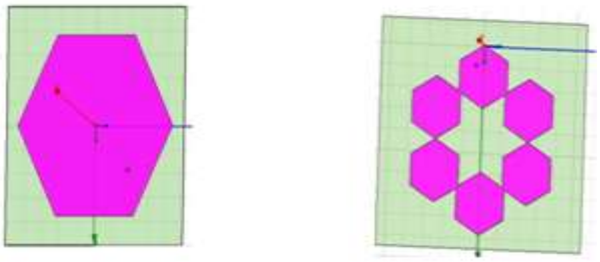

Figure 1: Hexagonal patch & Hexagonal fractal antenna.

III. SIMULATION RESULTS

The simulations around the performance parameters namely Return Loss S11 in dB , VSWR ratios and Radiation Pattern are carried out for the hexagonal Microstrip antenna as well the hexagonal fractal antenna. This simulation result in the normal range validates these designs.

Hexagonal Microstrip Antenna Results

Return Loss:

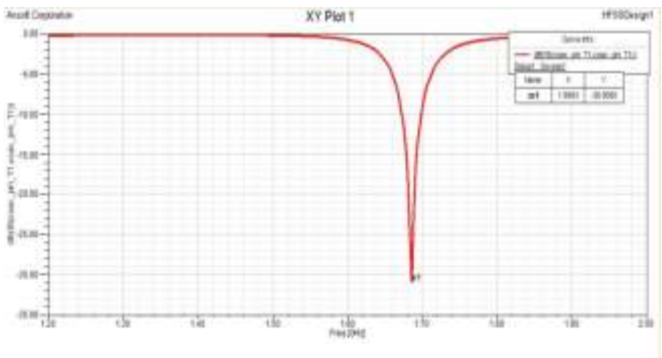

Figure 3: Measured Simulated Return Loss = - 30.90(dB)

VSWR& Bandwidth:

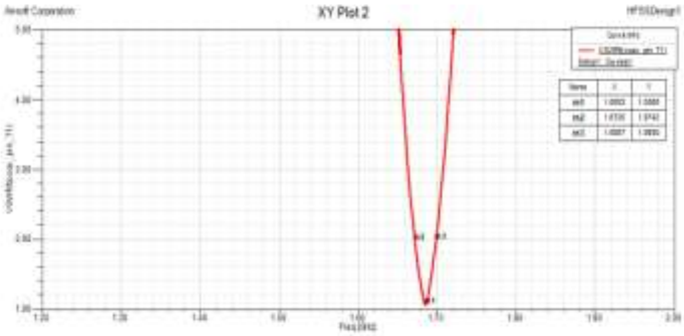

Figure 4: Measured Simulated VSWR = 1.06 & Bandwidth is 26.7 MHZ

Directivity:

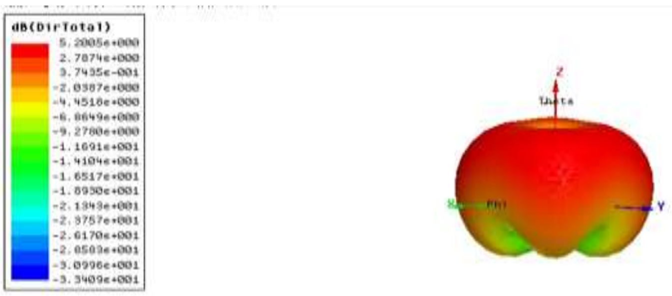

Figure 5: Measured Simulated Gain = 5.2 dB

Radiation Pattern:

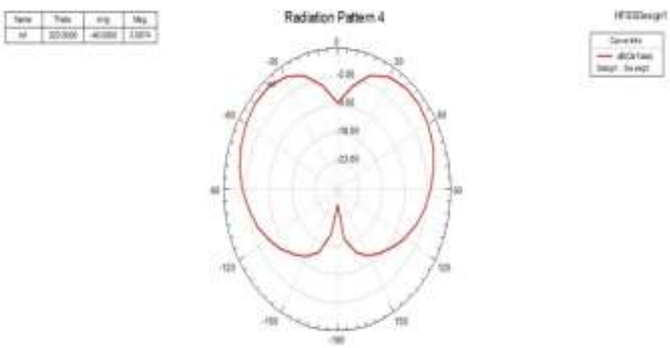

Fig 6 . Measured Simulated Gain = 3.8757 dB

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Hexagonal Fractal Antenna

Return Loss:

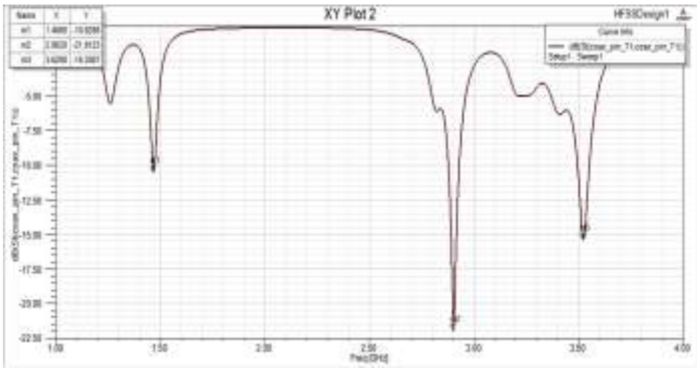

Fig 7. Simulated Return Loss

VSWR& Bandwidth:

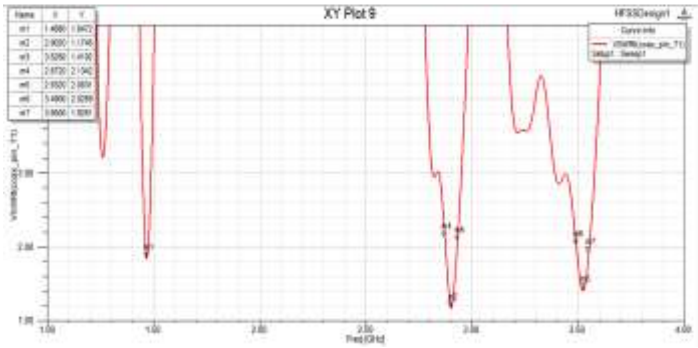

Fig 8 . Measured Simulated VSWR & Bandwidth is 60MHZ

Directivity:

Fig 9. Gain of Hexagonal Fractal Antenna is 7.481 dB

Radiation Pattern:

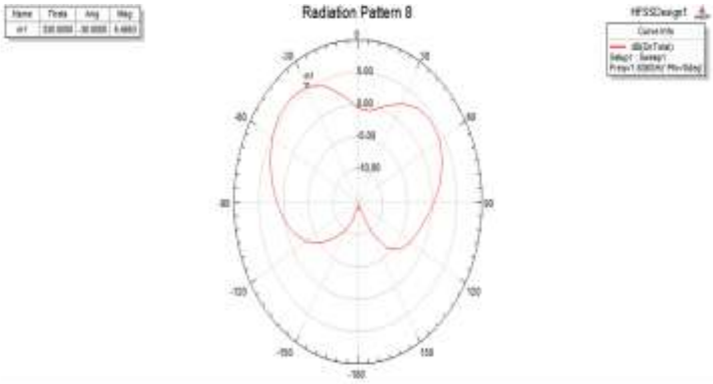

Figure10. Measured Simulated Gain = 5.4653Db

Current Distribution:

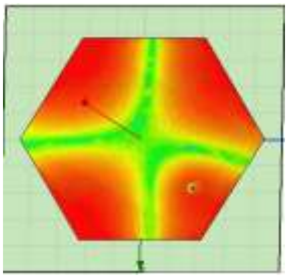

Figure .11

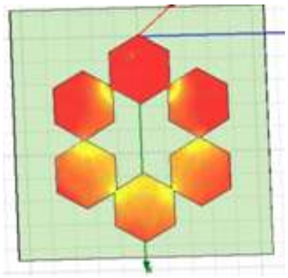

Figure .12

Figure .11-12 Current distribution of the Hexagonal Patch Antenna & Hexagonal Fractal Antenna

Fig .11 show Current distribution of the Hexagonal Patch Antenna is mainly along the circumference of the hexagonal disc. The current density is low in the middle area of the hexagonal disc antenna. Therefore, the current will not be affected if the middle area metallization of the hexagonal disc antenna is removed by triangle or other geometrical pattern. Fig .12 show Current distribution of Hexagonal Fractal Antenna is Removing some portion of metallization from hexagonal disc increases the effective path of the surface current. In this antenna, the effective length of current path is increased by removing triangular patterns inside & outer edges of hexagonal disc.

IV. RESULT

Sr. no	Geometry	Freq (GHz)	Return Loss (dB)	Bandwidth (MHZ)	Directivity (dB)
1.	Simple hexagonal patch	1.68	-30.90	26.70	5.20
2.	Hexagonal fractal	1.46	-10.52	60	7.481
		2.90	-21.91		
		3.52	-15.33		

TABLE: Iteration wise Simulated Results

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V. CONCLUSION

A simple Hexagonal patch antenna and hexagon shape fractal antenna has been designed and simulated by Using HFSS. Simulated result shows that performance of hexagonal fractal antenna is better than simple hexagonal patch antenna. This hexagonal fractal antenna is resonating at 1.46GHZ, 2.90GHZ & 3.52GHZ band of frequencies. Bandwidth of Hexagonal patch antenna gets enhanced from 26.70MHZ to 60MHZ. Also gain of hexagonal fractal antenna gets improved from 5.2 dB to 7.481 dB. The designed antenna is suitable for GPS and Wireless application. As compared to rectangular patch antenna hexagonal shape patch antenna give better result.

VI. REFERENCES

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