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A Novel Semi-Fractal Shaped Antenna for UWB Applications

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Abstract

In this paper, we propose a semi fractal shapedmicrostrip-fed monopole antenna for UWB applications. The proposed antenna has a main circular ring with four smaller rings inside the main one as the radiating patch. The ground plane of the antenna that is printed on the other side of the substrate, is in the shape of half an ellipse. The antenna size is 15×18×0.8mm^{3}and operates over the UWB frequency range. Good Agreement is seen between the simulated and measured results. Antenna design and discussion about its performance will be presented in the paper.

Keywords: UWB antenna, microstrip-fed monopole antenna, semi-fractal shaped antenna.

INTRODUCTION

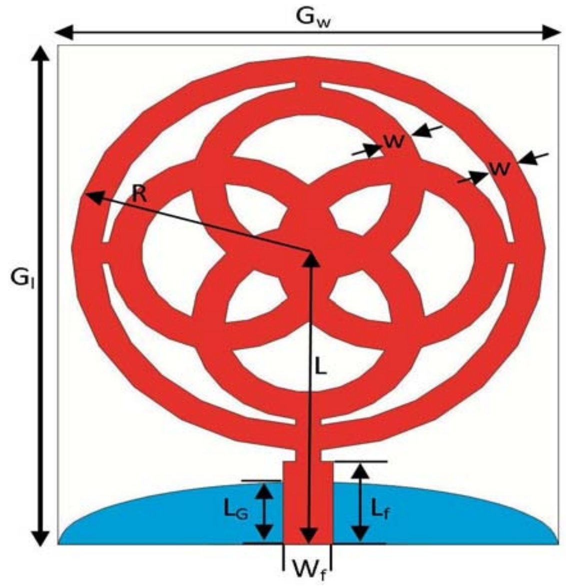
Recently, UWB technology has subjected to significant changesandhas improved greatly. Thus, the need for novel antennas with excellent characteristics has grown. Many antennas with different structures are presented for UWB applications, for example in [1],a ring shaped monopole antenna is presented for UWB applications. In [2], a novel butterfly-shaped monopole antenna is proposed that can operate over the UWB bandwidth. In [3], a novel CPW-fed circular patch antenna with tapered structure is introduced to be used in UWB systems. Among the presentedantennas, a fractal antenna with interesting structures and characteristics has become very popular. The fractal concept is used in [4] to design a T-shaped UWB antenna. Another multiband fractal antenna consisting of semicircles is presented in [5]. In [6] the authors present a miniaturized UWB monopole Microstrip antenna that combines Giusepe Peano and Sierpinski fractals. In this paper, we propose a novel microstrip-fed semi fractal antenna.

The antenna structure includes a main circular ring radiating patch in which four other circular rings are embedded. The antenna ground plane is in the shape of half of an ellipse that is printed on the back side of the FR4 substrate. The proposed antenna with the size of 15×18×0.8mm³ operates over the UWB frequency range. The antenna has smaller size respect to many of the recently published antennas.Materials and methods, results and discussion and finally the conclusion of the paper will be presented in the following sections.

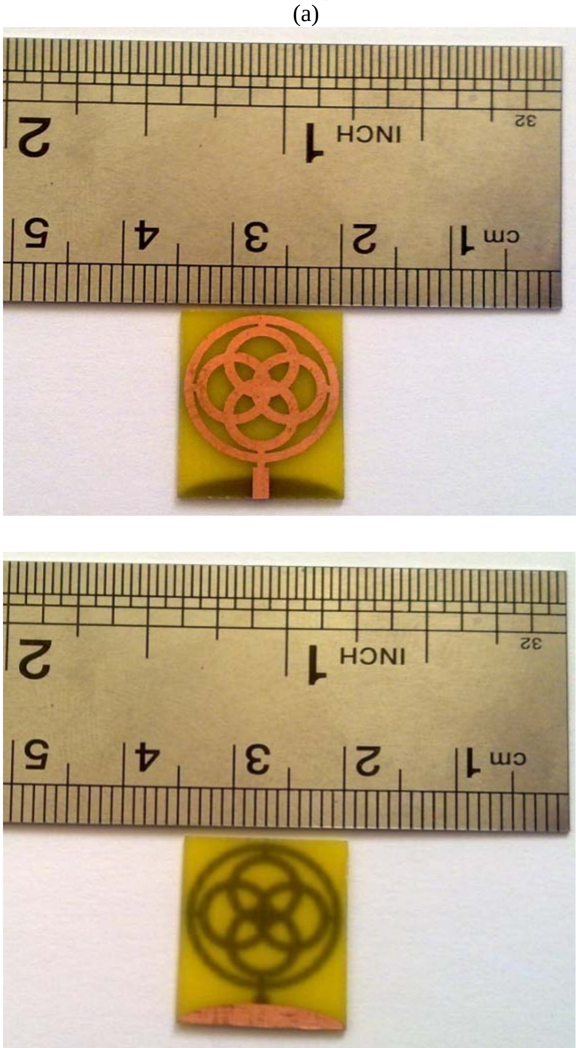
MATERIALS AND METHODS

The configuration and geometry of the proposed semi fractal antenna is shown in Fig.1. The antenna is printed on a FR4 substrate with thickness of 0.8mm and loss tangent of 0.022. 50 Ω microstrip feed line with the length and width of L_f and W_f respectively, feed the antenna structure. The radiating patch of the antenna consists of a main circular ring with four rings in the main one. The ground plane of the antenna which is half of an ellipse, with bigger and smaller diameter of 15mm and 4.5mm respectively, is printed on the other side of FR4 substrate. The optimized antenna values are as follows:

G_W = 15 mm, G_l=18 mm, L_G = 2.25 mm, R = 7.25 mm, L = 10.5 mm, L_f = 3mm, W_f = 1.5 mm, W = 1 mm.



(a)



(b)

Fig.1. The Geometry of the proposed antenna:(a) dimensions of the proposed antenna:(b) photograph of the proposed antenna(front and back).

RESULTS AND DISCUSSIONS

The parameter "w"

It was mentioned earlier that a semi-fractal antenna is presented in this paper for UWB applications.To show the effect of antenna parameters variations on its performance, parametric study is carried out. "w" is the parameter that is studied in this section. Three values of 0.5mm, 0.75mm and 1mm are selected for this parameter and simulated S_{11} curves are obtained for them. The simulation results in Fig. 2, show that by increasing of the w from 0.5mm to 1mm, the impedance matching at the frequency range of 5 to 8 GHz has improved and the bandwidth is enhanced. As it is seen from Fig.2,the widest bandwidth is achieved when w=1mm. By fixing the parameter at 1mm, the UWB frequency range of 3.1-10.6GHz is covered.

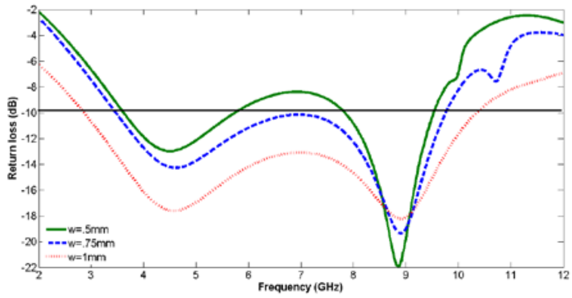


Fig.2. S_{11} curves for different values of w.

The parameter "L_G"

L_G is the other parameter that is investigated. This parameters is very influential in the antenna performance. Fig.3 shows simulated S_{11} curves for four values of this parameter. From simulation results, it is seen that by increasing of L_G, the impedance matching has improved significantly and the bandwidth is enhanced. By having L_G equal to 2.25mm, the best performance is obtained for the antenna.

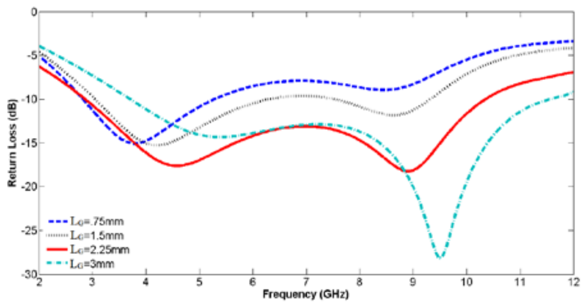


Fig.3. Simulated S_{11} curves for different values of L_G.

The antenna with the optimized values,has been fabricated and tested. Simulated return loss curves are shown in Fig 4. It is seen that suitable agreement is obtained between the results. Also,the gain of the antenna is measured and shown in Fig.5. Over the UWB frequency range, the antenna gain is increased as the frequency increases. Acceptable gain is obtained for the proposed antenna.

Antenna radiation patterns at the frequencies of 4.5 GHz, 6GHz, 8 GHz and 9 GHz are measured at E and H planes and are plotted in Fig.6.It is seen that omnidirectional pattern and low level cross polarization is achieved for the antenna that is good for UWB systems and applications.

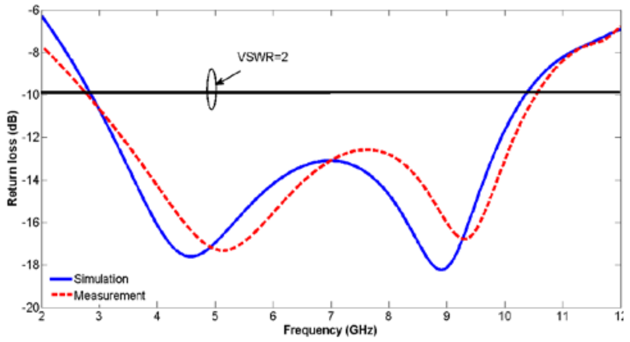


Fig.4. Simulated and measured S_{11} curves.

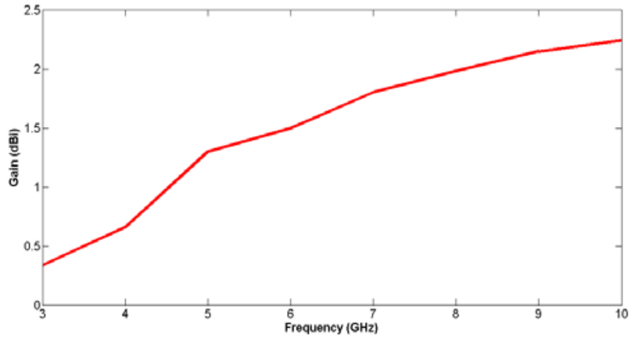


Fig.5. Measured gain of the proposed antenna

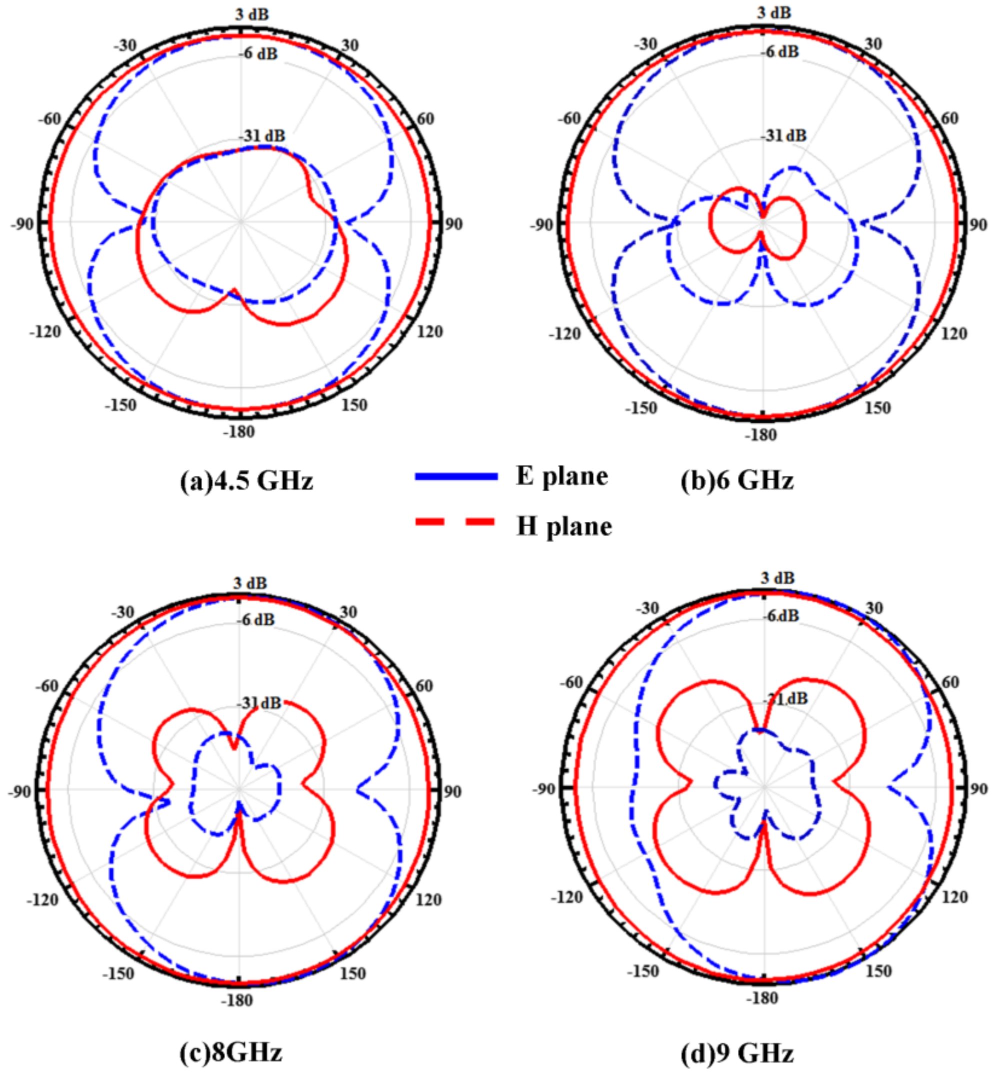


Fig.6. Measured radiation patterns of the proposed antenna at (a) 4.5GHz, (b) 6GHz, (c) 8GHz and (d) 9GHz.

CONCLUSION

A novel semi-fractal shaped antenna is presented in this paper for UWB applications. The radiating patch of the antenna is a main circular ring with four rings inside it. The half ellipse ground plane is on the other side of the FR4 substrate. The antenna with the size of 15×18×0.8 mm^3,operates over the UWB frequency range. Simulated and measured results are in good agreement. Nearly constant gain, omnidirectional patterns and simple structure cause the antenna to be good for UWB applications.

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