CPW-FED KOCH FRACTAL SLOT ANTENNA FOR UWB APPLICATION

Hai-Yang Xu
Missile Institute of Airforce Engineering University, Sanyuan, Shaanxi Province 713800, China;
Corresponding author: xuhaiyang.8888@163.com

Hou Zhang
Missile Institute of Airforce Engineering University, Sanyuan, Shaanxi Province 713800, China;
E-mail: warmer88@163.com

Bo Tian
Missile Institute of Airforce Engineering University, Sanyuan, Shaanxi Province 713800, China;
E-mail: tianbo0216@163.com

Xian-Feng Zeng
Missile Institute of Airforce Engineering University, Sanyuan, Shaanxi Province 713800, China;
E-mail: zengxianfeng521@163.com

Abstract: A novel printed ultra-wideband (UWB) CPW-fed 3-iteration Koch fractal slot antenna is proposed. The UWB bandwidth is largely enhanced by the three-iteration Koch fractal slot whose extrusive angle is 90° instead of 60° to obtain better convoluted shape and self-similarity. The measured -10 dB return loss bandwidth is from 1.26 to 1.66 GHz. The lower cut frequency is achieved with higher iterations to keep the total volume invariable. The in-band measured gain varies from 3.6 to 5.7 dB. The measured radiation patterns at E and H planes are stable and symmetrical.

1. INTRODUCTION
Owing to the progress in wireless communication systems and the increase in their applications, the ultra-wideband (UWB) antenna has become a key component in developing the UWB technique [1]. The coplanar waveguide (CPW) -fed printed slot antennas have the simplest structure of a single metallic layer [2-5]. It can be easily integrated with monolithic microwave integrated circuits. Some attempts have been made to enhance the bandwidth among various slot antennas, including the use of taper CPW [2], loaded strips [3] and inset L-strip tuning stub [4]. Reference [5] used a widened tuning stub to enhance the bandwidth of the square slot antenna to 60% bandwidth. In this Letter, a promising bandwidth-enhancement technique is applied in the CPW-fed slot antenna in [5]. It is known that fractal antennas, due to the property of self-similarity and the ability of filling the space, have the self-loaded characteristic to allow for smaller, multi-band and broadband antenna design [6-8]. The modified Koch fractal is applied in the slot of the proposed antenna. The slot is achieved by three Koch iterations. And then through adjusting the gap between the tuning stub and the ground plane, the impedance bandwidth can be enhanced largely.

2. ANTENNA DESIGN AND PERFORMANCE
The geometry of the proposed three-iteration Koch antenna is shown in Fig.1. The antenna is printed on the FR-4 substrate with the thickness of \( h = 1.6 \) mm and relative permittivity of \( \varepsilon_r = 4.6 \). The ground is chosen to be square, whose side length is \( G = 72 \) mm. The antenna is fed by a 50 \( \Omega \) CPW feed line, which has a metal strip of width \( w_f = 6.37 \) mm and a gap of distance \( g = 0.5 \) mm A
widened tuning stub of length $L_3=22.5$ mm and width $w=36$ mm is connected to the end of the CPW feed line. The spacing between the tuning stub and edge of the ground plane is $S=1.4$ mm. The Koch fractal slot of the proposed antenna is achieved by 3 iterations based on the square slot of $L=44$ mm.

Figure 1 Geometry of the proposed three-iteration Koch antenna

Fig. 2 gives the geometry of square slot and modified Koch slots with different iterations. The extrusive angle of fractal is $90^\circ$ instead of $60^\circ$ so as to obtain better convoluted shape in the slot and better self similarity in the corners. This fractal technique can also be expected to apply other antennas with square or rectangular slots to enhance the impedance bandwidth.

Figure 2 Geometries of the square slot and the Koch slots for different iterations
Fig. 3 shows the measured return loss of the slot antenna with square slot or Koch fractal slot of different iterations. The gap between the tuning stub and the ground plane has been adjusted with different slot. It is shown that the Koch fractal in the slot can largely enhance the impedance matching and bandwidth. It is also seen that higher iterated fractal slot makes the cut frequency lower while the volume of the antenna doesn’t increase at all. The -10 dB return loss bandwidth of the three-iteration Koch fractal antenna is from 1.26 to 1.66 GHz, while that of the reference antenna is only from 1.62 to 2.92 GHz.

![Figure 3](image)

Figure 3 Measured return loss against frequency of antenna with square slot or Koch fractal slot of different iterations

Fig. 4 is the measured co-polarized far-field radiation patterns of the proposed antenna at E and H planes at different frequencies. The radiation patterns keep relatively symmetrical and stable at both planes in the whole operating frequency band. Note that the deterioration at both E and H planes of 4.5 GHz, which is mainly due to the asymmetric slot with respect to the x-axis.

![Figure 4](image)

Figure 4 Measured co-polarized far-field radiation patterns at E and H planes of various frequencies: a E plane, b H plane

Fig. 5 is the gain of the fractal slot antenna from 3.6 to 5.7 dB, resulting in the maximum gain variation of 2.1 dB over the entire UWB frequency band.
3. CONCLUSION
A novel CPW-fed Koch fractal slot antenna has been proposed and investigated. The application of the Koch fractal slot enhances the impedance bandwidth obviously. This design is a breakthrough in expand the bandwidth of the slot antenna and can be directly applied to UWB communications.

REFERENCES