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MODIFIED MULTIBAND SIERPINSKI GASKET MONOPOLE ANTENNAS

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1. Introduction

The Sierpinski triangle and carpet gasket monopole and dipole antennas have been intensively studied to achieve multi-frequency operating band in [1] – [3]. The triangle gasket shows multiband but the carpet gasket does not show multiband. In [4] and [5], instead of the triangle shape of apertures, simplified or modified horizontal slots have been applied to the Sierpinski monopole and conical monopole antennas. The results show that the modified gap structure monopole and 3-dimensional gap structure conical monopole antennas exhibits improved operating band characteristics.

In this paper, we present printed modified Sierpinski triangle and carpet monopole antennas. To reduce the overall size of the Sierpinski gasket antenna, the ground plane is printed on the backside of the substrate. The Sierpinski triangle gasket is made and compared with the modified Sierpinski triangle and carpet or truncated triangle gasket monopole antennas.

2. The Sierpinski gasket monopole antennas

Modified Sierpinski triangle and truncated triangle gasket monopoles are made and compared with a conventional triangle gasket monopole. First, the Sierpinski triangle gasket monopole antenna with iteration 4 is printed on a 31-mil thickness Rogers RT/Duroid 5880 ($\epsilon_r = 2.2$). The antenna is fed by a 50 Ω microstrip line (4.4mm) and ground plane is at the behind of the microstrip line. The heights of the triangles are 6.5, 12, 23, and 44mm. Then the triangle apertures in the gasket are simplified into three different lengths of horizontal slots as in Figure 1 (b). Finally instead of the triangle gasket, the triangle gasket is truncated and fed by a microstrip line at the one of the four corners as in Figure 1 (c). To obtain a multi-frequency operating band, the Sierpinski carpet monopole is tried in [6]. It doesn't show multiband characteristics but it shows broadband antenna characteristics. The modified truncated triangle gasket design in Figure 1 (c), however shows multiband characteristics as the antennas in Figure 1(a) and

(b). Not only the multiband characteristics but also it has the smallest size among the three antennas in Figure 1.

All antennas in the Figure 1 are fabricated and measured at the SIUC Antennas and Propagations Laboratory.

3. Results

Measured return losses of the three antennas are shown in Figure 2. All three antennas show clearly four frequency bands and good agreement. From the Figure 2, it is evident that the modified triangle gasket and truncated triangle gasket maintain operating band characteristics. The Sierpinski triangle gasket antenna, Figure 1 (a), shows very broad bandwidth. Approximately from 11GHz to 20 GHz, the return loss is below $VSWR < 2$.

Radiation patterns in all four bands of the three antennas are simulated using a Finite Difference Time Domain (FDTD) software CONCERTO from Vector Fields Inc. [7]. Figure 3 shows $\phi = 90^\circ$ at the second, third, and fourth band of the modified truncated triangle gasket antenna (Figure 1 (c)). It can be seen that the patterns are similar among those three bands. The rest of the two antennas also shows similar radiation patterns.

4. Conclusion

Here we have introduced three different Sierpinski fractal monopole antennas to obtain multiband frequency operation. All three antennas use a printed ground plane at the back of the $50\ \Omega$ feed line. As a result, the overall size of the antenna is smaller than that with a large ground plane, which is perpendicular to the antenna.

Simplified triangle and truncated triangle gasket exhibit very similar multiband characteristics with the Sierpinski triangle gasket monopole antenna. Especially the modified truncated triangle gasket monopole antenna has only half of the size compared with the other two antennas. These proposed designs are attractive candidates for array and mobile communication applications.

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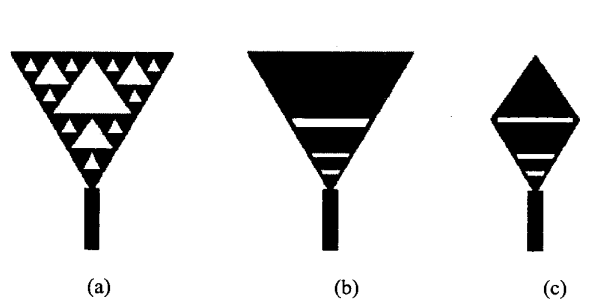


Figure 1. Sierpinski monopole antennas. (a) Sierpinski triangle gasket, (b) modified triangle gasket, and (c) truncated version of modified triangle gasket.

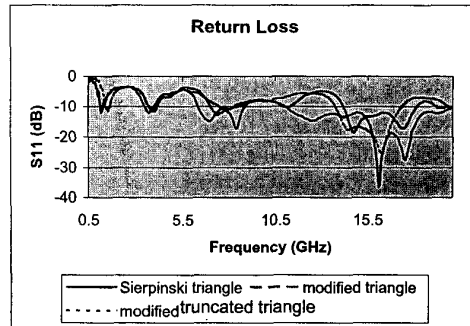


Figure 2. Return losses of the three Sierpinski monopole antennas.

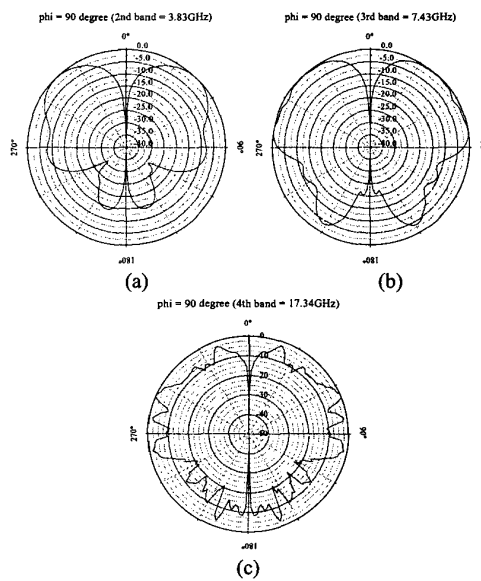


Figure 3. Radiation pattern of the modified truncated triangle gasket monopole antenna with $\phi = 90^\circ$. (a) 2nd band = 3.83GHz, (b) 3rd band = 7.43GHz, and (c) 4th band = 17.34GHz.