# A Compact CPW-Fed Planar Printed Antenna with Modified Ground Structure for Super-Wideband Applications

*Lei Chang, Jian-qiang Zhang, Ming-fang Zhang, Jiang-sheng Zhou, and Yu-feng Wang*

No. 36 Research Institute of CETC, Jiaxing, Zhejiang 314033, China
yutian_1986@163.com

## Abstract

A compact super-wideband antenna which is asymmetrically fed by a coplanar waveguide (CPW) line is investigated in this paper. The proposed antenna is composed of a rectangular patch and a modified ground plane. The ground plane with an L-shaped structure and a notch helps to improve the impedance match performance. The simulated result shows that the antenna has two frequency bands covering 2.07-2.22 GHz and 3.5-50 GHz with VSWR < 2. The antenna radiation pattern is nearly omni-directional over the whole operating band. Details of the antenna design and results are presented.

## 1. Introduction

Ultra-wideband (UWB) systems have been expanding at a stupendous rate since the Federal Communication Commission (FCC) of the United States allocated the spectrum 3.1-10.6 GHz for commercial use. However, current telecommunication systems require antennas with wider bandwidths. Antennas with a ratio bandwidth equal or greater than to 10:1 called super-wideband (SWB) antennas are presented in the open literature [1-9]. SWB technology is becoming more and more attractive to many wireless systems due to larger channel capacity.

To achieve a SWB characteristic, a corner-rounded ground plane, a tapered microstrip feeder and a modified radiating patch were applied in [1, 2]. These proposed antennas are suitable to operate within frequencies of 0.64 GHz to more than 16 GHz and 0.705 GHz to 25 GHz, respectively, their dimensions are 150 × 156.3 mm$^2$ and 150 × 150 mm$^2$. A planar circular asymmetrical dipole antenna with a dimension of 90 × 135 mm$^2$ was proposed to operate from 0.79 to 17.46 GHz [3]. A compact SWB antenna was presented in [4], and the size was 74 × 80 mm$^2$. The impedance bandwidth was enhanced by introducing an asymmetric dual-branch feed with an L-shaped feed branch, which was from 1.05 to 32.7 GHz.

The fractal technology has shown as an effective method for designing SWB antennas [5-8]. In [5], a semi-elliptically fractal-complementary slot was used into the asymmetrical ground plane, and a frequency band ranging from 1.44 GHz to 18.8 GHz was achieved. A SWB fractal antenna based on an iterative octagon with dimensions 60 × 60 mm$^2$ was proposed in [6]. The entire operating band of the proposed antenna was from 10 GHz to 50 GHz. In [7], by applying a circular-hexagonal fractal structure, an antenna achieved a bandwidth from 2.18 GHz to 44.5 GHz. The overall size of the proposed antenna was 31 × 45 mm$^2$. A modified star-triangular fractal SWR monopole antenna was proposed in [8].

In [9], a CPW-fed SWB printed monopole antenna was proposed to operate from 2.76 GHz to 40 GHz by using a trident shaped feed line structure. The CPW feeding has many attractive features, such as low dispersion and no soldering points.

In this paper, a novel CPW-fed compact printed antenna with good impedance matching characteristics is proposed. By applying an L-shaped structure and a notch into the ground plane, the proposed antenna is able to achieve two operating bands of 2.07-2.22 GHz and 3.5-50 GHz. The design and effects of the modified ground plane will be discussed in detail. Radiation patterns at different frequencies, and the gain across the operating bandwidth are studied.

## 2. Antenna Design

The configuration of the proposed antenna is illustrated in Fig. 1. The antenna is fabricated on a Rogers RT/duroid 5880 substrate with dimensions 40.45 × 21 mm$^2$ ($W_g \times L_g$), thickness 0.508 mm, relative permittivity $\varepsilon_r = 2.2$ and loss tangent 0.0009. The antenna is fed by a CPW line which has a width $W_m$ = 1.25 mm, and separated from the coplanar ground plane with a gap $G_1$ = 0.2 mm. The CPW is necessary for feeding the antenna with a 2.4-mm coaxial adaptor capable of working from dc to 50 GHz. The radiating patch has a compact size with width $W_p$ = 16.75 mm,

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length $L_p$ = 9 mm and chamfered radius $R_2$ = 1 mm. The feed gap is $G_2$ = 0.3 mm. The rectangular section of the ground plane has dimensions 10 × 11 mm ($L_1 \times L_2$). The distance between the CPW and the notch is $L_3$ = 5.8 mm and the radius of the semicircular notch is $R_1$ = 5.6 mm. The notch can be used to adjust the impedance matching. Furthermore, the size of stub ($L_5 \times L_6$) can also improve the bandwidth. The optimal dimensions are as follows: $L_4$ = 4 mm, $L_5$ = 11 mm, $L_6$ = 4 mm.

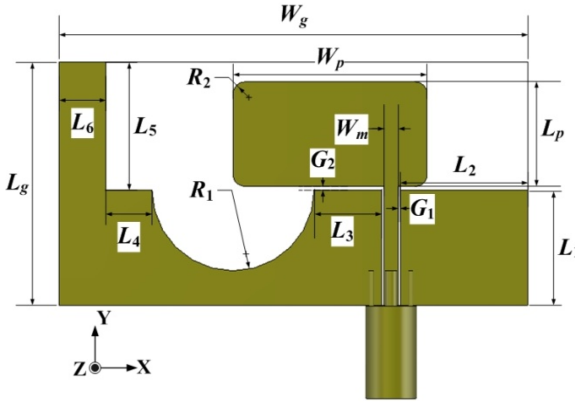



**Fig. 1. Geometry of the proposed antenna**

## 3. Results and Discussions

The performance of the proposed antenna has been analyzed and optimized based on full-wave electromagnetic simulation software based on FITD. The semicircular notch and rectangular stub on the asymmetric ground plane have an effect on impedance matching. From Fig. 2, it is observed that the impedance bandwidth is decreased without the notch or stub. The semicircular notch on the ground plane can increase the bandwidth significantly, especially reducing the VSWR at frequency bands 2.07-2.22 GHz and 12.27-14.9 GHz. The effect of the rectangular stub is also very remarkable, which reduces the VSWR dramatically in the frequency band 5-7 GHz.

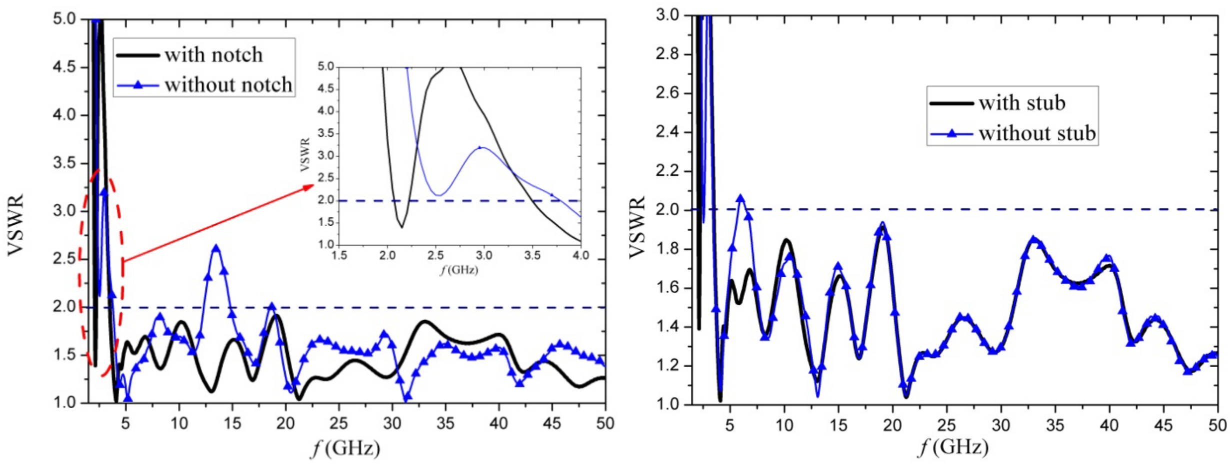
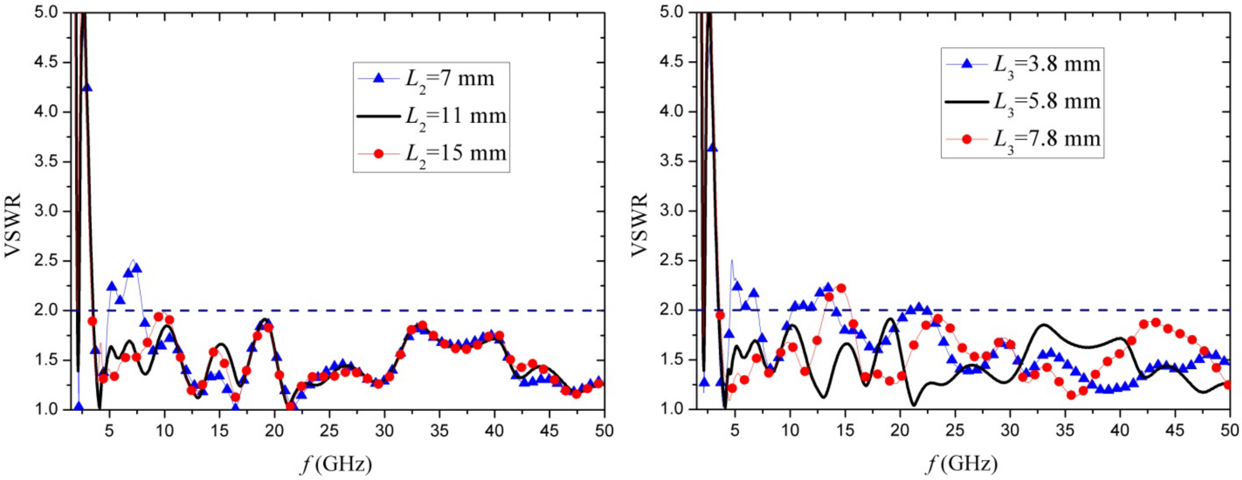



**Fig. 2. Simulated VSWR: (a) with and without semicircular notch, (b) with and without rectangular stub**

The width $L_2$ and distance $L_3$ also have effects on the operating bandwidth. First, we investigate VSWR by varying $L_2$. Fig. 3(a) is the simulated VSWR with and varying $L_2$ from 7, 11, and 15 mm, respectively. By increasing $L_2$, the operating band of 2.07-2.22 GHz is gone. It is also observed that the VSWR at 4.89-8 GHz gets worse when $L_2$ is decreased. Fig. 3(b) gives the VSWR curves with different values of $L_3$. It can be seen that the impedance bandwidth is dramatically affected by $L_3$. The optimized simulated result for VSWR is shown in Fig. 4. The operating bandwidths (VSWR < 2) cover 2.07-2.22 GHz and 3.5-50 GHz.

The peak gain of the SWB antenna from 4 to 50 GHz is shown in Fig. 5, and varies between 2.93-8.9 dBi. The radiation characteristics of the proposed antenna are also studied. Fig. 6 shows the radiation patterns for six different frequencies 4, 10, 20, 30, 40, and 50 GHz. The antenna exhibits a nearly omni-directional radiation over the entire frequency band.




(a) (b)

**Fig. 3. Simulated VSWR: (a) with varies $L_2$ of 7, 11, and 15 mm; (b) with varies $L_3$ of 3.8, 5.8, and 7.8 mm**

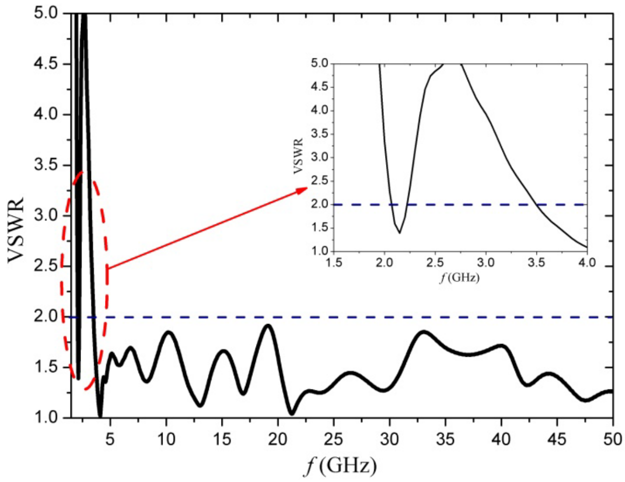



**Fig. 4. Simulated VSWR of the proposed antenna**

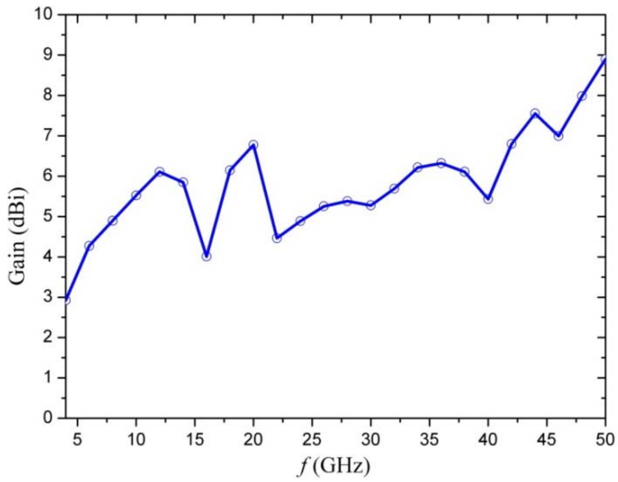
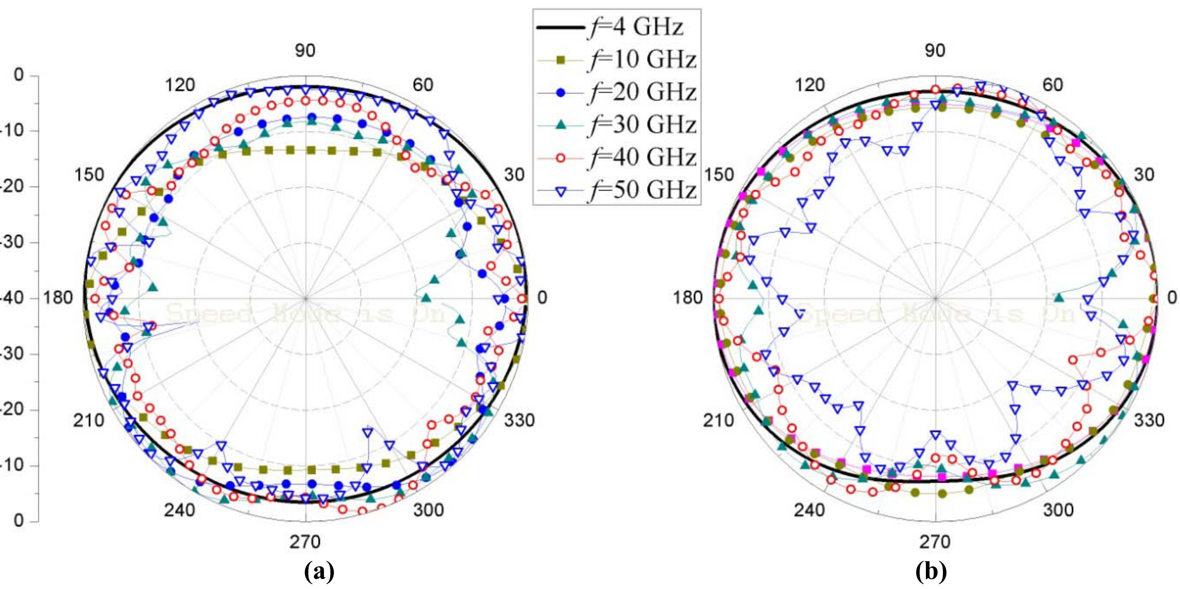



**Fig. 5. Simulated peak gain of the proposed antenna**




(a) (b)

**Fig. 6. Simulated radiation patterns at 4, 10, 20, 30, 40, and 50 GHz: (a) *xz*-plane, (b) *yz*-plane**

## 4. Conclusion

A new compact SWB printed CPW antenna, connected by a 2.4-mm coaxial adaptor capable, is successfully implemented with good impedance matching characteristic. The entire size of the proposed antenna is only 40.45 × 21 $mm^2$. The 2:1 VSWR bandwidths are from 2.07 to 2.22 GHz and from 3.5 to 50 GHz. Besides, the antenna exhibits a good and stable radiation performance across the whole band. The proposed antenna is suitable in many wireless systems.

## 5. References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