A method of elimination of undesired resonant points of microstrip antenna by cutting U-shaped slot on the ground

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Abstract: A method is proposed to eliminate undesired resonant points of a dual-layer circular polarization microstrip antenna, the frequency of which is 2.42 GHz. The simulation results show that there are two undesired resonant points, the frequencies of which are both greater than the resonant frequency. One is around 4.4 GHz, while the other is around 5.8 GHz. As they would disturb the proper functioning of the antenna, the paper will eliminate the undesired resonant points by cutting *U*-shaped slots on the ground. Size of the slot is half of the wavelength of corresponding frequency point if slot is cut on the patch, while it is a quarter of the wavelength if there is a opening port on the slot. The simulation results show that it's effective to eliminate the undesired resonant points in this way.

Key words: resonant points; microstrip antenna; *U*-shaped slot; simulation

CLD number: TP820.1$^+$1 **Document code:** A
Article ID: 1674-8042(2014)02-0080-03 **doi:** 10.3969/j.issn.1674-8042.2014.02.016

0 Introduction

With development of the microstrip antenna, circular polarization microstrip antenna has been wildly used because of the advantages of low profile[1], conformal, easy integration and low cost, etc..

In the Ref.[2], the author uses square patch and realizes circular polarization characteristics with cross slot, and axial ratio bandwidth of the circular polarization is 1.4%. In the Ref.[3], while perturbation method is used, the patch with corner cut realizes the circular polarization characteristics, and axial ratio bandwidth of the circular polarization is 1%. Here we design a dual-layer circular polarization microstrip antenna by cutting a rectangular aperture on the patch, but the antenna has some resonant points undesired. So we should eliminate these undesired resonant points by slotting on the ground[4,5].

1 Structure of designed antenna

The structure of designed antenna is shown in Fig.1. It's microstrip antenna of two layers medium. The purpose of cutting a rectangular aperture of 45°is to form a circular polarized wave. And sizes of the antenna are as follows: $l_1 = 89.23$ mm, $w_1 = 89.23$ mm, $l_2 = 20.87$ mm, $l_3 = 14.6$ mm, $w_2 = 4.84$ mm, $l_4 = 19.8$ mm, $w_3 = 1.8$ mm, $\theta = 45°$, $h_1 = 1.6$ mm, $h_2 = 1.87$ mm.

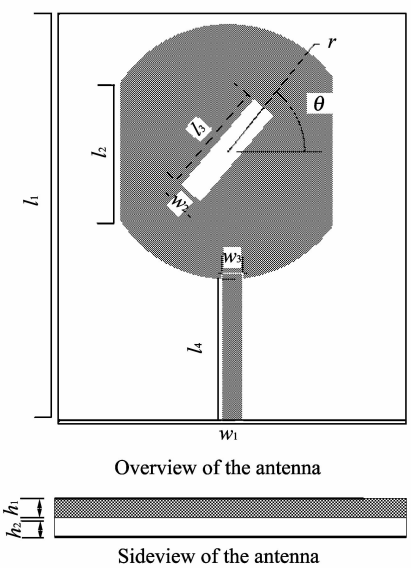

Fig.1 Structure of designed antenna

Based on the design, we use the electromagnetic simulation software to build up the antenna model and simulate. The simulation results are shown in Fig.2.

From Fig.2, we know that the frequency of the resonant point is 2.42 GHz. However, there are two undesired resonant points, the frequencies of which are both greater than the resonant frequency. One is around 4.4 GHz, the other is around 5.8 GHz.

Slotting with an appropriate size on the ground

* **Received date:** 2013-11-25
Foundation item: Qingdao Basic Research of Science and Technology Plan Projects (No. 13-1-4-132-jch)
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can generate high impedance at the corresponding frequency point. In the way, the conduction and radiation of the corresponding frequency wave can be suppressed, and the same way applies to the corresponding frequency. Thus, we eliminate the undesired resonant points by slotting on the ground.

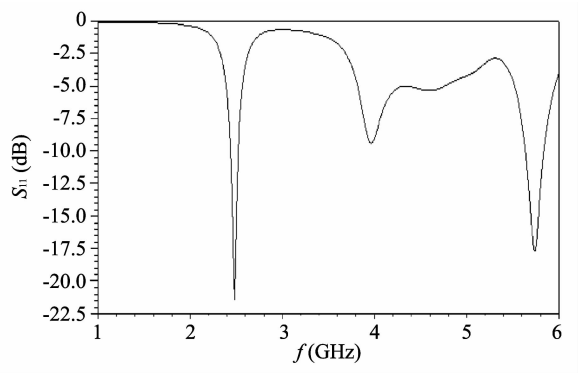

Fig. 2 S_{11} of the antenna

2 Elimination of resonant frequency point of 5.8 GHz

In order to eliminate the resonant frequency point of 5.8 GHz, we open a U_1-shaped slot on the ground of the antenna. Shape of the slot is shown in Figs. 3 – 4.

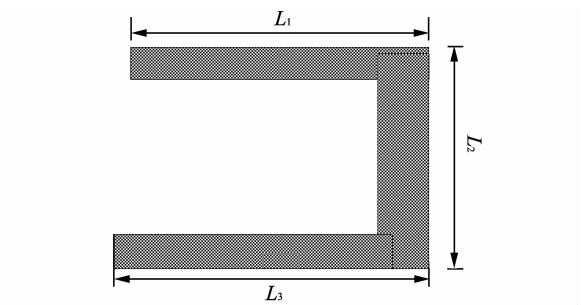

Fig. 3 Diagram of U_1-shaped slot on the ground

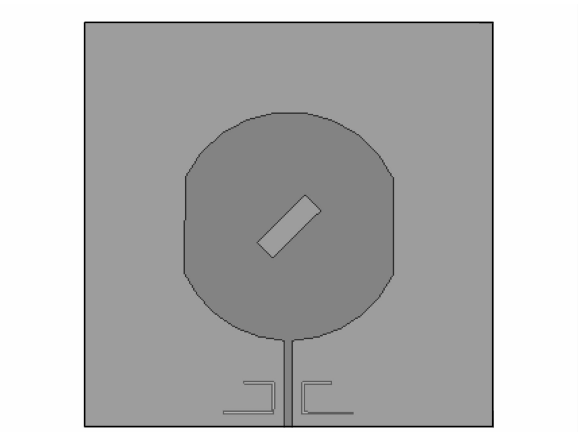

Fig. 4 Diagram of slot on the ground of antenna

From the above analysis we know that the length of the U_1-shaped slot is half of the wavelength of corresponding frequency point of 5.8 GHz, so $L = L_1 + L_2 + L_3 = 25$ mm.

Based on the above design we use the electromagnetic simulation software to build up the antenna model and simulate. The simulation results are shown in Fig. 5.

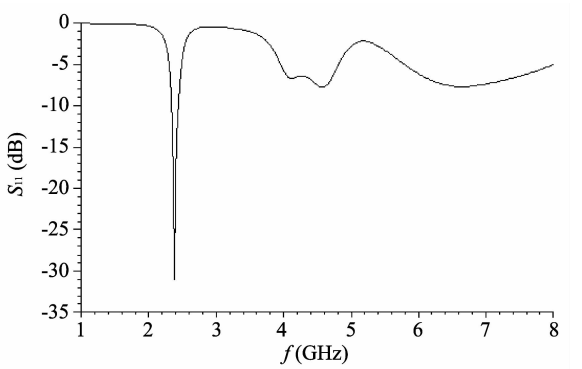

Fig. 5 S_{11} inhibition of 5.8 GHz

From Fig. 5 we know that the resonant point of 5.8 GHz can be inhibited greatest when $L = 25$ mm. The result of simulation is illustrated above. As shown in the Fig. 5, the resonant depth at 5.8 GHz can be inhibited to −5 dB. So we eliminate the resonant frequency point of 5.8 GHz by cutting a U_1-shaped slot on the ground.

3 Elimination of resonant frequency point of 4.4 GHz

Similarly, in order to eliminate the resonant frequency point of 4.4 GHz, we open a U_2-shaped slot shown in Fig. 6 on the ground of the antenna.

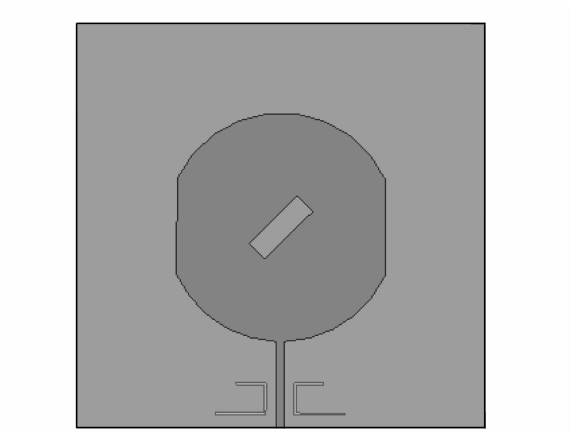

Fig. 6 Diagram of U_2-shaped slot on the ground

In the same way, length of the U_2-shaped slot is half of the wavelength of corresponding frequency

point of 4.4 GHz, so $L' = L_4 + L_5 + L_6 = 37$ mm, and the simulation results are shown in Fig. 7.

From the results we know that the resonant depth at 4.4 GHz can be inhibited to −7 dB. So the U_2-shaped slot opened on the ground can eliminate resonant frequency point of 4.4 GHz effectively.

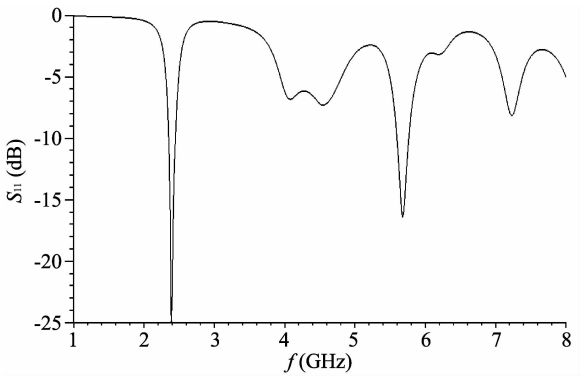

Fig. 7 S_{11} inhibition of 4.4 GHz

4 Conclusion

In this paper, we propose a method to eliminate undesired resonant points of designed microstrip antenna by cutting U- shaped slots on the ground. In the way S_{11} of 4.4 GHz and 5.8 GHz are both greater than −10 dB, so the undesired resonant frequency points of 4.4 GHz and 5.8 GHz can be eliminated effectively.

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一种在接地板开 U 型缝消除微带天线杂谐振点的方法

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摘 要: 本文提出一种消除微带天线杂谐振点的方法, 该微带天线为双层介质板, 其谐振频率为 2.4 GHz, 共有两个杂谐振点分别在 4.4 GHz 附近及 5.8 GHz 附近。这两个杂谐振点破坏了微带天线的性能, 故本文通过在接地板上合理地开 U 型缝来消除这两个谐振点, U 型缝隙的长度为相应频率谐振点波长的一半; 如果在缝隙上有开放端口, 则 U 型缝隙长度为相应频率谐振点波长的四分之一。仿真结果表明: 该方法可有效消除杂谐振点。

关键词: 谐振点; 微带天线; U 型缝; 仿真

引用格式: TENG Fei, CHENG Xiu-yang. A method of elimination of undesired resonant points of microstrip antenna by cutting U-shaped slot on the ground. Journal of Measurement Science and Instrumentation, 2014, 5(2): 80-82. [doi: 10.3969/j.issn.1674-8042.2014.02.016]