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ULTRA WIDEBAND FRACTAL MICROSTRIP ANTENNA DESIGN

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Abstract—New fractal geometry for microstrip antennas is presented in this paper. This fractal structure is implemented on hexagonal and several iteration is applied on initial shape. This antenna has low profile, lightweight and is easy to be fabricated and has successfully demonstrated multiband and broadband characteristics. The simulated results show that proposed antenna has very good performance in impedance bandwidth and radiation pattern.

1. INTRODUCTION

Modern telecommunication system require antennas with wider bandwidth and smaller dimensions than conventionally possible.This has initiated antenna research in various directions,one of which is by using fractal shaped antenna elements [1]. There are an important relation between antenna dimensions and wavelength. This relation states if antenna size is less than $\lambda/4$ (λ is wave length) then antenna is not efficient because radiation resistance, gain and bandwidth is reduced and therefore antenna size is increased [2]. Fractal geometry is a very good solution for this problem. These structures are recognized by their self similarity properties and fractional dimension. In the recent years, the geometrical properties of self-similar and space filling nature has motivated antenna design engineers to adopt this geometry a viable alternative to meet the target of multiband operation. Fractional dimensions, self-similar and scaling properties, characterize these structures. The structures that are studied as antenna are not the ones that we obtained after infinite iteration but those after finite iterations as desired by the designer. The space filling property lead to curves that are electrically very long but fit into a compact physical space. This property can lead to the miniaturization of antennas [3, 4].

In different papers, microstrip fractal antenna has been studied in more cases, Sierpinski patch structure has been used that different researches have been done on size, dielectric layers and feed [5–7].

In this paper a new hexagonal fractal is presented. This new fractal antenna has very high bandwidth and good properties.

2. ANTENNA CHARACTERISTICS

Figure 1 shows the base shape of hexagonal fractal and its first and second iterations. In this paper only the first and the second iterations are considered since higher order iteration do not make significant affect on antenna properties.

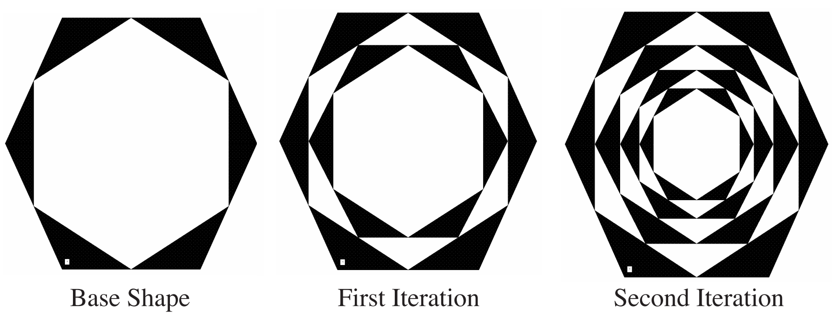

Figure 1. Hexagonal fractal.

For this new fractal antenna, the length of each side at hexagonal is 3 cm and a substrate with $\varepsilon_r = 2.3$ and $h = 2$ mm thickness. Microstrip line with $W = 1$ mm wide and copper material placed on the substrate. Dimensions of ground plate are 7×7 cm.

Location of the coax feed placed on the patches which is 1 mm from the each side at the corner.

Figure 2 shows the structure of antenna on the dielectric layer.

3. SIMULATION RESULTS

The MOM (method of moment) is used to analyze this antenna with MWO (microwave office) software.

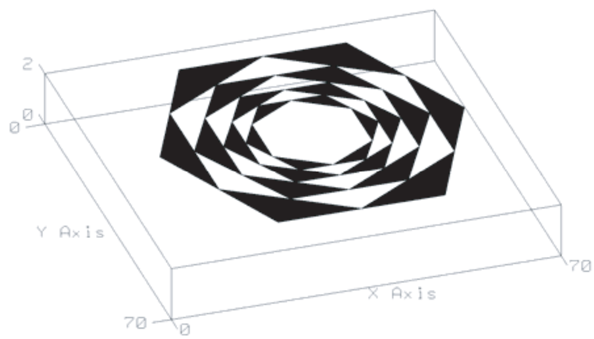

Figure 2. Antenna structure.

Figure 3 and Figure 4 depict the S_{11} (return loss) and VSWR (voltage standing wave ratio):

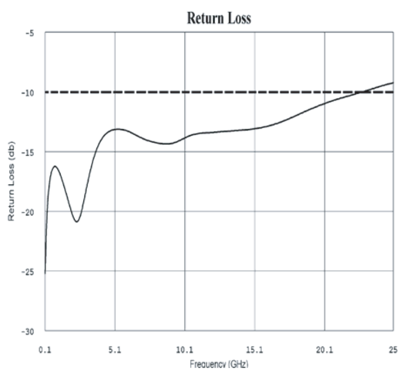

Figure 3. S_{11} (return loss).

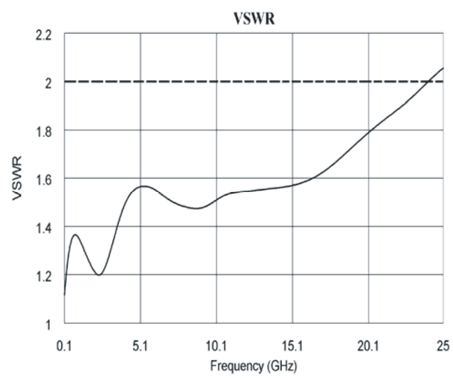

Figure 4. VSWR (voltage standing wave ratio).

The above figures show that, this antenna is broadband and applied in all frequencies (0.1 GHz–24 GHz) since in these frequencies the $S_{11} < -10\,\text{dB}$ and VSWR < 2.

Figure 5 and Figure 6 depict the real and the imaginary parts of input impedance of this antenna.

For studied radiation pattern, Figure 7 and Figure 8 depict the PPC (principal plane cut) in $\phi = 0°$, $\phi = 90°$ for multiple frequency at all of bandwidth: $(1 : 1 : 24)$ GHz.

Figure 9 and Figure 10 depict the PPC_RHCP (principal plane cut _ right hand circular polarization) and PPC_LHCP (principal plane cut _ left hand circular polarization) in $\phi = 0°$. RHCP and LHCP are

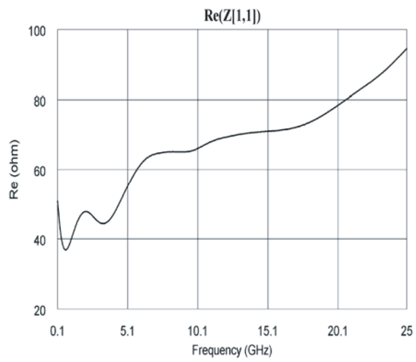

Figure 5. Real part of input impedance.

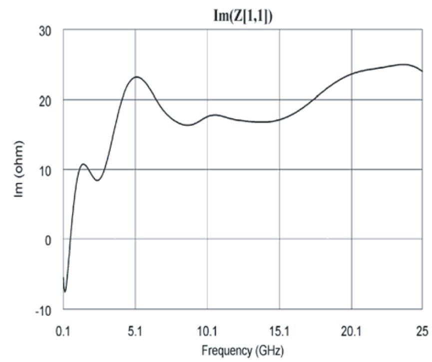

Figure 6. Imaginary part of input impedance.

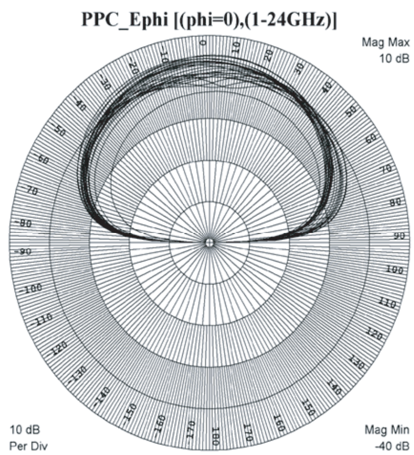

Figure 7. Radiation pattern (PPC) in $\phi = 0°$.

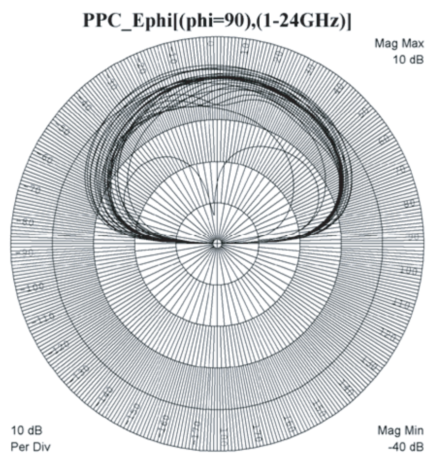

Figure 8. Radiation pattern (PPC) in $\phi = 90°$.

obtained from following formula:

$$\text{RHCP} = \frac{E_\theta + jE_\phi}{\sqrt{2}}$$

$$\text{LHCP} = \frac{E_\theta - jE_\phi}{\sqrt{2}}$$

Figure 11 depict PPC_TPWR (PPC_total power) in $\phi = 0°$. PPC_TPWR is available total power from E_ϕ, E_θ regardless of polarization.

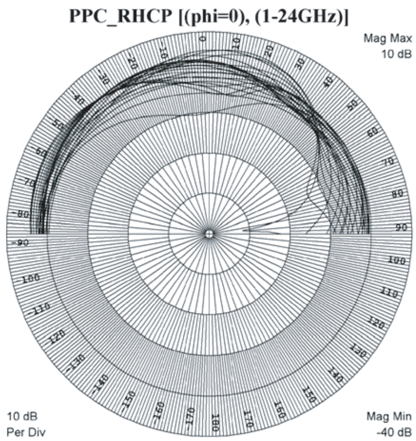

Figure 9. PPC_RHCP in $\phi = 0°$.

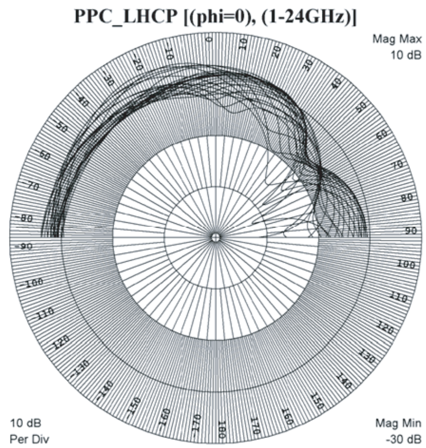

Figure 10. PPC_LHCP in $\phi = 0°$.

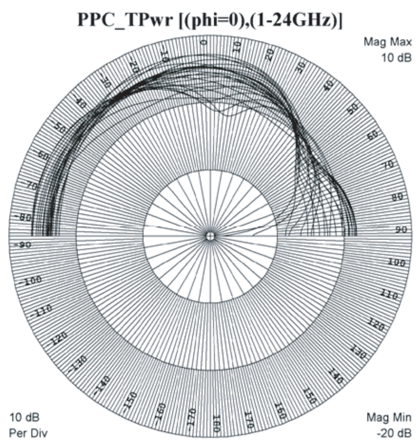

Figure 11. PPC_TPWR in $\phi = 0°$.

4. CONCLUSION

A novel fractal microstrip antenna with multiband and broadband characteristics has been successfully demonstrated. Multiband characteristics of proposed antenna are also observed. The antenna is compact, simple to design and easy to fabricate. A significant gain improvement is achieved.

REFERENCES

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