Research and Design of Planar Ultra-wideband Notch Antenna

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Abstract

Ultra-wideband technology determines the development trend of the future society. As the core technology of ultra-wideband technology, ultra-wideband antennas are the most important structure in the radio system. When it is working, it will generate electromagnetic waves in free space and be converted into radio waves. There are many narrow-band frequency bands in the ultra-wideband frequency range (3.1GHz-10.6GHz). Use possible ways to make the antenna filter out other narrow-band interference in the working frequency band to realize the notch function.

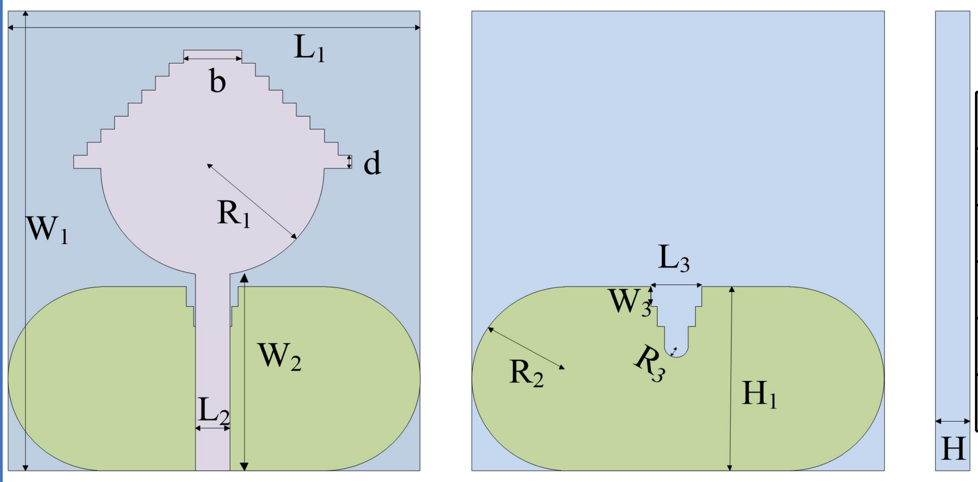
Introduction

This article mainly focuses on the three frequency bands in the UWB (ultra-wideband) range WLAN (Wireless Local Area Networks) frequency band (5.2GHz-5.8GHz), WiMAX (World Interoperability for Microwave Access) frequency band (3.4GHz-3.7GHz) and X frequency band (7.25GHz-7.75GHz) for notch design. And use HFSS software to simulate and verify antenna performance. It uses the slotting method and the method of adding open branches to design the notch function.

Antenna Structure Design

A microstrip patch antenna is designed, the dielectric substrate is FR_4, and load a hat-shaped patch on the dielectric substrate, the brim of the hat is composed of a progressive structure, and then use progressive slotting on the ground plate. Making the four corners of the ground plate smooth to obtain a larger bandwidth and increase the matching degree of the low frequency band. The surface image is shown in Fig.1. Optimized size is shown in TABLE I, Fig.2 is S_{11}, and Fig.3 is VSWR.

The operating frequency range of this antenna is 2.8GHz-11.1GHz, including the ultra-wideband frequency range (3.1GHz-10.6GHz). And the S_{11} are less than -15dB when work in the central frequency band, and the voltage standing wave ratio less than 2 in the ultra-wideband, the antenna performance is good. Fig.4 is the EH plane gain diagram of the antenna center frequency .



Tab.1 Size of the first antenna

Size of the first antenna（mm）					
L_1	30	L_2	1.8	L_3	3
W_1	35	W_2	16.5	W_3	1.15
R_1	7.95	R_2	8	R_3	0.5
H	1	H_1	16	b	2.19
d	1.09				

Fig.1 Surface of the UWB antenna

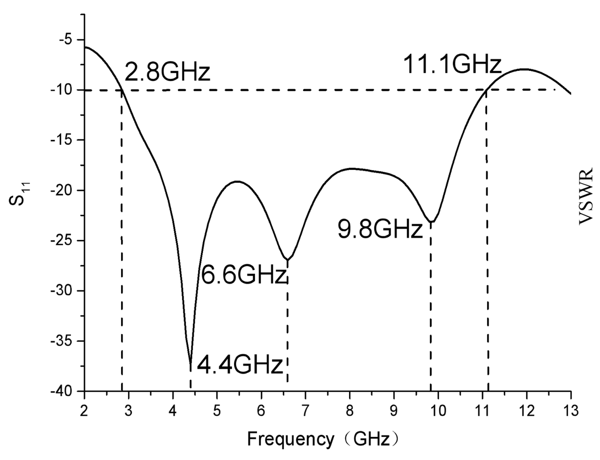


Fig.2 S_{11} after optimize

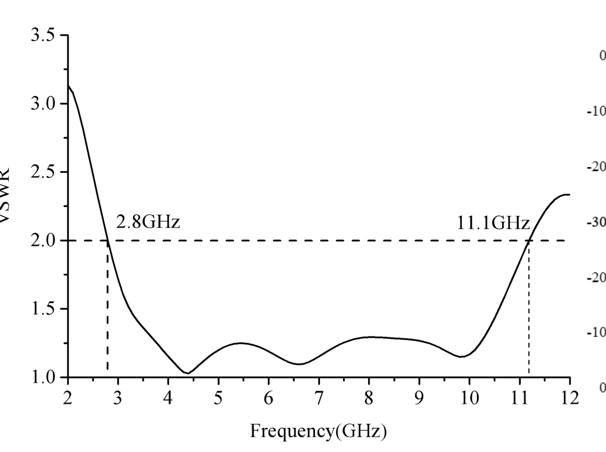


Fig.3 VSWR after optimize

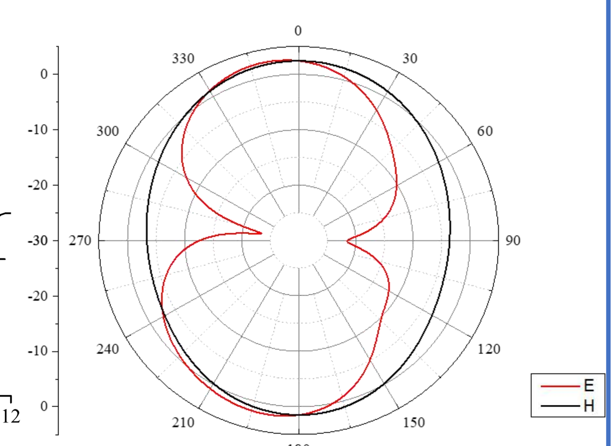


Fig.4 The EH surface gain

Antenna Performance Analysis

The main factors that affect antenna performance are slot position and slot length. The length of the slot can be determined according to the principle of half-wavelength resonance. When the slot length is equal to half of the wavelength calculated by the center frequency of the trap, the circuit will resonate, causing a large amount of current to get near the slot, making the antenna impedance ineffective, and achieving the trap function. The formula for calculating the slot length is the formula 1. Over the years, many scholars have proposed a series of slotting methods for trap function design, such as X-shaped, H-shaped, L-shaped, U-shaped [1-7].

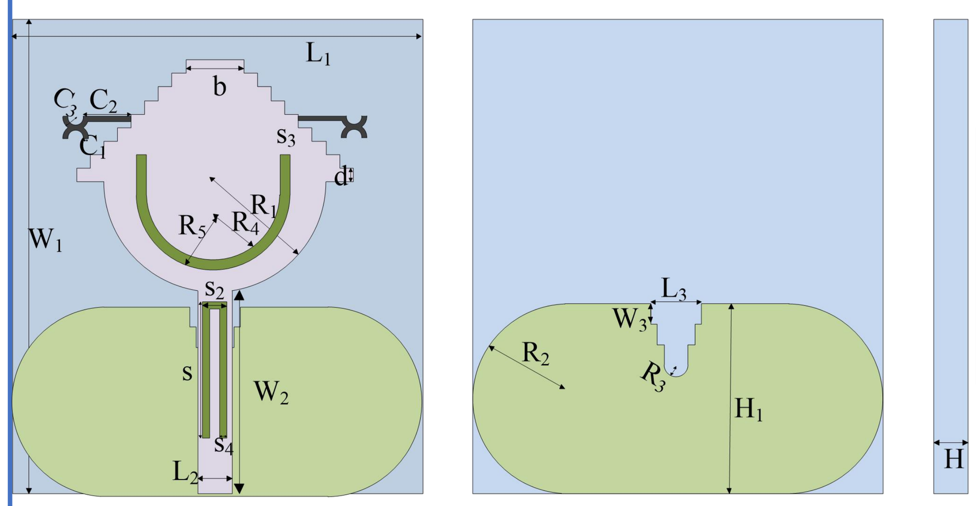
$$L = \frac{c}{f_{notch}\sqrt{2(\varepsilon_r + 1)}}$$

The principle of the trap branch and slotting method is roughly the same, they are all circuit resonance, the formation of impedance's invalidation is to achieve the trap function, the difference is the difference in structure, the trap branch to be integrated in a symmetrical manner on the substrate, and the two sections of the branch require equal length. The branch length is calculated using the following formula 2. In the present study, the shapes of open branch nodes are T, U, C and L shapes [8-10].

$$L = \frac{c}{f_{notch}\sqrt{8(\varepsilon_r + 1)}}$$

This antenna has a notch function in the WLAN frequency band, WiMAX frequency band and X frequency band. A positive U-shaped groove is opened on the patch to filter out the WLAN frequency band, and an inverted U-shaped groove is grooved on the microstrip line to filter out WiMAX frequency band. Filter the X frequency band by adding a combination of X-type and a straight-line branch. In these three frequency bands, S_{11}>-10dB and the voltage standing wave ratio is greater than 2, while in the center frequency band S_{11}<-15dB and the voltage standing wave ratio is less than 2.

In Fig.5 is the surface image of the triple notch antenna.



Tab.2 Size of the second antenna

The size of the second antenna（mm）			
R_4	4.5	R_5	4.6
s	12.3	s_1	2
s_2	0.8	s_3	0.3
s_4	0.3	c_1	0.44
c_2	4.15	c_3	1.05

Fig.5 Surface of the triple notch antenna

Optimized size is shown in TABLE II. Fig.6 is S_{11}. Fig.7 is VSWR.

The first notch frequency band of the second antenna is 3.4GHz-3.9GHz, which covers the WiMAX frequency band (3.4GHz-3.7GHz). The notch function is good, and the voltage standing wave ratio in this frequency band is greater than 2, S_{11}>-10dB.

The second notch frequency band is 5.1GHz-6.0GHz, and it has good performance in the WLAN frequency band (5.15GHz-5.85GHz), S_{11}>-10dB.

The third notch frequency band is 7.1GHz-8.1GHz, covering the X-band downlink frequency (7.25GHz-7.75GHz), which perfectly filters out the X-band wave and the wave center frequency S_{11}>-6dB, the voltage standing wave ratio is greater than 3.

Fig.8 shows the gain diagram of the third antenna EH plane.

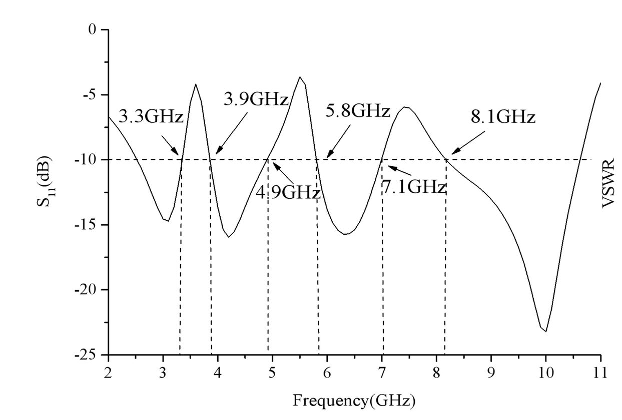


Fig.6 S_{11} after optimize

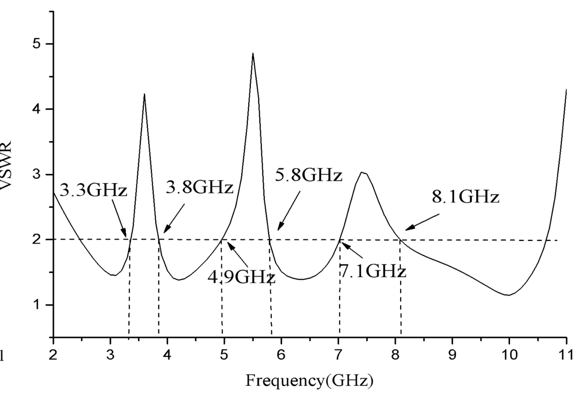


Fig.7 VSWR after optimize

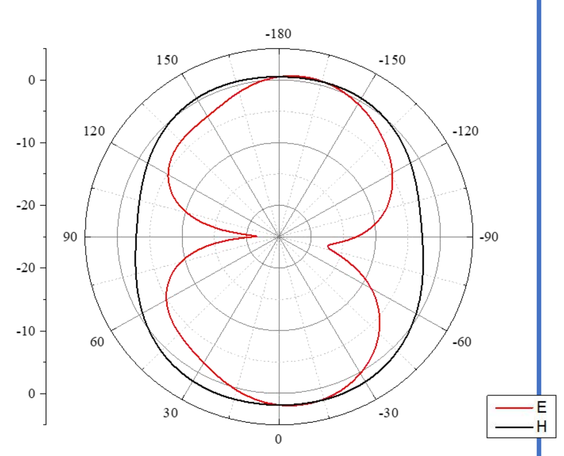


Fig.8 S_{11} The EH surface gain

Conclusion

The shape of the antenna is hat-shaped, and the theory of stepped structure and floor smoothing is used to achieve bandwidth expansion. Utilizing the method of slotting and using open-circuit branches, the three most important bands WLAN (5.1GHz-5.8GHz) (positive U-shaped slot on the patch), WiMAX (3.4GHz-3.7GHz) (open inverted square U-shaped groove on microstrip line) and X-band (7.25GHz-7.75GHz) (a straight line and X-typed open branches above the patch).The antenna in this design meet the actual requirements for antenna performance, and it can trap three frequency bands well and have good performance in work, with simple structure, It can achieve the needs of short-distance communication and communication systems.

UWB technology relies on many advantages and gradually become the foundation of communication technology， such as strong anti-interference ability, fast transmission rate, wide bandwidth, and low power consumption. UWB antenna is the carrier of UWB technology, and its performance determines the development process of ultra-wideband technology.

Acknowledgements

This paper was funded by the International Exchange Program of Harbin Engineering University for Innovation-Oriented Talents Cultivation. This paper was funded by the National Natural Science Foundation of China (61803356).

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